Climate Change Awareness and Participation
Identifying Typologies of Residents in Košice, Slovakia

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Abstract
This research focuses on studying climate change awareness and participation among different socioeconomic groups in the town of Košice, Slovakia. Public awareness is a key element when tackling complex issues demanding wide-ranging compliance across sectors and individuals. To be able to assess the perceptions and activities related to the climate change, we gathered questionnaires from almost 1600 respondents during the last quarter of 2019. The sample was then adjusted to reflect the sociodemographic structure of Košice's residents. Applying latent class cluster analysis to the sample of 368 observations, we were able to identify four typologies of respondents. These groups differ in the degree of vulnerability to adverse conditions due to climate change. This study sheds light on how different groups of citizens perceive the threat of climate change impacts in their everyday lives and how they act in order to adapt. Such findings can be applied by policymakers at both national and local level when designing and communicating socially just measures reflecting the needs of all major types of citizens.

Points for Practitioners
The paper identifies four different groups of residents based on their perceptions of climate change and their activities to adapt. Each group needs to be considered separately when designing adaptation strategy in order not to exacerbate existing socioeconomic inequalities. The findings also point to the need to strengthen municipality's activities in the area of climate change education.

Keywords
climate change, awareness, typologies, adaptation, mitigation

Introduction
Climate change and its impacts are a major global challenge, which also requires an active approach at other levels. At the local level, it is necessary to focus on adaptation activities, which will help agents to acclimate, or ideally take advantage of the climate change.
The authorities can act only if the public understands the potential impacts of climate change and acknowledges the importance of action. Designed policies must be perceived as a legitimate way how to tackle this issue. Although public opinion and climate change awareness evolves over time, the spectrum of stances remains broad. In addition, local authorities must understand the needs of the residents. Cities have to gather information on whether residents are aware of the risks connected to the climate change. In participatory planning of adaptation strategy, the local authorities should use specific knowledge of the residents, who possess specific knowledge about their neighbourhoods.

So far, the research on climate change awareness and typologies has been done mainly on national level, or in specific groups, e. g. teenagers or dairy producers (Leiserowitz et al., 2009; Maibach et al., 2011; Metag et al., 2015; Rhead et al., 2018; Kuthe et al., 2019; Barnes et al., 2013). As cities can play a major role in climate action, this study focuses on audience segmentation at local level. Košice, a second largest city in Slovakia, is an example of city which until recently had not experienced any major climate-change related problems. However, it seems that residents start to experience some of the manifestations of global warming in their own lives and local authorities are expected to act. So far, there is no climate adaptation strategy available for Košice, and therefore better understanding of climate change awareness, attitudes and activities of citizens, is vital at this stage. Therefore, the main contribution of this study to existing research is analysing climate change awareness in the context of cities, which is one of the main levels at which action should be taking place.

Adaptation and mitigation
Dealing with climate change can be either focused on mitigation, that is, on reducing the magnitude of changes, or adaptation, aiming to make such adjustments so that the harmful impacts are minimized. We can use a formal definition from Hallegatte (2011) - adaptation is "the set of organization, localization and technical changes that societies will have to implement to limit the negative effects of climate change and to maximize the beneficial ones". Reactive adaptation is executed ex post, when the impact of the climate change is already present. Proactive adaptation is prepared ex ante, trying to reduce vulnerability or take advantage of the forthcoming

changes (Smit et al., 2000). In order to be more efficient, it would be optimal to focus on mitigation, as the uncertainty makes costs of proactive adaptation measures higher and reactive measures do not, by their nature, prevent the damages (Shalizi and Lecocq, 2009). In reality, mitigation is most effective at global level, thus it is vital to focus on adaptation in regional scope.

Adaptation in cities
How climate change manifests itself in specific cities depends on multiple factors which affect micro-climatic conditions in the area. It is mainly horizontal and vertical structure of settlements, proportion of built-up area, ratio of permeable and impermeable surfaces, spatial allocation of green areas, shading and morphological features which influence air flow (MŽP, 2017).
Urban areas are specific because the original natural structures are replaced, and new materials have different properties, such as impermeability or capacity to accumulate heat (Gill et al., 2007). In such conditions, various micro-climatic phenomena occur - one of them being urban heat island (UHI). UHI is an urbanized area, which differs from its rural surrounding by having higher temperature. This phenomenon was also identified in Košice, where higher temperatures were present in areas with impermeable surfaces and lack of green spaces or water (Onačillová and Gallay, 2018; Hofierka et al., 2020).
Typically, the sectors that can be affected by climate change are the following - water management, energy, transportation, telecommunications, health-care, social services, buildings, recreational and historical sites (Revi et al., 2014).
In general, it seems that cities are lagging behind with their adaptation strategies and activities. According to global survey by Araos et al. (2016), a substantial number of studies cities had not prepared adaptation strategies or they had not provided any information about such activities. Only 18 % of cities published reports on their adaptation measures. New York, or London, Hamburg, Marseilles and Birmingham in Europe are among the most prominent examples of good practices.

Climate change awareness
According to the Eurobatometer survey conducted in 2019, 78% people in Slovakia consider climate change to be a serious problem, which roughly corresponds to the average in the EU. It is important to notice the trend – since 2017, the number has increased by 11 percentage points. Two-thirds of respondents declared that in the last 6 months they took part in activities focused on combatting climate change. It is more than the EU average and again, an increase by 22 percentage points. When specific examples are provided, the number increases to 94%.

The degree of climate change awareness differs across countries due to several reasons. One of the most prominent factors is education. 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 play a major role (Lee et al., 2015). A more recent study finds that even the effect of education is not the same across countries or political affiliation (Czarnek et al., 2020). In more developed countries, the topic of climate change is more politicized, and thus education might not be enough to raise awareness about the risks of climate change, and especially for right-wing voters.

A meta-analysis of papers studying various characteristics connected to perceptions of climate change and its impacts offers a wider perspective (Hornsey et al., 2016). It arrives at the conclusion that the effect of obvious factors such as education, sex, subjective knowledge or personal experience is overshadowed by the magnitude of the effect of values, worldviews and political orientation. Whether a person is liberal or conservative has two times stronger effect on belief in climate change than other sociodemographic characteristics. People who believe in climate change are usually younger, more educated, with higher income. Female sex or non-white race had smaller effect. Subjective knowledge of scientific findings concerning climate change is according to the meta-analysis approximately the same for "believers" and "sceptics", but higher level of objectively measured knowledge is connected to stronger belief in climate change.
Hornsey et al. (2016) argue that one of the psychological determinants of climate change belief is a cognitive heuristics, when people believe in validity of information based on trustworthiness of its source or existence of 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) also explains the role of identities. The most prominent factor in predicting climate change belief was "New Ecological Paradigm", which is a set of claims concerning the environment and the need for limiting the harmful impacts of human activity on the nature. Also those who identified themselves with "green" or activist identity, were more prone to believe in climate change. An intuitive finding is that people who value the environment are also more likely to believe in climate change. Hornsey et al. (2016) then elaborate on the Theory of Cultural Cognition which claims that people perceive risks based on how they think society should

function. If they value individualism and hierarchy, they also respect elites and prefer keeping the status quo. These people then do not believe that industry causes harm to environment. Scepticism towards climate change is also connected to belief in free market. On the other hand, people who are proponents of egalitarian society and value community values, are more likely to morally suspect industry and its impact on nature.

Whether personal experience with extreme weather conditions and their impacts is connected with stronger belief in climate change is a vital question. Meta-analysis shows that although this nexus is statistically significant, its magnitude is low (Hornsey et al., 2016). It also finds that belief in climate change is not a sufficient predictor of environmentally friendly action. Belief is more connected with intention to act, than with real activity.

When designing policies, authorities have to understand their audience and prepare efficient communication strategy. One of the approaches is to adjust the message to various groups within society, so that policies are communicated with respect to each group's needs. In the US, the research focused on finding the most prominent groups based on climate change awareness is conducted within the project Global Warming's Six Americas. It began in 2008, and since then, the authors regularly gather data from surveys and publish their findings. One of the main components of this research is audience segmentation. In this approach, the respondents are divided into groups based on their similar characteristics – their opinions and proclaimed values. In this particular project, six distinct typologies are identified. As the project has been running for more than 10 years, it allows to study the trends across time. We can see that ratio of sceptics in the population has been decreasing, while the group of "alarmed" is getting more prominent (in 2020 this group is twice as big as in 2015). Americans are more and more engaged and support policies aimed at combatting climate change. A similar research was conducted by Metag et al. (2015), who studied the typologies in Germany, Rhead et al. (2018) who analysed classes of respondents in the UK, or by Kuthe et al. (2019) who focused on teenagers in Austria and Germany.

Data

Data used in this paper originate from a survey among residents of Košice. It was conducted primarily online, from October 2019 to January 2020. The questionnaire was accessible and advertised through social media, web page of the project KOŠICE ± 40 and web pages of the partners of the project. Moreover, the information about the questionnaire was sent by Košice municipality to all its affiliated institutions with request to distribute it among employees. In addition, the questionnaire was sent to 100 businesses in Košice. In schools or retirement homes, the questionnaire was available also in paper form. Only responses from residents of Košice were accepted.

Together the sample consisted of 598 of valid responses. A random sample was then drawn in such way so that it was representing the structure of residents in Košice. The process of gathering the data and adjusting the sample was adopted from standard methodologies applied in market research (Trnka, 2016).

The final sample thus contains 368 observations and reflects the structure of residents based on these characteristics:
1. Sex
2. Age (categories: 15-19, 20-29, 30-39, 40-49, 50-59, 60 +)
3. Residents in Košice' districts (KE I, KE II, KE III, KE IV)

Descriptive statistics

Almost half of the respondents think that climate change is both a global and local issue. Interestingly, 38% of residents perceived climate change to be a local, but not global problem. Only 2% think that climate change is not a problem at any level.

Table 1: Percentage of respondents according to their perception of climate change as a global/local problem

		GLOBAL	
		yes	no
LOCAL	yes	47,6%	38,3%
	no	12,2%	1,9%

As for objective knowledge of climate change and its impacts, 61% of participants had sufficient level of knowledge. On the other hand, more than half of residents do not feel they receive sufficient information on the

impacts of climate change on the city. This signals that those who already have good knowledge on environmental issues are also eager to learn even more about the impact on their city.

Table 2: Level of objective knowledge and subjective level of received information

		Subjective level of received information			
		high	medium	low	SUM
Level of objective 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	

Residents of Košice mostly think that it is important to adapt to climate change (68%). Vulnerability, measured as own experience with the impacts of climate change, seems to be associated with perception that it is important to adapt – only 3% of all respondents are vulnerable and are neutral to adaptation at the same time. There was no such respondent who would claim to suffer from climate change impacts and think that it is not necessary to adapt.

Table 3: Objective vulnerability and perceived necessity do 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	

Figure 1 shows percentage of residents who engage in adaptation and mitigation activities according their frequency. Most of the sample claims they sometimes do both, and more than 30% of respondents engage in environmentally friendly activities on regular basis. The questionnaire also contained a question asking whether people think they are being informed about how to adapt to climate change in Košice. Only 5% claimed that they have sufficient information. Most of the respondents felt neutral in this respect.

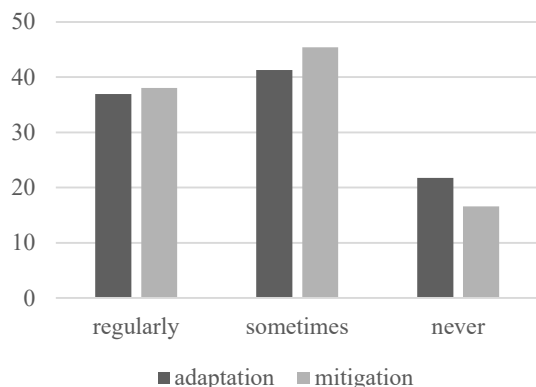**Fig. 1: Adaptation and mitigation activities**

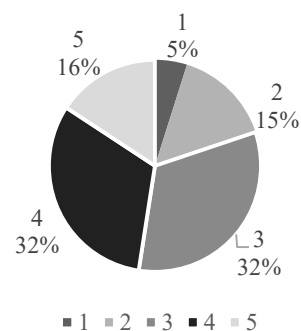**Fig. 2: Level of information (1 - high, 5 – low)**

Figure 3 shows how active interest local politics relates to received level of information about the adaptation to climate change. We can observe that those who are more engaged in civic participation are also less likely to be dissatisfied with the level of information they receive.

Fig. 3: Level of participation (1 – high, 3 – low) and level of information (1 - high, 5 – low)
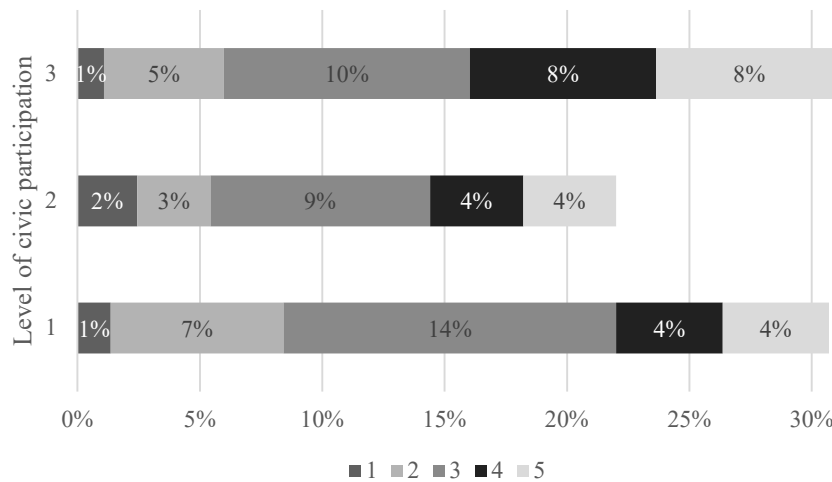
Methodology

Latent (unobservable) variables can sometimes explain behaviour of individuals. In psychologic research, methods which identify these variables are often used. In other to better understand the underlying characteristics which are associated with studied behaviours, we decided to apply Latent Class Analysis (LCA). This statistical method models relations among observed categorical variables and allows us to identify unobservable latent classes. These latent classes, or variables, are assumed to explain the variance of manifested variables. In this case, belonging to some group means that individual is similar to the others in this groups, while his behaviour differs from the one of the individuals from other groups. To conduct the analysis of the data, we used software Latent Gold, which is specifically designed for this purpose.

In our analysis, we used 7 explanatory indicators, based on which the respondents were divided into groups. These indicators reflect their opinions on climate change, their knowledge and participation. The variables were the following:

1. Knowledge about climate change and its impacts – indicator based on several questions trying to measure objective knowledge (three levels – high, medium, low)
2. Climate change awareness at global and local level (dichotomous - yes/no)
3. Awareness about the need to adapt (three levels – high, medium, low)
4. Level of information about the impact of climate change on the city (three levels – high, medium, low)
5. Vulnerability – own experience with the impacts of climate change (three levels – high, medium, low)
6. Participation in adaptation and mitigation activities (three levels – often, sometimes, never)
7. Civic participation at local level (three levels – often, sometimes, never)

Results

Using the LCA we were able to identify four types of residents. We assessed the fit of models with fewer or more classes based on information criteria and we chose the one with four groups because of the lowest value of information criteria. This means that the model with four classes is the most suitable for this sample. The groups and their characteristics are the following:

1. Potentially resilient

The largest group is the group of potentially resilient. It represents 29% of the sample. Almost two-thirds are women and 74% of people in this group are older than 40. They are mostly married and have children. As for their economic situation, they are typically employed and belong to the middle-income group.

The potentially resilient are aware that climate change is one of the greatest threats globally, but they do not admit it an issue with a high priority at the local level. This appears not to be in line with their (high) level of knowledge about climate change impacts and their proclaimed experience. On the other hand, they claim it is

important to adapt to climate change and take action in this respect. They regularly engage in adaptation and mitigation activities. They also take active interest in local politics.

2. Aware but passive

The second largest group is the group of aware but passive residents of Košice. They represent 27 % of the sample. Most of them are between 20 to 40 years old and lives in city centre. They are usually not married and do not have children. They belong in the middle-income group and are mostly employed.

People in this group are well aware of the seriousness of climate change and they are convinced it is an issue at global level. Their knowledge about the impacts is wide and is backed by their own experience. As a consequence, they are convinced it is necessary to adapt. However, in reality, their activities are not as numerous as in the Group 1. They are actively interested in local politics. They are not satisfied about the level of information available on how to adapt to climate change in cities.

3. Aware without opportunities to act

The third group constitutes 24% of respondents. Most of them are younger than 40, and in comparison to other groups, this group has more of respondents younger than 19. They are either well-educated, or they are still studying. If they are not studying, they are usually employed. As for their family status, they are not married and do not have children.

Similarly to the previous groups, they also think that climate change is a global problem, but do not fear it can endanger them at local level. they are well-informed about the climate change, but do not seem to experience it in their proximity. They engage only in few adaptation or mitigation activities. Their civic engagement is low and they claim they lack information about how to adapt to climate change.

4. Vulnerable

The smallest group represents 20% of respondents. It consists mainly of men and it is the group with the highest age – they are usually more than 60 years old. They usually live in family houses located in peripheries and have children. Most of them have a university degree and they are either employed or retired. In comparison to other groups, more unemployed are among the Vulnerable. People in this group belong to low-income group.

Unlike other groups, people in this group are not convinced that climate change is a problem. Their level of knowledge about climate change impacts is lower. They claim they do not experience the manifestation of climate change in their lives. Hence they do not think adapting should be a priority. On the other hand, in reality they engage in multiple adaptation or mitigation activities. They are not very engaged in local politics and do not feel well informed about adaptation to climate change in the city.

Discussion

The presented data-driven approach to identifying typologies of residents of Košice resulted in finding four distinct groups of people. In comparison to other research, we were able to identify fewer groups (e. g. in Leiserowitz et al. 2009, it was six groups in the US, or in Metag et al. (2015) it was five groups in Germany). As the methodology relies on the information that is present in the data, the results depend on the specific method chosen for the analysis and the way in which variables are coded. In further research, it would be useful to compare different methodologies (e. g. parametric LCA with non-parametric clustering methods) and different specification of input data. In this way, robustness of the results can be confirmed. Nevertheless, it is already possible to summarize some interesting observations from this analysis.

It is also necessary to understand the underlying motivation for given behaviour of people. For this, additional data would have to be collected. More specifically, it would be beneficial to study the awareness-action gap and the reasons why people do not act even though they think the society is facing a threat.

Conclusion

The topic of climate change is becoming more and present in public discourse. People are concerned, because their knowledge of the climate change has been broadening and is being supported by their own experience. Even though people are increasingly educated, an important finding for local policy makers is that residents of Košice are not satisfied with the amount of information they receive about climate change adaptation in the city. Using latent class analysis we were able to identify four distinct types of residents based on their attitude towards climate change. The people in the first group, the "potentially resilient", are very concerned and well informed about climate change. They also regularly engage in environmentally friendly activities and are active citizens. Second group, the "aware but passive" is similar in their perception of climate change as the first group. However, 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 not convinced that climate change

is a problem and they lack information about the impacts. On the other hand, in reality they engage in multiple adaptation or mitigation activities.

Local authorities can use these results to design efficient communication strategy focused on climate change. For example, they can encourage those who are already active, or provide more information to those who seem to underestimate the seriousness of the problem.

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APPENDIX – Table 1 – 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				
1 - regularly	50%	45%	7%	37%
2 - sometimes	31%	32%	22%	34%
3 - never	19%	22%	71%	29%

APPENDIX - Table 2: Percentage of respondents with given socioeconomic characteristics

	Group 1	Group 2	Group 3	Group 4
Sex				
1 - male	0,34	0,45	0,57	0,61
2 - female	0,66	0,55	0,43	0,39
Age				
do 19	0,03	0,03	0,20	0,01
20-29	0,07	0,29	0,27	0,08
30 - 39	0,16	0,42	0,23	0,10
40 - 49	0,21	0,19	0,20	0,17
50 - 59	0,25	0,05	0,00	0,20
60+	0,28	0,02	0,10	0,44
Place of residency				
1 - city centre	0,20	0,24	0,21	0,19
2 - large boroughs	0,60	0,63	0,77	0,60
3 - peripheries	0,20	0,13	0,02	0,22
Education				
primary school	0,03	0,05	0,10	0,01
high school	0,02	0,02	0,07	0,04
high school with diploma	0,35	0,20	0,31	0,28
university	0,60	0,73	0,53	0,67
Family status				
1 - single	0,18	0,57	0,63	0,05
2 - married	0,71	0,43	0,27	0,56
3 - divorced	0,07	0,00	0,09	0,14
4 - widowed	0,04	0,00	0,01	0,25
Children				
0 - no	0,15	0,65	0,64	0,09
1 - yes	0,85	0,35	0,36	0,91
Economic status				
0 - other	0,00	0,00	0,00	0,01
1 - employed	0,66	0,58	0,58	0,40
2 - self-employed	0,06	0,13	0,09	0,07
3 - student	0,08	0,20	0,33	0,05
4 - unemployed	0,00	0,04	0,00	0,08
5 - retired	0,18	0,00	0,01	0,37
6 - maternity leave	0,02	0,06	0,00	0,01
Type of building				
1 - apartment building	0,13	0,27	0,12	0,16
2 - block of flats	0,70	0,51	0,72	0,61
3 - family house	0,17	0,22	0,16	0,23
Income				
1 - low	0,10	0,16	0,00	0,42
2 - middle	0,90	0,84	1,00	0,58