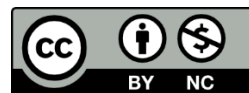


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Tailoring evidence-based local adaptation policies for climate change - an urban case study of Košice

Prispôsobenie miestnych politík adaptácie na zmenu klímy na základe dôkazov - prípadová štúdia mesta Košice

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Abstract: The perceptions of climate change have been studied from various perspectives, with considerable effort being made to identify the factors which contribute to variations in awareness among individuals. Public awareness is a key element when tackling complex issues which require compliance across a wide range of sectors and individuals. Our research focuses on climate change awareness and participation among different socioeconomic groups in the town of Košice, Slovakia. The research is based on a questionnaire survey conducted between 2019 and 2020. The sample of participants was adjusted to reflect the sociodemographic structure of Košice's residents, and four types of respondents were identified using latent class cluster analysis. These groups were found to differ in the degree of vulnerability to adverse conditions caused by climate change. This study sheds light on how different groups of citizens perceive the threat of climate change impacts on their everyday lives and how they act to adapt. The findings can be applied by policymakers at both national and local levels when designing and proposing socially just measures which reflect the needs of all major groups of citizens.

Key words: *Climate change awareness. Urban adaptation policy. Citizen engagement.*

JEL Classification: Q51, Q54.

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Introduction

Urban areas are highly vulnerable to the impacts of climate change, in particular the risk of increased temperatures which are exacerbated by the urban heat island effect and extreme weather events. The impact of climate change on urban areas has become a pressing issue, and are more relevant still with the accelerating pace of urbanisation. In order to effectively adapt to climate change, urban areas must integrate systems science into their adaptation and mitigation strategies (Proust et al., 2012).

An awareness of climate change among urban citizens is crucial for successful urban adaptation. Increased awareness can lead to informed decision-making, behavioural changes, and support for policies and initiatives aimed at reducing greenhouse gas emissions and developing climate resilience.

However, climate change policies must be perceived by local populations as a legitimate means of facing this challenge. Local authorities are crucial actors in tackling the issues related to climate change, and their task is to design adequate measures and ensure support from their constituents. Residents should be actively engaged at all stages of these processes – either by providing initial inputs, commenting on proposed measures or taking part in implementation or monitoring. This case study presents an analysis of the climate change perceptions, adaptation and mitigation activities of the residents of the Slovak city of Košice which could serve as a first step in establishing well-informed communication strategies between authorities and residents.

As the second largest city in Slovakia, Košice serves as an excellent case study for analyzing evidence-based local adaptation policies for climate change due to the combination of its industrial legacy, urban planning challenges and proactive climate initiatives (this aspect will be discussed in more detail in Part 4 of this study). In 2022, Košice launched its first climate change adaptation plan for 2022-2030 which is based on comprehensive vulnerability assessments and outlines specific adaptation goals.

Despite these proactive measures, Košice faces a notable challenge in engaging local residents in political participation, as is apparent in the fact that the city had the lowest voter turnout in municipal elections among eight similar-sized cities in 2022, with only 31% of residents participating compared to an average of 41.2% and a median of 39.3% across the studied cities (Statistical Office of the Slovak Republic, 2022). This context of low civic engagement, coupled with the city's significant climate initiatives, provides a rich ground for

examining the effectiveness and challenges of implementing evidence-based local adaptation policies.

The research paper focus on the attitudes of a diverse range of urban residents towards climate change and their predisposition to take action. The study addresses the following research questions: What are the differences in attitudes towards climate change between various sociodemographic groups of citizens? Additionally, what factors are associated with varying levels of awareness?

The paper examines these issues by means of a quantitative examination using latent class cluster analysis aimed at investigating the typology of residents based on their awareness of climate change.

1. Background

Urbanized areas are especially vulnerable to climate change, as the physical properties of their environment can potentially intensify the impacts of extreme weather conditions. Climate change is widely expected to exert an impact on various urban sectors, such as water management, energy, transportation, telecommunications, healthcare, social services, the built environment and recreational or historical sites (Revi et al., 2014). The specific ways in which climate change manifests itself in individual cities depend on a wide range of factors which affect local micro-climatic conditions. Urban areas are specific in this respect because the original natural structures have typically been replaced by newly installed materials which possess different properties, such as reduced permeability or an increased capacity to accumulate heat (Gill et al., 2007). These changes to the urban environment can result in various micro-climatic phenomena, one of which is the formation of urban heat islands (UHI), an urbanized area that differs from its rural surroundings in terms of its higher temperature. This phenomenon has also been identified in Košice, with higher temperatures being recorded in areas with impermeable surfaces and a lack of green spaces or water (Hofierka et al., 2020; Onáčillová & Gallay, 2018).

Hot and dry environments in cities can have a detrimental effect on human health, urban nature and economic activity. For example, the European heatwave of 2003 led to 70,000 reported heat-related deaths across the continent (Robine et al., 2008) and 100,000 estimated lost life-years in France alone (Keller, 2015). The impact of climate change on the health of urban residents was shown to vary among different groups of citizens. There is unambiguous evidence of higher heat-related mortality among the elderly, particularly those suffering from cardiovascular, respiratory or renal diseases and citizens with mental health issues (European

Environment Agency, 2020a). Women appear to be more vulnerable than men as they form a greater proportion of the elderly population; similarly, they are more likely to live alone and have a reduced sweating capacity, which affects their ability to respond to heat stress (D'Ippoliti et al., 2010). Air pollution and heat exposure have also been linked to low birth weight in some studies (Dadvand et al., 2014).

The topic of climate change awareness in the specific context of the urban environment has not been extensively studied to date (Lenzholzer et al., 2020). Although the issue of urban flooding has been widely discussed in existing literature, there is a notable lack of analysis regarding the awareness of other urban climate phenomena such as temperature and wind.

In general, studies suggest that cities are lagging behind in terms of their adaptation strategies and activities. According to a global survey conducted by (Araos et al., 2016), a substantial number of cities questioned in the research had not prepared adequate adaptation strategies or refused to provide any information about such activities, with only 18% of cities publishing reports on their adaptation measures. A survey of South-Eastern European countries confirmed the slow pace of systemic adaptation efforts, as many countries in the sample were lacking either a comprehensive National Adaptation Strategy or a National Action Plan, but the survey also concluded that an increased awareness of climate change action was discernible among the studied countries (Pietrapertosa et al., 2018). In the eastern part of the Czech Republic, the strategic adaptation response was also found to be insufficient, focusing mainly on water management and omitting areas such as population health, agriculture, forestry and tourism (Křištofová et al., 2022).

Previous research has demonstrated that simply believing in the existence of climate change does not necessarily lead to environmentally friendly behaviour. Instead, belief in climate change is more closely linked to the intention to act rather than to any actual behaviour (Hornsey et al., 2016). Bridging the gap between awareness and action is crucial for achieving climate change goals, but this is by no means a straightforward task. The awareness-action gap has significant policy implications, highlighting the need for strategies that address barriers such as resource access, social norms and perceived effectiveness. Effective interventions must make sustainable choices more accessible and promote community engagement to turn intentions into real actions

2. Factors Affecting Climate Change Awareness

The degree of climate change awareness was found to differ across countries, contexts and individuals. A review by Gifford and Nilsson (2014) and a meta-analysis by Hornsey et al. (2016) offer a comprehensive list of the relevant factors which are summarized in Table 1.

Table 1 Factors affecting climate change awareness and climate-friendly activities

Sociodemographic	Psychological	Social, cultural and political	Country context
race	cognitive heuristics and biases	political ideology/affiliation	country
gender	motivation	identities:	level of development
age	place-attachment	- New Ecological Paradigm	municipal support
income	personal experience	- activist/green identity	
education	knowledge (objective/subjective)	values:	
urban/rural residence	trust in science	- biospheric values	
	short vs. long term orientation	- individualistic cultural values	
	emotions and affect	- hierarchical cultural values	
	sense of control	- free market	
	personal traits	worldviews	
		norms	

Source: authors' own summary based on literature review

Firstly, we can categorise the intuitive characteristics such as gender, age, education or other socioeconomic and sociodemographic variables. People who believe in climate change are usually younger, more educated and with higher incomes, while gender or race have a less significant effect. Differences in the stances of male and female respondents towards adaptation to climate change are thought to be associated with their respective motivations – men are more likely to be motivated by financial reasons and advances in technology, while women tend to be more egalitarian and are more concerned with concepts of community and ecology (Alló and Loureiro, 2014; Brink and Wamsler, 2019).

In addition to the sociodemographic context, other factors play a role which could be classified as psychological. A subjective knowledge of scientific findings concerning climate change is approximately the same for “believers” and “sceptics”, but a higher level of objectively measured knowledge is connected to a stronger belief in climate change (Hornsey et al., 2016). Personal traits such as open-mindedness, conscientiousness and lower emotional stability were also found to be related to environmental concerns (Gifford & Nilsson, 2014).

An important psychological determinant of belief in climate change is cognitive heuristics, the willingness of individuals to accept the validity of information based on the trustworthiness of its source or the existence of a perceived consensus (“scientists are trustworthy, and therefore scientific findings are true”, and “There is a scientific consensus on this topic, and therefore it is true”) (Hornsey et al., 2016). Moreover, a greater willingness to support climate-related policies also stems from attitudes regarding long-term planning or attachment to place (Alló & Loureiro, 2014); those expressing stronger global attachment rather than national loyalties are more likely to be aware of climate change and view climate change responses positively (Devine-Wright et al., 2015).

Based on theories of risk perception, we would assume that personal experience would affect perceived risk and personal relevance of the issue more than cognitive information (Howe et al., 2014). As has been shown in the meta-analysis by Alló and Loureiro (2014), experience with extreme weather increases the willingness of individuals to invest in mitigation and adaptation policies. In other empirical research, personal experience with extreme weather conditions and their impacts was shown to be connected to a stronger belief in climate change, but the association was of relatively low significance (Hornsey et al., 2016). Sometimes even individuals who have had direct experience of extreme weather events are not necessarily convinced of the need to adopt policies directed to climate change mitigation and adaptation (Gärtner & Schoen, 2021). However, this relationship could also work conversely, as our perception of our experiences can be influenced by our belief systems; essentially, peoples’ beliefs about global warming can affect their propensity to recollect extreme weather events (Howe & Leiserowitz, 2013). A feedback mechanism between climate change perceptions and negative affect has been also identified, with studies suggesting that people process both cognitive information and affect heuristic simultaneously (Linden, 2014).

In examining the magnitude of the effects of climate change, the socioeconomic and psychological characteristics were overshadowed by variables connected to values, beliefs, political affiliation, worldviews and culture (Hornsey et al., 2016). One of the most important factors is that of social identity (Casey & Scott, 2006; Fielding & Hornsey, 2016; Hornsey et al., 2016; McCright et al., 2013). The most prominent factor in predicting climate change belief was the “New Ecological Paradigm”, a series of assertions concerning the environment and the need to limiting the harmful impacts of human activity on the natural world. Individuals who identify themselves with “green” or activist identities or who declare their affinity with the natural environment were more likely to believe in climate change. One possible value-based explanation for this phenomenon is provided by the theory of cultural cognition, which claims

that people perceive risks based on how they think society should function (Hornsey et al., 2016). Individuals who value individualism and hierarchy tend to show deference to elites and favour the status quo, rejecting the assertion that industrial activities cause harm to the environment. Scepticism towards climate change is also connected to belief in free market values. On the other hand, people who are proponents of a more egalitarian society and who favour community values are more likely to express moral distrust of industry and its impact on nature.

A recent study by Sabherwal et al. (2021) documented the so-called “Greta Thunberg effect” in a nationally representative survey of U.S. adults. The findings indicate that a familiarity with the Swedish environmental activist Greta Thunberg is associated with a higher intention of undertaking collective action to reduce global warming, mediated by stronger collective efficacy beliefs. This effect is observed across various age groups and political ideologies, although it may be more pronounced among liberals. The study points out that young public leaders like Greta Thunberg are an effective means of motivating and inspiring collective action (Sabherwal et al., 2021).

Climate change awareness has also been found to differ across countries (Poortinga et al., 2019). While the reasoning that human activities contribute to climate change is a predictor of risk perceptions in Latin America and Europe, in Asia and Africa it is the changes in temperature that take the lead (Lee et al., 2015). There are even considerable differences in the effect of education in different countries or in the political affiliations of citizens (Czarnek et al., 2021). In more developed countries, the topic of climate change is more politicized, and in such a context, education might not be enough to raise awareness about the risks of climate change, and especially among right-wing voters. Differences were also observed between European countries; the effects of demographic and socio-political factors were found to be less pronounced in Eastern countries when compared to Western states (Poortinga et al., 2019).

Several other conditions have been linked with the intention to act in a climate-friendly manner. People can be motivated by economic or resource-based considerations, moral obligations or perceived social norms and expectations, beliefs in personal efficacy, and habits (Klößner, 2013; Vesely et al., 2021). Identity can be employed as a concept which could potentially encompass the majority of the aforementioned factors (Vesely et al., 2021).

Academic studies also differ in terms of their outcome variables; while some studies examine the intention to act, other research focuses instead on past behaviours. To date, research into the issue has shown that belief in climate change is not a sufficient predictor of

environmentally friendly action; the findings suggest that it is more connected with the intention to act rather than any real activity (Hornsey et al., 2016).

Emotions (operationalized by positive or negative affect in psychology) can play a role in predicting collective or individual climate action (Coelho et al., 2017; Stanley et al., 2021). “Eco emotions”, and eco-anger in particular, can lead to both individual and collective climate action. Perceived injustice, moral outrage and collective guilt manifested in belonging to an activist group can all be transformed into collective action (Furlong & Vignoles, 2021; Haugestad et al., 2021; Stanley et al., 2021).

These more complex mechanisms have been studied using structural models; the study with the most methodologically comprehensive and statistically approach to date is the paper by Saari et al. (2021) which analyses representative data for nine EU/EFTA countries which was obtained through the International Social Survey Programme (ISSP). The results of this analysis illustrate how environmental risk perception and environmental knowledge, mediated by environmental concern, can be translated into behaviour intention and realization.

When designing policies, relevant authorities must understand their audiences and formulate efficient communication strategies. One approach is the need to adapt the desired message to ensure acceptance of policies by various groups within society. Research conducted in the Global Warming’s Six Americas project focused on identifying the most prominent groups in the US society in terms of climate change awareness (Leiserowitz, 2009). The project has gathered data regularly through surveys since its commencement in 2008, and findings have been published in several reports. One of the main components of this research is audience segmentation. In this approach, respondents are divided into groups based on their similar characteristics, primarily their opinions and espoused values. The results have identified six distinct typologies, and as the project has been running for more than ten years, it has been possible to study the shifts in these trends over time. We can see that the proportion of sceptics within the population has gradually decreased, while the group which describes themselves as “alarmed” have become more prominent, having doubled in size between 2015 and 2020. The results suggest that Americans are becoming more and more engaged and are increasingly likely to support policies aimed at combatting climate change.

Similar research has also been conducted in several European countries. A project by Metag et al. (2015) studied attitudes toward climate change in the German population, with the findings suggesting that the sample group could be categorized into five segments: the Alarmed (24%), the Concerned Activists (18%), the Cautious (28%), the Disengaged (20%), and the Doubtful (10%). In a similar approach based on the UK population, Rhead et al. (2018)

identified four classes of people: Pro-environmental (28,7%), the Neutral Majority (36,6%), Disengaged (18,6%) and Paradoxical (16,1%). Kuthe et al. (2019) focused on the typology of teenagers in Austria and Germany based on their cognitive, affective and conative aspects of climate change awareness, assigning the teenagers into the following four groups: Disengaged (25%), Paralysed (14%), Charitable (40%) and Concerned Activists (21%). Kácha et al. (2022) used data from European Social Survey to scrutinise the segmentation of people according to their attitudes and beliefs concerning climate change and identified four potential groups: Engaged (18%), Pessimistic (18%), Indifferent (42%), and Doubtful (21%).

3. Local context of the study

Slovakia is on average less urbanized in comparison to the rest of the EU; while 75 % of European Union citizens live in cities, the urban population of Slovakia accounts for only 54 % of the population (World Bank, 2020b). However, the Slovak population shares the concerns over climate changes identified in other member countries. According to the Eurobarometer survey conducted in 2019, 78% of people in Slovakia consider climate change to be a serious problem, a proportion which roughly corresponds to the average in the EU and a substantial rise from the figure of 67% which was recorded in 2017, indicating that Slovaks are becoming increasingly concerned about this issue. Two-thirds of respondents declared that they had taken part in activities focused on combating climate change within the last six months.

In Košice, the most salient climate-change related issues in future will most likely be related to extreme heat. The European Environmental Agency (European Environment Agency, 2020b) has compiled a list of the observed and projected impacts for seven types of biogeographical regions in the EU. The simulation shows that cities in Central Europe will face both a higher frequency of heatwave days and higher heatwave maximum temperatures, with increases of 14°C in the worst-case scenarios (Guerreiro et al., 2018). Studies such as that by Tapia et al. (2017) tried to provide an objective indicator-based view on climate change vulnerability of European cities. In this assessment, Košice was found to rank among the most vulnerable quartile of cities facing heat and drought.

Košice has a substantial industrial legacy and several urban planning issues that pose a challenge (or, alternatively, an opportunity) for future adaptation policies. The second largest city in Slovakia with 240,000 inhabitants, the city is located in the eastern part of the country on an extensive plain. Košice is also marked by its extensive industrial heritage connected to the still active steel industry and several disused industrial brownfield sites which remain an environmental burden. The city also redirected the River Hornád from its original course

through the central part of the city to its outer rim. Košice has recently introduced its first adaptation plan which builds upon vulnerability assessments and recommends specific goals in the process of climate change adaptation. The effort to pursue a more sustainable future is also manifested in the city's application for the European Green Capital Award and its participation in the 100 Climate Neutral Cities 2030 initiative. Since 2019, Košice has also been part of the Covenant of Mayors for Climate and Energy initiative, pledging to reduce GHG emissions and to increase climate change resilience through adaptation.

4. Data

The data used in this paper was obtained through a survey conducted among residents of Košice between October 2019 to January 2020. The questionnaire was accessible online and advertised through social media, the web page of the project KOŠICE ± 40 and the web pages of the partners of the project. The Košice municipality also sent information about the questionnaire to all its affiliated institutions with the request that it be distributed among employees. The questionnaire was also sent to 100 local businesses and to schools and retirement homes, where the questionnaire was also made available in paper format. Only responses received from residents of Košice were considered for the purposes of this study.

A total of 598 acceptable responses were received, and a random sample was then formed which accurately reflected the structure of the city's residents. The process of gathering the data and adjusting the sample was adapted from standard methodologies applied in the field of market research (Trnka, 2016).

The final sample prepared for our analysis consisted of 368 observations and is based on the following characteristics:

- 1 Sex
- 2 Age (categories: 15-19, 20-29, 30-39, 40-49, 50-59, 60 +)
- 3 Residency in individual city districts (KE I, KE II, KE III, KE IV).

5. Descriptive Statistics

Approximately half of all respondents believed that climate change was both a global and local issue. Interestingly, 38% of residents perceived climate change to be a local rather than global problem. Only 2% stated that climate change was not a problem at any level. The limitation of the research results is that the final sample size might not fully capture the diversity of the population, including the diversity of attitudes toward climate change. We believe that

people with concerns about climate change are overrepresented in the sample, as indicated by the descriptive statistics.

Table 2 Percentage of respondents according to their perception of climate change as a global/local problem

		yes	no
LOCAL	yes	47.6%	38.3%
	no	12.2%	1.9%

Source: authors's own

Regarding the respondents' objective knowledge of climate change and its impacts, 61% of participants stated that they had a sufficient level of knowledge. In contrast, more than half of residents felt that they had not received sufficient information on the impacts of climate change on the city. This suggests that those who already possess a good level of knowledge on environmental issues are also eager to learn even more about their impact on the city.

Table 3 Level of objective and subjective knowledge of received information

		Subjective level of received information			
		high	medium	low	SUM
Objective level of knowledge	high	11.1	18.8	31.5	61.4
	medium	6.8	9.5	17.9	34.2
	low	1.1	1.1	2.2	4.3
	SUM	19.0	29.3	51.6	

Source: authors's own

The survey findings indicate that residents of Košice generally accept the importance of adapting to climate change (68%). Vulnerability, measured as the degree of a respondent's own experience with the impacts of climate change, seems to be associated with the perception that it is important to adapt; only 3% of all respondents stated that they felt both vulnerable to climate change impacts and neutral towards adaptation. Similarly, none of the respondents claimed to suffer from climate change impacts while denying the need to adapt.

Table 4 Objective vulnerability and perceived necessity to adapt

		Adaptation is important			
		important	neutral	not important	SUM
Vulnerability	high	23.1	3.0	0.0	26.1
	medium	29.6	13.3	0.8	43.8
	low	15.2	12.8	2.2	30.2
	SUM	67.9	29.1	3.0	

Source: authors's own

Figure 1 shows the percentage of residents who engage in adaptation and mitigation activities at different frequency levels. The majority of the respondents claimed that they sometimes perform both types of activities, while more than 30% of respondents reported that they engaged in environmentally friendly activities on a regular basis. The questionnaire also featured a question which asked people whether they felt informed about how to adapt to climate change in Košice. The responses are shown in Figure 2, with only 5% claiming that they felt highly informed, although a majority of the respondents stated that they felt informed to some degree.

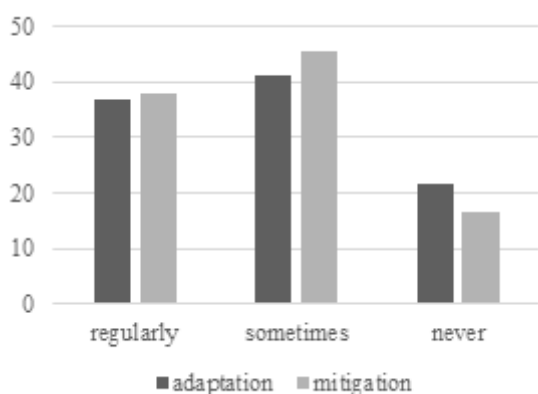


Figure 1 Adaptation and mitigation activities

Source: authors's own

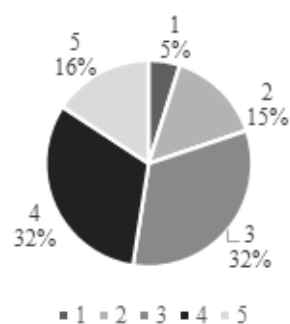


Figure 2 Level of information (1 - high, 5 – low)

The survey also examined the level of civic participation among respondents using an indicator aggregated from eight sub-questions, related to activities such as participating in local elections, signing petitions for local issues, participating in public meetings about local issues, or being involved in local civic initiatives. The respondents were requested to state how often they participated in activities of this nature (either regularly, sometimes or never. Figure 3 shows how the level of engagement in local politics relates to the respondents' perceived level of information about adaptation to climate change. We can observe that respondents who are more engaged stated that they felt insufficiently informed about how to adapt to climate change in Košice.

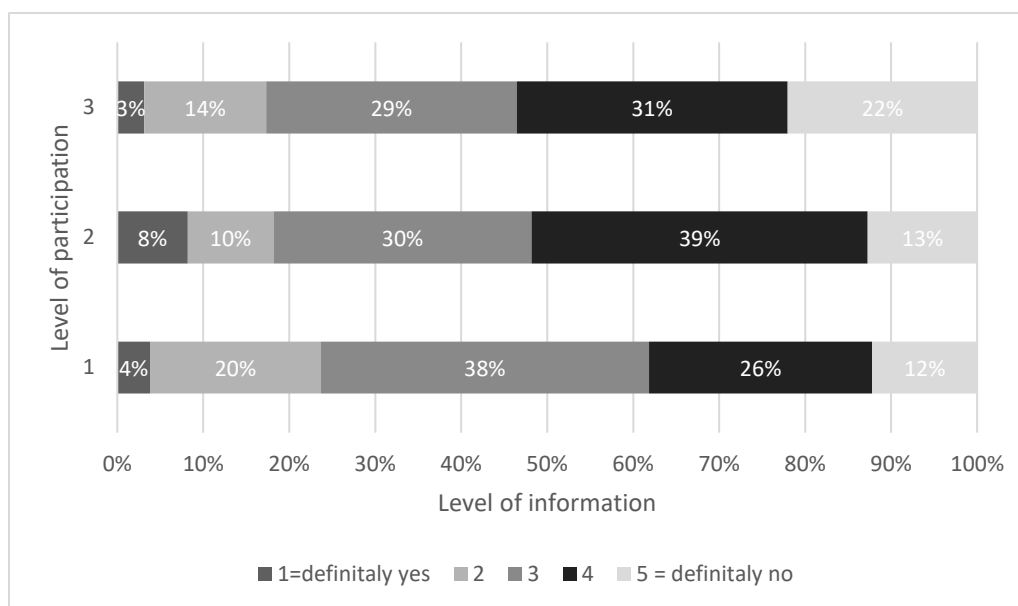


Figure 3 Level of participation (1 – high, 3 – low) and level of feeling informed (1 – definitely yes, 2- yes, 3 – rather ye, 4- rather no, 5- definitely no)

Source: authors’s own

6. Methodology

Research into the segmentation of the population based on climate change awareness has employed a wide variety of methodological approaches, including the two-step factor and cluster analysis described by Metag (2015) and the two-step hierarchical cluster analysis applied by Kuthe (2019).

Other studies have applied latent class analysis, most notably Rhead (2018) and Kácha et al. (2022).According to Rhead (2018) “using a clustering method such as latent class analysis can be a valuable tool for studying environmental attitudes as they exist within a given population”.

In our research, we decided to implement Latent Class Cluster Analysis (LCCA), an advanced model which combines latent class analysis with clustering method which is seeing increased usage in social sciences (Lezhnina, Kismihók, 2022).

Latent Class Cluster Analysis (LCCA) is a clustering method for use with categorical variables with assumed multinomial distributions. By applying LCCA, we aimed to model the relationships between the observed categorical variables and reveal unobservable latent classes. These latent classes are presumed to account for the variance in the observed variables, allowing us to identify distinct groups of individuals with similar behaviors. Individuals within the same latent class share similar characteristics, and their behaviors differ from those in other classes. Our primary goal was to distinguish between homogeneous groups of respondents and create a

segmentation which can use for targeted policies. Using LCCA enabled us to achieve this by identifying and analyzing the latent classes that could explain the patterns observed in the data.

The data obtained in the survey was analyzed using Latent Gold software, a program which has been specifically designed for this purpose.

By processing the data, we reduced the sample size from 598 to 368 by refining the sample (by, for example, excluding missing values) in order to produce a representative sample. We subsequently recoded the variables and reduced some dimensions for clarity and to ensure the better applicability of the statistical method.

In our analysis, we used nine explanatory indicators to categorise the respondents into groups. These indicators reflect their opinions on climate change, their knowledge and the level of their participation. Detailed information regarding the reductions and final variables can be found in the accompanying Table 5.

Table 5 Explanatory Variables

Variable	Type	Description	Questionnaire item (example in case of multiple sub-questions)
Climate Change Awareness at global level	dummy	Mapping if the respondent considered climate change to be the most serious threat at the global level	Which of the following problems facing the world do you consider to be the most serious threat?
Climate Change Awareness at local level	dummy	Mapping if the respondent considered climate change as one of the most serious threats at the local level	Which of the following problems facing Košice do you consider to be the most serious threat?
Knowledge about climate change and its impacts	Index based on the summed scores from 10 statements with Likert scale responses (5 levels), adjusted by min-max normalization	Statements regarding the anthropogenic causes of climate change, the scientific consensus on climate change, and impacts of climate change	Research shows that climate change is caused by human activity. Do you agree with this statement?
Awareness about the need to adapt	Likert scale score (10 levels), reduced to three levels – high, medium, low	Degree of seriousness of climate change as an issue	How important do you think it is to prepare and react to the effects of climate change (i.e., to adapt)?
Vulnerability – own experience with the impacts of climate change	Index based on the summed scores of 8 statements with Likert scale responses (5 levels), reduced to	Statements concerning negative climate change impacts on health, agriculture, infrastructure and	Summer heatwaves decrease my work performance (focus/attention).

Variable	Type	Description	Questionnaire item (example in case of multiple sub-questions)
	three levels – high, medium, low	property, services or business	
Civic Participation	Index based on the summed scores of 8 examples with Likert scale responses (3 levels – often, sometimes, never)	examples of activities indicating engagement in local politics	I participate in local elections.
Level of information about the impact of climate change on the city	Likert scale score (5 levels), reduced into three levels – high, medium, low	Degree of satisfaction with available information concerning climate change impacts	1) Do you feel sufficiently informed about climate change and its impact on Košice?
Frequency of engaging in adaptation activities	Index based on the summed scores of 8 examples with Likert scale responses (5 levels), adjusted by min-max normalization	Examples of activities related to adaptation	e.g. air-conditioning in apartments, improved insulation, etc.
Frequency of engaging in mitigation activities	Index based on the summed scores of 8 examples with Likert scale responses (5 levels), adjusted by min-max normalizátor	Examples of activities related to mitigation	e.g. I try to reduce the amount of waste I produce, Instead of using a private car, I use environmentally friendly alternatives such as walking, cycling, public transport or carpooling.

Source: authors's own

A methodological approach was applied which was based on revealing possible latent variables that could potentially influence the behaviour but which were not explicitly stated in the observed data.

The issue of selecting the optimal number of clusters in clustering methods, including LCCA, is often seen as a somewhat controversial issue (Lezhnina, Kismihók, 2022). Methodological literature notes that the decision about the number of clusters can be inherently subjective, as clustering outcomes can vary depending on the perspective of the investigator. However, the most common approach is the selection of the number of clusters based on predefined criteria (Lezhnina, Kismihók, 2022). In the case of LCCA, we followed the Bayesian Information Criterion (BIC) which is frequently used as the primary criterion (Lezhnina, Kismihók, 2022), in which the model with the lowest BIC value is considered to provide the best fit.

6.1. Results

Using LCCA we were able to identify four types of residents. We assessed the fit of models featuring different numbers of classes based on BIC values and ultimately chose a four-class model on the basis of the criteria of the lowest value of information. The selected model not only demonstrated statistical robustness but also provided the most interpretable results, allowing for clear identification of patterns and logical connections between the characteristics of the groups within each cluster. This interpretability facilitated a deeper understanding of the latent classes and their associated behaviors, thereby enhancing the validity and applicability of the findings. The groups and their characteristics are listed in Table 6.

Table 6 Percentual representation of respondents with the given characteristics

	Group 1	Group 2	Group 3	Group 4
Share	29%	27%	24%	20%
Awareness about the threat of climate change at global level				
0 – not aware	24%	12%	41%	85%
1 - aware	76%	88%	59%	15%
Awareness about the threat of climate change at local level				
0 – not aware	75%	60%	89%	97%
1 - aware	25%	40%	11%	3%
Knowledge about climate change and its impacts				
1 – high level	78%	82%	51%	21%
2	22%	18%	45%	62%
3 – low level	1%	0%	4%	16%
Vulnerability to climate change				
1 - high	44%	40%	4%	7%
2	47%	48%	37%	42%
3 - low	10%	11%	59%	51%
Awareness about the need to adapt				
1 – not aware	1%	0%	3%	10%
2	26%	6%	38%	54%
3 - aware	73%	94%	59%	36%
Frequency of engaging in adaptation activities				
1 - regularly	77%	25%	15%	23%
2 - sometimes	22%	50%	48%	50%
3 - never	2%	25%	37%	27%
Frequency of engaging in mitigation activities				
1 - regularly	65%	36%	16%	28%
2 - sometimes	32%	50%	51%	52%
3 - never	3%	14%	33%	20%
Information level of impact of climate change on the city				
1 - high	32%	9%	18%	18%
2	36%	28%	34%	33%
3 - low	32%	63%	48%	49%
Participation in public life				

	Group 1	Group 2	Group 3	Group 4
1 - regularly	50%	45%	7%	37%
2 - sometimes	31%	32%	22%	34%
3 - never	19%	22%	71%	29%

Source: authors's own

1. Potentially resilient

The largest group is the group which we have termed “potentially resilient”. This class represents 29% of the sample; almost two-thirds are women and 74% of the group are over 40 years of age. They are mostly married with children, and they are typically employed, falling within the middle-income group. The potentially resilient are aware that climate change is one of the most serious global threats, but they do not consider it to be a high priority issue at the local level, an approach which appears to be in conflict with their (high) level of knowledge about climate change impacts and their stated personal experience. In contrast, however, they claim it is important to adapt to climate change and to take action in this direction. They regularly engage in adaptation and mitigation activities, and they also take an active interest in local politics.

2. Aware but passive

The second largest group is the group which we have identified among the residents of Košice is that which we term “aware but passive”. Representing 27 % of the sample, the majority of this class are between 20 and 40 years of age and live in the city centre. Typically unmarried and childless, they fall under the middle-income group and are mostly employed. People in this group are well aware of the seriousness of climate change and are convinced it is an issue at global level. Their knowledge about the impacts is wide and is backed up by their own experiences. As a consequence, they are convinced of the necessity to adapt but their actual activities in this direction are not as numerous as that of the first group, despite their active interest in local politics. They are typically dissatisfied with the availability of information on how to adapt to climate change in cities.

3. Aware without opportunities to act

The third group which we term “aware without opportunities to act”, constitutes 24% of the respondents. Most of this group are younger than 40, featuring a greater share of teenagers than any other group. Members of this group are either well-educated or still studying; those who have completed their education are usually employed, and they are both unmarried and

childless. As with the preceding groups, they also think that climate change is a global problem, but they do not feel threatened by its impact at the local level; although they are well-informed about the issue of climate change, they do not perceive its influence in the local environment. Members of this group engage in relatively few adaptation or mitigation activities. Their civic engagement is low, and they claim they lack sufficient information on how to adapt to climate change.

4. Vulnerable

The smallest group, termed “vulnerable”, represents 20% of respondents. It consists mainly of men and is the group with the highest age, with members typically over 60 years old. They usually live in family houses located in the peripheries of the city and have children. The majority are university educated and are either employed or retired, although this group also features the highest number of unemployed. People in this group belong among the low-income group. Unlike the other classes, people in this group are not convinced that climate change is a problem. Their level of knowledge about the impact of climate change is lower, and they claim that they do not experience manifestations of climate change in their lives and are therefore unconvinced that adaptation should be a priority. Paradoxically, however, they also engage in multiple adaptation or mitigation activities. They are largely uninvolved in local politics and do not feel well informed about adaptation to climate change in the city.

More detailed results regarding the sociodemographic characteristics of the groups in the model can be found in the Appendix.

Conclusion

In earlier research, climate change awareness has been found to be associated with different sociodemographic, psychological, cultural or contextual factors. However, an awareness of climate change is not a sufficient predictor of climate-friendly action.

The topic of climate change is becoming more and pressing in public discourse, and the general public are becoming increasingly concerned about the issue as their knowledge and personal experience of the impact of climate change continues to rise. However, despite this wider knowledge, an important finding of our study for local policy makers is the fact that the residents of Košice remain dissatisfied with the amount of information they receive about climate change adaptation measures within the city.

This study applied a latent class analysis methodology to identify four distinct groups of residents based on their attitudes towards climate change. The first group, the “potentially

resilient”, are active citizens who are very concerned and well informed about climate change, and who also regularly engage in environmentally friendly activities. The second group, the “aware but passive” is similar to the first in their perception of climate change although they differ in their scope of adaptation and mitigation activities. The respondents in the third group, the “aware without opportunities to act” are usually young and educated, but their actions are limited due to objective reasons. The members of the fourth group, the “vulnerable”, are usually older individuals who are unconvinced that climate change is a problem despite their lack of information about its impact. Interestingly, despite this scepticism, members of this group actively engage in multiple adaptation or mitigation activities. Brink and Wamsler (2019) note that the older population typically show a low motivation to adapt and a high vulnerability to climate change, arguing that efforts to support this section of the population should be increased.

One distinct feature of this study is the fact that we identified a smaller number of groups than was found in other similar studies. For example, the “Global Warming’s Six Americas” project in the US identified six typologies based on climate change awareness and engagement; similarly, a study by Metag et al. (2015) identified five groups in Germany. The smaller number of groups in our study suggests that differences in sociodemographic, cultural and political contexts that may influence individuals’ perception and willingness to act on climate change.

Additionally, the differences in the design of the survey and the indicators measured likely contributed to the variation in the number of identified groups. Our survey focused on specific aspects of climate change awareness, knowledge and engagement which are relevant to Košice, and this local focus may differ from the broader or differently structured surveys used in other studies. These methodological variations underscore the importance of context-specific research designs tailored to the unique characteristics of the population under examination.

This discrepancy also highlights the unique aspects which Košice offers as a case study and underscores the importance of tailored communication and policy strategies. Understanding the specific characteristics and motivations of these groups can help the local authorities in Košice to design more effective and inclusive climate adaptation policies. Furthermore, it emphasizes the need for continuous data collection and methodological refinement to accurately define the evolving dynamics of public perception and behavior regarding climate change mitigation and adaptation.

These results could also help local authorities to design efficient communication strategy focused on climate change, allowing them to either encourage those who are already active or provide more information to those who seem to underestimate the seriousness of the problem.

The recent developments in AI technology offer policy makers valuable tools for leveraging the results of our study to promote positive behaviors and overcome barriers to climate change adaptation. AI can enhance the visualization, simulation and explanation of climate change impacts; it can also make this information more accessible and engaging, especially in educational settings, a potentially huge benefit in helping people to understand the urgency of climate action.

However, we must also remain aware of the potential misuse of AI for spreading misinformation and conspiracy theories which could promote climate scepticism, and therefore the need to integrate critical thinking and fact-checking into AI-driven initiatives is essential in mitigating these risks. By applying AI in a thoughtful and responsible manner, we can maximize its benefits while minimizing its drawbacks, fostering a more informed and proactive approach to climate change.

The awareness-action gap is a crucial phenomenon that warrants further exploration and justification within the context of climate awareness due to its significant policy implications. This specific gap, where individuals recognize the importance of climate change but fail to take corresponding action, is a complex and multifaceted issue, and a more thorough examination of the relevant factors such as psychological, social, and structural barriers, would greatly enhance the depth of our study. A fuller understanding of these dynamics is essential for designing effective policies and interventions that can contribute to bridging this gap and translating climate awareness into tangible actions. Addressing the awareness-action gap in a holistic and comprehensive way can lead to more impactful climate change mitigation and adaptation strategies.

In further research, it would be useful to compare different methodologies (e. g. parametric LCCA with non-parametric clustering methods) and different specification of input data to ensure the robustness of the results. Similarly, a survey collecting data on values or worldviews could also contribute to widening our knowledge in this field.

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References

- [1] Alló, M., & Loureiro, M. L. (2014). The role of social norms on preferences towards climate change policies: A meta-analysis. *Energy Policy*, 73, 563–574. <https://doi.org/10.1016/j.enpol.2014.04.042>

- [2] Araos, M., Berrang-Ford, L., Ford, J. D., Austin, S. E., Biesbroek, R., & Lesnikowski, A. (2016). Climate change adaptation planning in large cities: A systematic global assessment. *Environmental Science & Policy*, 66, 375–382. <https://doi.org/10.1016/j.envsci.2016.06.009>
- [3] Brink, E., & Wamsler, C. (2019). Citizen engagement in climate adaptation surveyed: The role of values, worldviews, gender and place. *Journal of Cleaner Production*, 209, 1342–1353. <https://doi.org/10.1016/j.jclepro.2018.10.164>
- [4] Casey, P. J., & Scott, K. (2006). Environmental concern and behaviour in an Australian sample within an ecocentric – anthropocentric framework. *Australian Journal of Psychology*, 58(2), 57–67. <https://doi.org/10.1080/00049530600730419>
- [5] Coelho, F., Pereira, M. C., Cruz, L., Simões, P., & Barata, E. (2017). Affect and the adoption of pro-environmental behaviour: A structural model. *Journal of Environmental Psychology*, 54, 127–138. <https://doi.org/10.1016/j.jenvp.2017.10.008>
- [6] Czarnek, G., Kossowska, M., & Szwed, P. (2021). Right-wing ideology reduces the effects of education on climate change beliefs in more developed countries. *Nature Climate Change*, 11. <https://doi.org/10.1038/s41558-020-00930-6>
- [7] Dadvand, P., Wright, J., Martinez, D., Basagaña, X., McEachan, R. R. C., Cirach, M., Gidlow, C. J., de Hoogh, K., Gražulevičienė, R., & Nieuwenhuijsen, M. J. (2014). Inequality, green spaces, and pregnant women: Roles of ethnicity and individual and neighbourhood socioeconomic status. *Environment International*, 71, 101–108. <https://doi.org/10.1016/j.envint.2014.06.010>
- [8] Devine-Wright, P., Price, J., & Leviston, Z. (2015). My country or my planet? Exploring the influence of multiple place attachments and ideological beliefs upon climate change attitudes and opinions. *Global Environmental Change*, 30, 68–79. <https://doi.org/10.1016/j.gloenvcha.2014.10.012>
- [9] D’Ippoliti, D., Michelozzi, P., Marino, C., de’Donato, F., Menne, B., Katsouyanni, K., Kirchmayer, U., Analitis, A., Medina-Ramón, M., Paldy, A., Atkinson, R., Kovats, S., Bisanti, L., Schneider, A., Lefranc, A., Iñiguez, C., & Perucci, C. A. (2010). The impact of heat waves on mortality in 9 European cities: Results from the EuroHEAT project. *Environmental Health*, 9(1), 37. <https://doi.org/10.1186/1476-069X-9-37>
- [10] European Environment Agency. (2020a). *Urban adaptation in Europe: How cities and towns respond to climate change*. Publications Office. <https://data.europa.eu/doi/10.2800/324620>

- [11] European Environment Agency. (2020b). *Urban adaptation in Europe: How cities and towns respond to climate change*. Publications Office. <https://data.europa.eu/doi/10.2800/324620>
- [12] Fielding, K. S., & Hornsey, M. J. (2016). A Social Identity Analysis of Climate Change and Environmental Attitudes and Behaviors: Insights and Opportunities. *Frontiers in Psychology*, 7, 121. <https://doi.org/10.3389/fpsyg.2016.00121>
- [13] Furlong, C., & Vignoles, V. L. (2021). Social Identification in Collective Climate Activism: Predicting Participation in the Environmental Movement, *Extinction Rebellion. Identity*, 21(1), 20–35. <https://doi.org/10.1080/15283488.2020.1856664>
- [14] Gärtner, L., & Schoen, H. (2021). Experiencing climate change: Revisiting the role of local weather in affecting climate change awareness and related policy preferences. *Climatic Change*, 167(3), 31. <https://doi.org/10.1007/s10584-021-03176-z>
- [15] Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, 49(3), 141–157. <https://doi.org/10.1002/ijop.12034>
- [16] Gill, S. E., Handley, J. F., Ennos, A. R., & Pauleit, S. (2007). Adapting Cities for Climate Change: The Role of the Green Infrastructure. *Built Environment*, 33(1), 115–133. <https://doi.org/10.2148/benv.33.1.115>
- [17] Guerreiro, S. B., Dawson, R. J., Kilsby, C., Lewis, E., & Ford, A. (2018). Future heat-waves, droughts and floods in 571 European cities. *Environmental Research Letters*, 13(3), 034009. <https://doi.org/10.1088/1748-9326/aaaad3>
- [18] Haugestad, C. A. P., Skauge, A. D., Kunst, J. R., & Power, S. A. (2021). Why do youth participate in climate activism? A mixed-methods investigation of the #FridaysForFuture climate protests. *Journal of Environmental Psychology*, 76, 101647. <https://doi.org/10.1016/j.jenvp.2021.101647>
- [19] Hofierka, J., Gallay, M., & Onáčillová, K. (2020). Physically-based land surface temperature modeling in urban areas using a 3-D city model and multispectral satellite data. *Urban Climate*, 31, 100566. <https://doi.org/10.1016/j.uclim.2019.100566>
- [20] Hornsey, M. J., Harris, E. A., Bain, P. G., & Fielding, K. S. (2016). Meta-analyses of the determinants and outcomes of belief in climate change. *Nature Climate Change*, 6, 622–626. <https://doi.org/10.1038/nclimate2943>
- [21] Howe, P. D., Boudet, H., Leiserowitz, A., & Maibach, E. W. (2014). Mapping the shadow of experience of extreme weather events. *Climatic Change*, 127(2), 381–389. <https://doi.org/10.1007/s10584-014-1253-6>

- [22] Kácha, O., Vintř, J., & Brick, C. (2022). Four Europes: Climate change beliefs and attitudes predict behavior and policy preferences using a latent class analysis on 23 countries. *Journal of Environmental Psychology*, 81, 101815. <https://doi.org/10.1016/j.jenvp.2022.101815>
- [23] Keller, R. C. (2015). *Fatal isolation: The devastating Paris heat wave of 2003*. University of Chicago Press.
- [24] Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—A meta-analysis. *Global Environmental Change*, 23(5), 1028–1038. <https://doi.org/10.1016/j.gloenvcha.2013.05.014>
- [25] Křištofová, K., Lehnert, M., Martinát, S., Tokar, V., & Opravil, Z. (2022). Adaptation to climate change in the eastern regions of the Czech Republic: An analysis of the measures proposed by local governments. *Land Use Policy*, 114, 105949. <https://doi.org/10.1016/j.landusepol.2021.105949>
- [26] Kuthe, A., Keller, L., Körfgen, A., Stötter, H., Oberrauch, A., & Höferl, K. M. (2019). How many young generations are there? A typology of teenagers' climate change awareness in Germany and Austria. *The Journal of Environmental Education*, 50(3), 172-182.
- [27] Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C.-Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature Climate Change*, 5(11), Article 11. <https://doi.org/10.1038/nclimate2728>
- [28] Lenzholzer, S., Carsjens, G.-J., Brown, R. D., Tavares, S., Vanos, J., Kim, Y., & Lee, K. (2020). Urban climate awareness and urgency to adapt: An international overview. *Urban Climate*, 33, 100667. <https://doi.org/10.1016/j.uclim.2020.100667>
- [29] Leiserowitz, A. (2009). *Global Warming Six Americas 2009: An Audience Segmentation Analysis*. Yale Project on Climate Change.
- [30] Lezhnina, O., & Kismihók, G. (2022). Latent Class Cluster Analysis: Selecting the number of clusters, *MethodsX*, Volume 9, 101747, ISSN 2215-0161, <https://doi.org/10.1016/j.mex.2022.101747>.
- [31] Linden, S. van der. (2014). On the relationship between personal experience, affect and risk perception: The case of climate change. *European Journal of Social Psychology*, 44(5), 430–440. <https://doi.org/10.1002/ejsp.2008>
- [32] McCright, A. M., Dunlap, R. E., & Xiao, C. (2013). Perceived scientific agreement and support for government action on climate change in the USA. *Climatic Change*, 119(2), 511–518. <https://doi.org/10.1007/s10584-013-0704-9>

- [33] Metag, J., Füchslin, T., & Schäfer, M. S. (2015). Global warming's five Germanys: A typology of Germans' views on climate change and patterns of media use and information. *Public Understanding of Science*, 1-18.
- [34] Onáčillová, K., & Gallay, M. (2018). Spatio-Temporal Analysis of Surface Urban Heat Island Based on Landsat ETM+ and OLI/TIRS Imagery in the City of Košice, Slovakia. *Carpathian Journal of Earth and Environmental Sciences*, 13(2), 395–408. <https://doi.org/10.26471/cjees/2018/013/034>
- [35] Pietrapertosa, F., Khokhlov, V., Salvia, M., & Cosmi, C. (2018). Climate change adaptation policies and plans: A survey in 11 South East European countries. *Renewable and Sustainable Energy Reviews*, 81, 3041–3050. <https://doi.org/10.1016/j.rser.2017.06.116>
- [36] Poortinga, W., Whitmarsh, L., Steg, L., Böhm, G., & Fisher, S. (2019). Climate change perceptions and their individual-level determinants: A cross-European analysis. *Global Environmental Change*, 55, 25–35. <https://doi.org/10.1016/j.gloenvcha.2019.01.007>
- [37] Proust, K., Newell, B., Brown, H., Capon, A., Browne, C., Burton, A J., Dixon, J., Mu, L., & Zarafu, M. (2012, June 6). *Human Health and Climate Change: Leverage Points for Adaptation in Urban Environments*.
- [38] Revi, A., Satterthwaite, D., Aragón-Durand, F., Corfee-Morlot, J., Kiunsi, R., Pelling, M., Roberts, D., & Solecki, W. (2014). *Urban Areas in Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. (pp. 535–612).
- [39] Rhead, R., Elliot, M., & Uphamc, P. (2018). *Using latent class analysis to produce a typology of environmental concern in the UK*. Social Science Research.
- [40] Robine, J.-M., Cheung, S. L. K., Le Roy, S., Van Oyen, H., Griffiths, C., Michel, J.-P., & Herrmann, F. R. (2008). Death toll exceeded 70,000 in Europe during the summer of 2003. *Comptes Rendus Biologies*, 331(2), 171–178. <https://doi.org/10.1016/j.crv.2007.12.001>
- [41] Saari, U. A., Damberg, S., Frömbling, L., & Ringle, C. M. (2021). Sustainable consumption behavior of Europeans: The influence of environmental knowledge and risk perception on environmental concern and behavioral intention. *Ecological Economics*, 189, 107155. <https://doi.org/10.1016/j.ecolecon.2021.107155>
- [42] Sabherwal, A., Ballew, M. T., van der Linden, S., Gustafson, A., Goldberg, M. H., Maibach, E. W., Kotcher, J. E., Swim, J. K., Rosenthal, S. A., & Leiserowitz, A. (2021). The Greta Thunberg Effect: Familiarity with Greta Thunberg predicts intentions to engage

- in climate activism in the United States. *Journal of Applied Social Psychology*, 51(4), 321–333. <https://doi.org/10.1111/jasp.12737>
- [43] Stanley, S. K., Hogg, T. L., Leviston, Z., & Walker, I. (2021). From anger to action: Differential impacts of eco-anxiety, eco-depression, and eco-anger on climate action and wellbeing. *The Journal of Climate Change and Health*, 1, 100003. <https://doi.org/10.1016/j.joclim.2021.100003>
- [44] Tapia, C., Abajo-Alda, B., Feliu, E., Mendizabal, M., Martínez-Sáenz, J. A., Fernández, G., Laburu, T., & Lejarazu, A. (2017). Profiling urban vulnerabilities to climate change: An indicator-based vulnerability assessment for European cities. *Ecological Indicators*, 78, 142–155. <https://doi.org/10.1016/j.ecolind.2017.02.040>
- [45] Vesely, S., Masson, T., Chokrai, P., Becker, A. M., Fritsche, I., Klöckner, C. A., Tiberio, L., Carrus, G., & Panno, A. (2021). Climate change action as a project of identity: Eight meta-analyses. *Global Environmental Change*, 70, 102322. <https://doi.org/10.1016/j.gloenvcha.2021.102322>
- [46] World Bank. (2020b). *Urban population (% of total population) - European Union*. The World Bank Data. https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=EU&most_recent_value_desc=true
- [47] Yale Program on Climate Change Communication. (2020, December). *Global Warming's Six Americas*. Retrieved from https://climatecommunication.yale.edu/publications/?_sft_filter-years=2006,2005,2004