Geographia Polonica
2023, Volume 96, Issue 2, pp. 221-237
https://doi.org/10.7163/GPol.0252

INSTITUTE OF GEOGRAPHY AND SPATIAL ORGANIZATION
POLISH ACADEMY OF SCIENCES
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ADAPTATION TO CLIMATE CHANGE AT DISTRICT LEVEL IN THE CASE OF BUDAPEST, HUNGARY

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Abstract

Hungary's capital, Budapest is divided into 23 districts, which have significantly distinct topography: thus, having different level of vulnerability to certain climatic effects; in addition, their climate adaptation potential also varies. This study aimed to analyze the 23 districts of Budapest, Hungary, in terms of their climate adaptation consciousness from governmental perspective. The study compares the 23 districts through a scoring matrix with three main categories – attitude, planning, and implementation – and several criteria. In addition, interviews were organized with municipal employees with 43 questions following the structure of the scoring matrix, learning more about the districts' commitment to climate adaptation.

Key words

climate change • climate adaptation • district scale • Budapest • Hungary

Introduction

The world population is constantly increasing, and according to the United Nations forecast (UN 2018), the rate of urbanization in Europe by 2050 may reach 83%, which proportion in global terms was more than 50% from the beginning of the 2000s (UN, 2015). Extreme weather events are becoming more prevalent in cities (Bai et al., 2018), having increased adverse impacts on them and their infrastructures, such as inland flooding and associated damages, or storm-induced damages in coastal areas, and harm to key economic sectors according to the European region (IPCC, 2022). Changing climatic patterns and their direct and indirect effects make cities even more vulnerable (Ürge-Vorsatz et al., 2018), affecting urban systems, such as infrastructure, built environment and the residents (Carter et al., 2015), and the health status will be negatively impacted by climate change and its local effects in the coming decades, according to Uzzoli (2016). As a consequence, the issue of climate change and climate adaptation[1] needs to be given higher priority in urban life and municipal governments must take actions. Meeting the energy and climate goals of the EU, regions, provinces, and municipalities play an important role (Pietrapertosa et al., 2021), and thus measuring the adaptation performance of cities becomes essential. In the international literature, several studies examined the adaptation planning of cities (Preston et al., 2011; Baker et al., 2012; Heidrich et al., 2013; Reckien et al., 2015; Araos et al., 2016; Geneletti & Zardo, 2016; Aguiar et al., 2018; Reckien et al., 2018; Heikkinen et al., 2020; Olazabal & Gopegui, 2021; Yang et al., 2021; Pietrapertosa et al., 2021), some of which analyzed adaptation planning along with mitigation (Reckien, 2014; Pietrapertosa et al., 2019; Otto et al., 2021).

The main aim of this study is to establish a qualitative strategy evaluation system to assess the 23 districts of Budapest in terms of their climate adaptation consciousness from a local government perspective by deeply analyzing thematic planning documents. Furthermore, we aim to develop an evaluation framework that can be easily adopted by other cities, mainly in the Central and Eastern European region; consequently, international comparative analyses can be made in the future. As Reckien et al. (2015) concluded, a city's population size and unemployment rate are correlated with the odds of having mitigation and adaptation plans; the comparison of the districts becomes justified as the districts of Budapest significantly vary in terms of socioeconomic factors. The following is a summary of the contributions of this work:

- expands the international literature by elaborating and applying a strategy-based qualitative analysis approach to evaluate climate adaptation processes on local scale;
- the quantitative, methodological vulnerability/adaptation analysis can be supplemented by this study;
- reveals the obstacles and drivers of successful adaptation planning.

Literature review

Hungary faces various changes regarding its climate, e.g., increasing warming for all the four seasons, with the largest temperature increase for summer (Bartholy et al., 2007), moreover heatwaves are expected to happen more frequently in the twenty-first century (Pongrácz et al., 2013). Therefore, numerous aspects of vulnerability or climate adaptation studies can be found in the Hungarian literature, most commonly with sector focus, such as tourism (Csete et al., 2013; Németh et al., 2020; Kovács & Király, 2021), agriculture (Mesterházy et al., 2014; Kovacs et al., 2017; Li et al., 2017; Biró & Szalmáné Csete, 2020; Buzási, 2021), transport (Csiszár et al., 2019), and human health (Paldy & Bobvos, 2010; Uzzoli, 2016). Besides that, Csete and Horváth (2012) compared a foreign (London) and a Hungarian (Csömör) city regarding their adaptation strategy, Csete and Buzási (2016) evaluated an applied set of indicators regarding local adaptation plans; Baranyai et al. (2017) examined the regional differences in attitudes on climate change; Uzzoli and Bán (2018) examined Hungarian local municipalities according to their preparation for and adapting to the health effects of heatwaves; finally, Uzzoli et al. (2018) evaluated the vulnerability level of the LAU1 levels of Hungary, based on the exposure, sensitivity, and adaptive capacity. Csete and Buzási (2020) analyzed the climate change strategies on different spatial levels (NUTS-3 and LAU-1); Buzási (2022) evaluated the heatwave vulnerability of the 23 districts of the Hungarian capital, Budapest, which paper fills a scientific gap in the Hungarian literature in terms of the methodology applied and a result obtained. Through careful consideration of the studies concentrating on the Hungarian context, it may be concluded that the strategy-based

[1] "Adaptation is defined, in human systems, as the process of adjustment to actual or expected climate and its effects in order to moderate harm or take advantage of beneficial opportunities. In natural systems, adaptation is the process of adjustment to actual climate and its effects; human intervention may facilitate this." (IPCC, 2022: 5)

analysis approach of urban climate adaptation processes is almost entirely lacking in the Hungarian literature.

Research area

The study area of this paper is Budapest, the capital of Hungary, situated in the Carpathian Basin on the line of the river Danube. Budapest has 23 districts on the western (Buda) and eastern (Pest) side (see Fig. 1), and according to the Hungarian Central Statistical Office (HCSO's) statistics, there are 1.7 million people living in 525 km^2, meaning an average population density of about 3200 people per km^2. However, the area and population size vary greatly among the 23 districts, so does the population density (see Table 1.). Even though there are only 6 districts on the Buda side, they account for a significant share of the territory and population compared to the districts of Pest side.

In terms of demographic characteristics, a Buda and Pest axis can be observed. The elders and children are the most vulnerable age groups (Uzzoli et al., 2018), and considering the age distribution of Budapest, fairly high values can be determined on the Buda side regarding the proportion of over 65 (elders); however, the sample is more homogeneous between the districts in terms of the percentage of children under two (see Fig 2.).

According to the Sustainable Energy and Climate Action Plan (SECAP, 2021) of Budapest, the high-risk climate hazards are extreme heat and heatwaves, heavy rainfalls, flash floods and flooding, drought and water shortage, diseases spreading through the air (droplet infection), the spread of invasive, non-indigenous animal species, and spread of invasive, non-indigenous plant species. Floods, storm-wind, diseases spread by pathogen transmitters, the spread of allergens, rise in UV-B radiation, and infestation or mycosis of vegetation are at medium risk level, whilst landslide and land subsidence are noted as low risks. As Buzási (2014) acknowledged, the two primary climate-related concerns facing Budapest in the twenty-first century are intensifying heatwaves and rising flood danger. Flood danger is not relevant to all districts, only for the population living on a floodplain or near flood protection structures of insufficient crest height; nonetheless, heatwaves appear as a high priority issue, as Smid et al. (2019) highlighted that Budapest, as a continental European city, will experience a sharp rise in heatwaves occurrence. According to Buzási (2022), the number of tropical nights – when the daily minimum temperature exceeds 20°C (European Environment Agency, 2012) – also shows a significant increase in the 2010s, reaching almost the number of 250. As it is clearly depicted in Figure 3, in the period from 1952 to 2021, a total of 16 tropical nights were

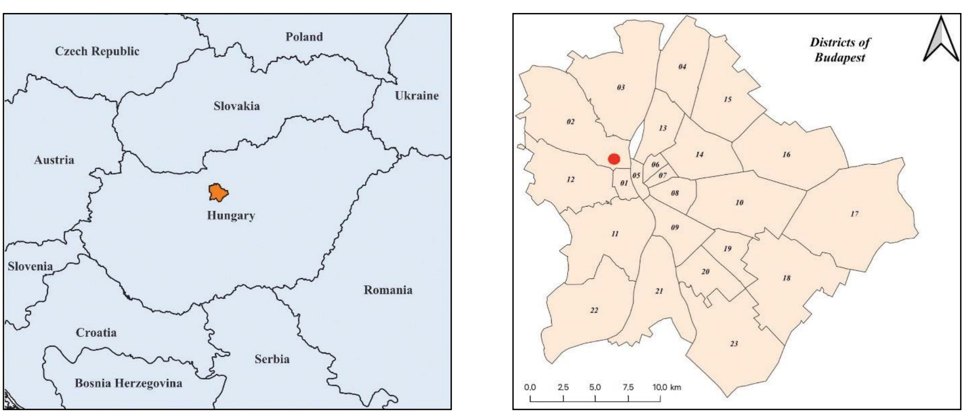

Figure 1. Study area and Budapest inland station situated in the 2nd District (red circle)

Table 1. Statistical data of the districts of Budapest, 2020

District	Buda or Pest side	Population size, 2020 [ppl]	Area size, 2020 [km^2]	Population density, 2020 [ppl/km^2]
BP01	Buda	25,966	3.41	7,614.66
BP02	Buda	86,708	36.34	2,386.02
BP03	Buda	124,582	39.7	3,138.09
BP04	Pest	94,877	18.82	5,041.29
BP05	Pest	25,629	2.59	9,895.37
BP06	Pest	36,686	2.38	15,414.29
BP07	Pest	50,196	2.09	24,017.22
BP08	Pest	70,431	6.85	10,281.90
BP09	Pest	54,221	12.53	4,327.29
BP10	Pest	70,873	32.49	2,181.38
BP11	Buda	131,288	33.49	3,920.21
BP12	Buda	57,091	26.67	2,140.64
BP13	Pest	115,568	13.44	8,598.81
BP14	Pest	112,361	18.13	6,197.52
BP15	Pest	76,875	26.94	2,853.56
BP16	Pest	72,800	33.51	2,172.49
BP17	Pest	86,905	54.82	1,585.28
BP18	Pest	99,893	38.6	2,587.90
BP19	Pest	57,075	9.38	6,084.75
BP20	Pest	62,294	12.19	5,110.25
BP21	Pest	71,977	25.75	2,795.22
BP22	Buda	55,660	34.25	1,625.11
BP23	Pest	22,482	40.77	551.43

Source: elaborated by the authors based on TeIR (National Spatial Development and Spatial Planning Information System) data.

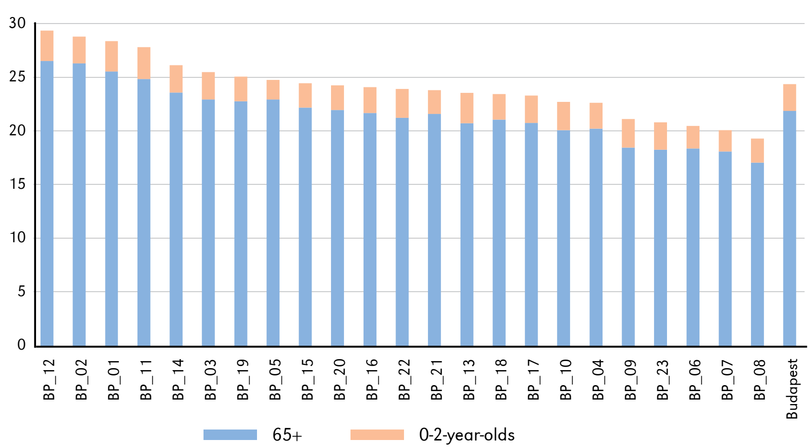

Figure 2. The share of the most vulnerable age groups -elderly (65+) and 0-2-year-olds- of Budapest and its districts compared to the overall population, 2020 (%)

Source: elaborated by the authors based on TeIR (National Spatial Development and Spatial Planning Information System) data.

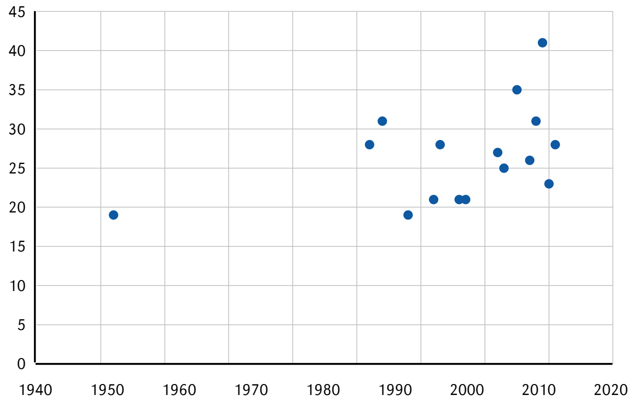

Figure 3. The years with the highest number of tropical nights at the Budapest inland station from 1952 to 2021[2]

Source: elaborated by the authors based on Hungarian Meteorological Service (OMSZ) data.

measured in Budapest inland station (the location of the station is indicated in Figure 1 – red circle in the 2nd District of Buda side), with increasing frequency since the 1990s. Though extreme events, such as storms, mostly affect the Temperate Oceanic regions (Lindner et al., 2010), they also appear as a serious problem in the case of Budapest. As Hattermann (2018) stated, cities are particularly vulnerable to pluvial floods in part due to their high ratio of impervious surfaces.

A considerable heterogeneity can be observed through the green area intensity of the districts. According to the most recent data (2019), the average green area in municipality property (e.g., public gardens) in Budapest is about 9 m^2/capita; however, in the 6th and 7th Districts it does not reach 1 m^2, whilst in the 21st District this value is almost 30 m^2/capita. Green areas play a crucial role in climate adaptation; however, as Figure 4 (A) illustrates, the green area intensity is exceedingly lower in downtown of Budapest than in the case of outer areas. Figure 4 (B) also depicts that the surface temperature in Buda side is significantly less than in the Pest side, and it is conspicuous that the surface temperature increases when the green area intensity decreases, mostly in the inner district; thus, it emphasizes the necessity of the development of green areas in cities.

Scoring /evaluation matrix

The methodology of this study is based on two parts; establishing a scoring /evaluation matrix based on primary data collection from websites, local climate strategies, and SECAPs, moreover gathering precious information by interviewing the municipality employees of the districts. The interview questions were prepared in a Microsoft Word document and sent via e-mail to the interviewees. During the establishment of the scoring/evaluation matrix, the focus was on three categories, serving as a guideline while collecting data: attitude, planning, and implementation, with distinct aspects in each category (see the details in the Appendix I – available in online issue).

Analyzing the attitude of each municipality, the aim was to get an understanding of their willingness to move forward to adequate adaptation processes and prepare the districts for the negative effects of climate change. Most of the points belong to the

[2] The Budapest inland station is situated at the central building of the Hungarian Meteorological Service, indicated by the red circle in the 2nd District, Figure 1.

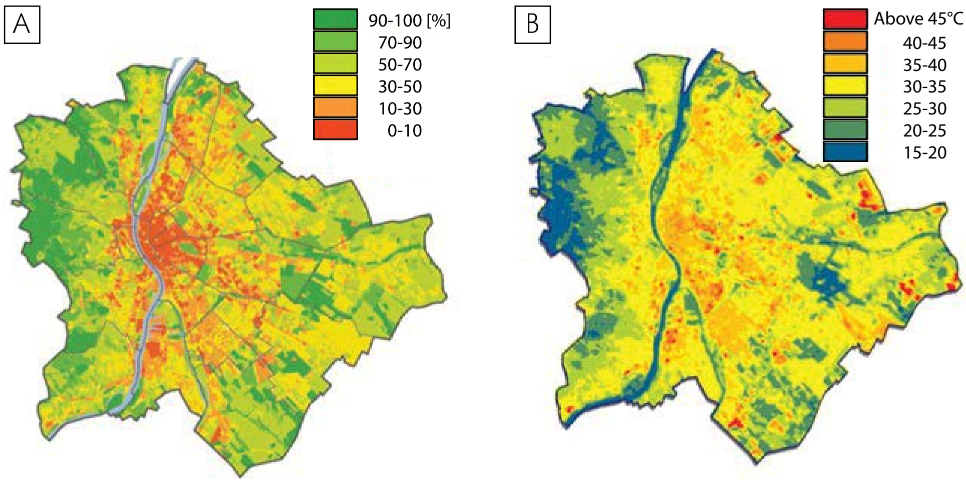

Figure 4. (A) Green area intensity in Budapest, 2015; (B) Surface temperature of Budapest on August 31, 2016

Source: (A) SECAP Budapest (2021); (B) Edited, based on Budapest Climate Strategy (2018)

planning part, emphasizing its high relevance at the municipality level; thus, in addition to having climate strategies, it is important to evaluate their quality regarding the goals, directions and actions involved. Since Climate Strategy and SECAP are non-binding documents, the papers completed before 2014 receive a higher point than the documents completed later; however, in the case of the Environmental Protection Strategy, as being a legally defined, binding document (LIII of 1995 Act on the General Rules of Environmental Protection), the more recent ones get the higher point. The SECAP of Budapest (2021) provided the criteria for further analysis of the strategies at the district level. Budapest's SECAP defines six comprehensive adaptation objectives, four of which are relevant for all the 23 districts; see them listed below:

- Development of the green–blue infrastructure (Objective Aá-1).
- Mitigation of the heat island effect in the built environment (Objective Aá-2).
- Adaptive rainwater management (Objective Aá-4).
- Preparation for extreme weather conditions and the health impacts of climate change (Objective Aá-5).

The strategies were scored by the extent to which they cover the previously defined four adaptation objectives. In the next part, the vulnerable sectors were assessed, for which the Second National Climate Change Strategy of Hungary (2014-2025) provided as a guide. Considering the characteristics and competence of the districts, the sectors listed below have been selected in the process.

- Human health and safety.
- Water management.
- The built environment, settlement development, and settlement infrastructure.
- Energy infrastructure.
- Transport.

The aim was to analyze whether the strategies mentioned the listed vulnerable factors and whether adaptation actions have been imposed on them. Studying the Climate Strategy of Budapest (2018), the SECAP of Budapest (2021), and the Second National Climate Change Strategy of Hungary (2014-2025), seven vulnerable social groups have been defined (see them listed below) as the following analytical premise:

- Elderlies (population over 65 years).
- Smaller children and babies (population 0-5-year-olds).

- People with disabilities.
- People with cardiovascular disease.
- People with allergies.
- Homeless people.
- Unemployed people.

In the following section, the municipal implementation was analyzed with the aim to judge whether the municipalities have the appropriate organizational structure and tools to achieve climate adaptation goals. For example, the existence of the departments and committees relevant to the topic, or the projects, websites, and cooperation with civil associations can improve the progress of the climate adaptation objectives.

Interviews with municipal employees

The second part of the methodology is based on interviews with municipal employees. Due to the COVID-19 pandemic and the considerable number and complexity of the questions, it was decided that the municipal departments are contacted electronically; thus, having the opportunity to discuss the questions with their expert colleagues relevant to the topic; moreover, the interviewees had the occasion to gather further information from other municipal departments. The purpose at this stage was to find the most relevant municipal department to receive adequate answers to the questions. Primarily, departments involved in environmental protection were contacted; in the absence of this, architectural departments were interviewed since they also deal with settlement development. Altogether forty-three interview questions were defined (see them in the Appendix II – available in online issue), which also followed the structure of the previously introduced scoring matrix (attitude, planning, implementation). The interview contained diverse types of questions, such as rating scales (1-10), open and closed text, list choice, and ranking questions. The aim was to get to know the municipalities' knowledge on the subject and their commitment to climate adaptation; furthermore, the formulated questions also aimed at getting information about their plans, drivers, and barriers.

Results

This paper aims to analyze the adaptation consciousness of the 23 districts of Budapest by establishing an evaluation/scoring matrix and formulating interviews with the municipality employees in each district. Figure 5 that was created in Microsoft Excel by Conditional Formatting Color Scale function to represent a nuanced list of partial and total results demonstrates the partial (attitude, planning, implementation) and total results of the scoring matrix, in which the greener values indicate the desirable outcomes. In terms of the partial results, the 18th District is remarkable since having homogeneously high values in each category, as illustrated by the green signal (see Fig. 5.); nonetheless, the 11th District has better results in terms of planning. According to the findings the outer districts are typically those at the bottom of the ranking. Surprisingly, the adaptation planning of the 2nd District (Buda side) lags the others, despite it is located between the well-represented 3rd and 12th District.

It can be stated that half of the districts are members of associations regards with climate change (Covenant of Mayors and Climate-Friendly Municipalities), which positively affect both planning and implementation. Even though just three – 3rd, 13th, and 18th District – of the twenty-three districts received climate awareness rewards, we considered it promising as it could have a good impact on future developments. Additionally, points were given for attending the interview, which offers valuable insight into a district's willingness and level of commitment to climate adaptation; the participation was about 50%, which is deemed encouraging for future analysis and cooperation.

Most of the districts have Climate Strategy; however, SECAP is not that widespread, only appearing in around half of the districts. The climate strategies and SECAPs were

	ATTITUDE	PLANNING	IMPLEMENTATION	TOTAL
BP01	3	15.5	6.0	24.5
BP02	0	0.0	7.0	7.0
BP03	3	27.0	7.0	37.0
BP04	1	35.0	7.5	43.5
BP05	0	0.0	5.5	5.5
BP06	1	18.5	5.5	25.0
BP07	2	37.0	8.0	47.0
BP08	2	19.0	6.0	27.0
BP09	0	16.0	8.0	24.0
BP10	3	20.0	6.0	29.0
BP11	2	37.0	8.5	47.5
BP12	3	32.0	7.5	42.5
BP13	2	20.0	5.0	27.0
BP14	3	24.0	6.5	33.5
BP15	1	0.0	2.5	3.5
BP16	2	0.5	6.5	9.0
BP17	0	2.0	7.0	9.0
BP18	3	35.0	8.5	46.5
BP19	2	30.0	5.5	37.5
BP20	0	34.0	6.0	40.0
BP21	1	18.0	7.0	26.0
BP22	2	16.0	6.0	24.0
BP23	0	0.5	6.0	6.5

Figure 5. The partial and total results of the scoring system (Green color (higher points) indicates more climate-conscious attitude, while red color (less points) indicates less climate-conscious attitude)

released around the year 2020, which is not surprising since they strongly depend on the funding source KEHOP – Environmental and Energy Efficiency Operational Programme, "aim to support sustainable growth and contribute to achieving the Europe 2020 targets for smart, sustainable and inclusive growth" (ec.europa.eu, n.d.) – in terms of the development of the strategy and the funding of some of the projects. In general, it can be concluded that the districts' adaptation actions largely address the four previously introduced climate change-related problem areas. Figure 6 depicts the number of climate adaptation actions according to the objectives they cover, of which "Preparations for extreme…" objective represents outstanding values. Figure 7 illustrates the district-scale distribution of the adaptation actions, which does not provide complete coverage due to the absence of SECAPs or climate change strategies, and hence, the lack of defined actions in some districts.

It is crucial to identify sectors and social groups that are vulnerable to climate change in climate strategies and SECAPs, which define objectives and actions. Undeniably, all residents of a city are considered vulnerable e.g., in the event of extreme storms and heat, but there are groups that require special attention due to certain characteristics. Although all the twenty-three districts of Budapest cover the vulnerable sectors -albeit with different details-, the disadvantaged social groups are rarely mentioned in the strategies. As Figure 8 highlights, mostly the group of elderly people along with smaller children and babies appear in the strategies.

Regarding the adaptation actions of the vulnerable sectors in climate strategies, it can be stated that most of the actions belong to the area of "Built environment, settlement development, settlement infrastructure", not surprisingly, since it covers numerous different areas. The least number of actions belong to "Energy infrastructure" and "Transport"

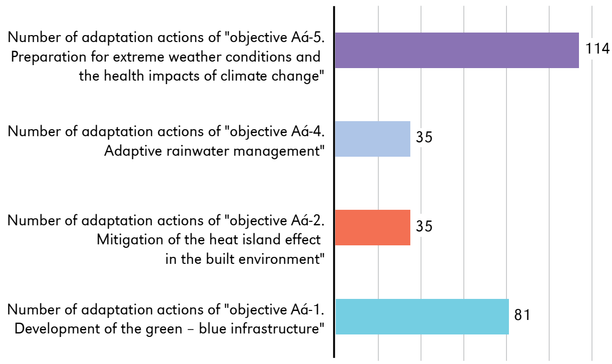

Figure 6. Classification of the adaptation actions regarding the objectives they cover

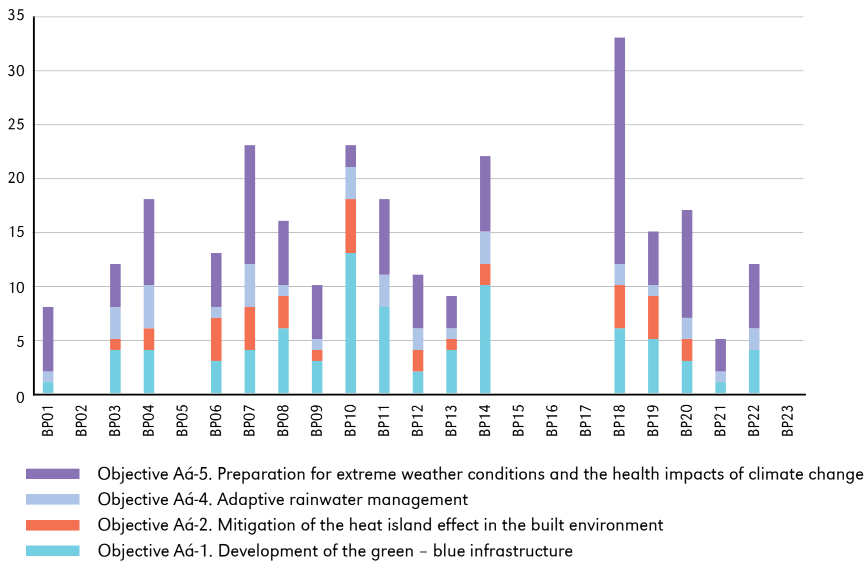

Figure 7. Classification of the adaptation actions based on the objectives they cover – district scale

sectors (Fig. 9), since most of their actions are included in mitigation planning; thus, other areas are given higher priority in the adaptation section.

The category of implementation describes how the districts attempt to conduct climate adaptation actions, how they attempt to meet the targets set, what resources they have available, and what sort of framework they have constructed to enable all of this. About half of the districts do not have Environmental Protection Department; instead, other municipal units are assigned environmental protection, and therefore also climate protection goals, which may, for example, indicate the low relevance of the climate protection topic area. Only five districts (7th, 13th, 14th, 15th, 17th) do not have an environmental, climate, or sustainability committee, whereas the remaining districts all have at least one of these. According to the projects, civil association collaborations, and climate/environmental funds, the districts present a favorable picture. Projects related to rainwater harvesting, greening (e.g., green wall), and energy

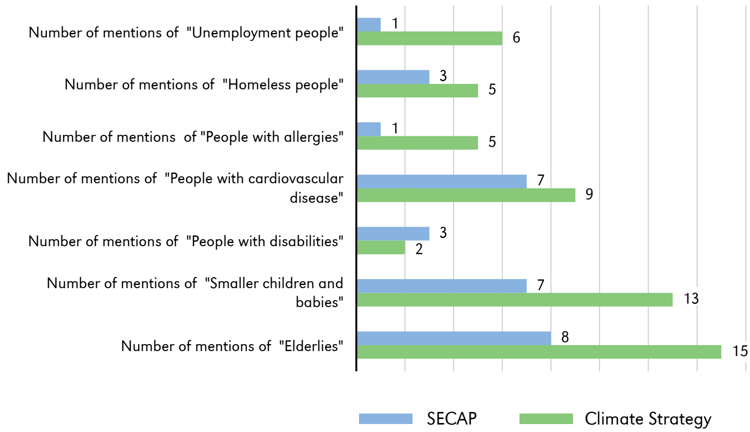

Figure 8. How many times did each plan of the districts refer to the social groups described as being vulnerable?

efficiency were found to be exceedingly popular in the districts and occurred in large numbers.

Altogether, eleven of the twenty-three municipalities participated in the interviews. Even though fewer than half of the districts participated, it can be concluded that approximately half of Budapest (48.68%) was covered during this phase of the examination based on population data. The municipalities were contacted in February 2022 and responded within a month on average; however, it took them longer to respond to the questions. The interviewees' professions varied widely, there was a chief architect, head of the Climate Protection and Sustainability Cabinet among them, and other interviewees covered the area of environmental protection, spatial planning, geospatial information, and landscape architecture. According to their opinions heatwaves are found to be the most relevant problem, to which the elderly and young children are identified as the most vulnerable. Although all the participant districts find vulnerability analysis important, only the 12th District performed such an analysis. Despite the districts' belief about being sufficiently aware of the concept of climate change, which is proved generally, not everyone was aware of the local regulations related to climate adaptation. According to their experience, there are numerous barriers to preparing for climate adaptation, including a lack of funding, organization, public awareness of climate change, regulations, and commitment; nevertheless, they also reflect that tenders, financial support, the development of public opinion, sponsor participation, the coordination of organizational units, and a dedicated representative body seem to be the driving forces.

Figure 10 demonstrates the overall results of the analysis, the degree of climate adaptation consciousness of the 23 districts of Budapest. Comparing the performance of the districts of Buda and Pest side, we cannot clearly state which of them is more adaptive-conscious; however, half of the Buda side districts (11th, 12th, and 3rd) were found to be highly conscious regarding their adaptation. The 2nd District, situated between the well-performed 3rd and 12th District, appears as an exception due to its low adaptation consciousness. It has neither a Climate Strategy nor a SECAP, which is one of the key causes of the significant lag of this district since the planning category receives the highest percentage of points in the scoring process. Broadly, the Pest side districts being in the outer part of Budapest belong to the lower performing districts, followed by the highly built-up inner districts. Despite being

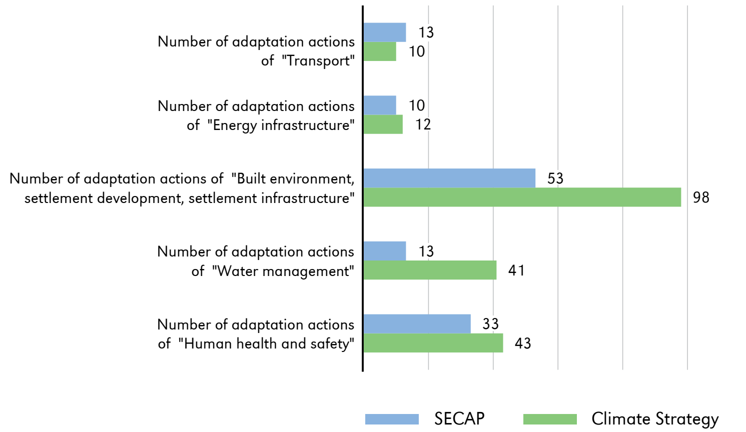

Figure 9. Distribution of the adaptation actions in the climate strategies and SECAPs of the districts – vulnerable sectors

bordered primarily by districts that are lagging, the 7th District achieved the prestigious second place in the analysis.

In summary, implementation proved to be the most homogeneous category, while the values of attitude and even more of planning range on a much wider scale, meaning that the differences are much more perceptible; all this let us conclude that the districts of Budapest do not present a coherent picture in terms of their quantity and quality of planning strategies. Despite the similar structure of the strategies the number and types of the adaptation actions vary greatly. It is worth highlighting that the grouping of adaptation actions is often unclear, and there may be significant overlap between them. All the plans do pay attention to the relevant vulnerable sectors -although discuss it in a different depth-; however, the appearance of the vulnerable social groups does not show unified image.

Discussion and conclusions

The commitment of the districts to climate adaptation is slightly different; eight of the 23 districts (2nd, 5th, 9th, 15th, 17th, 20th, 21st, and 23rd District) are not members of the Covenant of Mayors or Climate-Friendly Municipalities, even though Reckien et al. (2015) found a correlation between belonging to such a network and the existence of adaptation plans, as well as Heikkinen et al. (2020) stated that the cities members of transnational municipal networks are more advanced in adaptation. This study also depicts a correlation between the memberships and results: the districts not being a climate network member are at the bottom of the ranking; in addition, in most cases, the districts being a climate network member do have higher values in the planning category, which let us conclude that this membership has a positive influence on the quality of the climate plans.

Almost half of the districts participated in the interview, in which the forty-three questions were formulated based on the three categories applied in the scoring matrix. Due to non-100 percent participation, the replies were primarily used as additional information, and occasionally they were incorporated into the evaluation/scoring matrix. The main purposes of the interviews were to measure the districts' knowledge of climate adaptation and their attitudes toward the topic. The interviewees' professions varied, which influenced the information in their possession. The interviewed municipalities heavily rely on EU funds, which could act as a driver in adaptation planning, as Massey et al.

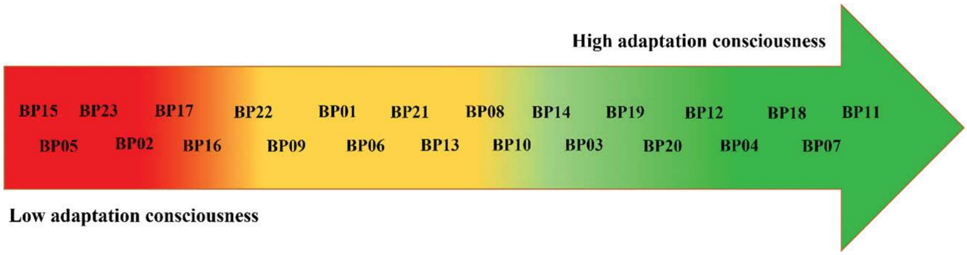

Figure 10. The overall results of the analysis – climate adaptation consciousness level of the districts of Budapest

(2014) pointed out EU adaption initiatives – as external factors – might act as a catalyst. Biesbroek et al. (2010) revealed the strengths, weaknesses, opportunities, and threats for several National Adaptation Strategies (NAS) in EU Member States. Among other things, they identified funding and coordination between sectors as the contributions to achieve NAS objectives, whilst the lack of coordination between administrative levels and stakeholder involvement may hinder the achievements. These findings are consistent with some of the barriers and drivers of successful climate adaptation stated by the Budapest district representatives. Aguiar et al. (2018) examined 147 Local Adaptation Strategies in Europe and reviewed several topics and categories in the strategies. One of their findings was to uncover the barriers to implementation of adaptation, in which the lack of financial/human resources, unclear responsibilities, limited capacity in the policy and lack of knowledge exchange can be identified as shared problems with the districts analyzed in our assessment.

Based on the findings of Buzási (2022), districts being at moderate or high risk in terms of the degree of their average sensitivity and adaptive capacity score, some of them appear to be lagging behind the other districts in the current study, namely the 1st, 15th, 16th, 21st, 22nd; however, the 20th and the 14th District, being at high risk proved to be adequately adaptive from a governmental perspective in this study. In their empirical study of 902 European nations, Yang et al. (2021) argued that the pressure to adopt a climate adaptation policy may arise from the older population's growing concentration in urban areas. Despite the high proportion of the elderly population on the Buda side, our results could not clearly assert the dominance of Buda side over Pest side regarding adaptation consciousness; nonetheless, half of Buda side districts had successful outcomes in our evaluation. Based on the findings of Lioubimtseva and da Cunha (2020) examining small and mid-sized urban communities in France and the United States, a more comprehensive monitoring procedure and the exchange of good practices between cities would be required to increase the quality of adaptation planning. According to the gained knowledge through our empirical study a more well-organized system including goals, actions, and data of the districts would be considered necessary, which would enhance transparency and traceability, as well as the districts' cooperation and the possibility to measure their progress. The daily operations of municipal governments must completely incorporate climate adaption planning, as Baker et al. (2012) also highlighted the need to embed adaptation processes since it influences the effectiveness of local planning.

During the analysis, it was obvious that the availability of the data appears as one of the primary limiting factors for this study, similarly to quantitative studies, in which the statistical dataset is not available at all levels, e.g., at the district level. The applied methodology and the main findings of this study can contribute to widening the existing literature:

- Based on the literature review, there is no established approach for assessing cities' potential for climate adaptation, and during this analysis, it was obvious that the role of local characteristics is very decisive, even at the district level; thus, this study can serve as a suitable basis for the development of further, deeper evaluation systems.
- Due to the unique local characteristics, it is also crucial to note that a certain degree of homogeneity is vital for comparative, qualitative analyses with regard to the examined cities or city districts since the high degree of diversity—which may be of an economic, social, or even relief nature—greatly influence which criteria should be examined, as well as what opportunities are available to cities/districts in terms of adaptation planning.

The applied methodologies aimed to compare the 23 districts of Budapest from a governmental perspective, and thus a qualitative assessment was conducted with the following main findings:

- The districts should pay particular attention to the demographic, economic, and topographical disparities that occur among them when adopting good practices and defining adaptation actions, even at the scale of the districts.
- Environmental protection, especially climate protection, should appear as a higher priority and in a better organized and coordinated manner in the municipal departments of the districts in order to achieve more effectively the desired goals and take the necessary actions.
- It would be crucial to develop a suitable monitoring system so that the precise adaptation actions could be observed and adjusted in response to changing conditions.
- The drivers of adaptation planning can be adequate financial support, legally defined adaptation obligations, adequate political/managerial interest, residential interest, climate organization memberships (e.g., of Climate-Friendly Municipalities, Covenant of Mayors), climate-actions monitoring system, climate protection department at municipalities and a better organized municipal department system.
- The lack of resources let us conclude that climate adaptation planning is a privilege for cities/city districts, although it should be better incorporated into the processes of individual municipal departments.

Acknowledgment

The research reported in this paper and carried out at BME has been supported by the ÚNKP-21-3 New National Excellence Program of the Ministry for Innovation and Technology from the Source of the National Research, Development, and Innovation Fund.

Editors' note:
Unless otherwise stated, the sources of tables and figures are the authors', on the basis of their own research.

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Article first received • August 2022
Article accepted • May 2023