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Evaluating the effectiveness of urban sustainability and climate objectives: a comparative approach

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Abstract
This study takes a unique approach to analyzing the sustainability and climate planning in major Hungarian cities. It conducts a qualitative analysis, examining the selected cities' sustainability and climate strategy objectives/goals. The aim is to comprehensively assess the extent of harmony between these objectives and identify potential hindering factors. An impact series with six distinct levels (+ +, +, 0, NR, –, –) was established for this analysis, from which positive (+ +, +), neutral (0, NR), and negative (–,–) categories were formulated. The main result of the study presents the efficiency score of the sustainability and climate goals, in which only the ratio of the positive impacts are covered. The findings reveal that the impacts of sustainability objectives show significant differences among the cities, particularly concerning positive and neutral effects. However, climate objectives present a more modest discrepancy regarding positive, neutral, and negative effects observed among the cities. There was no clear regional pattern in terms of sustainability and climate planning efficiency; on the other hand, Budapest, Győr, and Nyíregyháza emerged with outstanding performances.

Keywords Strategy analysis · Planning efficiency · Urban sustainability · Climate palnning

1 Introduction

Urban areas play an unquestionable role in climate mitigation [1] and adaptation processes [2] due to their concentrated features regarding social [3], economic [4], and environmental factors [5, 6]. The increasing share of the urban population [7], the concentration of economic power [8], and the considerable amount of emitted greenhouse gases [9] and air pollution [10, 11] make cities highly important regarding sustainability and climate goals. Since numerous goals and aims are related to urban areas [12–15], therefore, planning processes have a pivotal role in sustainability and climate-friendly transformations [16, 17]. The need for mainstreaming sustainability and climate-related aspects into everyday decision-making processes is not new; nevertheless, cross-checking of the goals, actions, and monitoring are often lacking [18–20]. The consequence of this inconsistent planning is the increasing risk of lock-ins [21], or in other words, non-desirable long-term impacts that can counteract the initial goals [22]. Linking climate-related issues to various environmental aspects through the lens of resource management is an undeniable and current need for cities [23]. Eco-efficiency can be achieved by considering social planning, legal practices and related policy challenges to improve the integration of a low-carbon economy and zero-emission policies [24]. Promoting renewable energy sources as part of climate mitigation activities [25] and linking them to resilience issues by considering climate neutrality and adaptation in policymaking is part of a broader sustainability challenge [26]. Based on a previous detailed literature review [27], it

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can be stated that cross-checking of sustainability and climate-oriented goals of different urban development strategies is (1) an understudied area in current urban studies; (2) not integrated into the policy-making processes.

Mitigation and adaptation planning of cities with diverse geographical locations is gaining increasing attention from scholars nowadays [28–30]; moreover, sustainability-centered analysis of urban plans is also at the forefront of urban studies [31–33], nevertheless, the before-mentioned consistency analysis is often lacking from the literature. Besides the planning perspectives, regional differences can also be identified regarding the selected study areas, with a massive overrepresentation of Western-European cities [30, 34–37] compared to their Central- or Eastern counterparts, with a limited number of studies focusing on those cities [38–41]. Apart from the country-scale comparisons of different urban areas, numerous papers focused on the inter-regional analysis of plan quality by applying different methodologies from descriptive assessments through statistical analyses to consistency evaluations [42–47].

This paper aims to analyze various forms of urban plans regarding major Hungarian cities for two main reasons by applying content analysis and a related analytical framework. Firstly, the selected urban areas are situated in the Carpathian basin, which is a highly sensitive area regarding changing climatic patterns according to numerous regional climate models and related analyses [48–51]. Consequently, Hungarian cities unquestionably need to develop effective and well-written strategies to address adequate actions to decrease their climate vulnerability, furthermore, to ensure their sustainability transitions. Secondly, integrating sustainability and climate-related aspects into an assessment framework and applying it to the major Hungarian cities is a relevant literature gap; however, we can find some studies that are in line with these aspects, the papers focused on a distinguished aspect instead of a holistic approach [52–54]. Based on the above-mentioned aspects, the aim of this study is based on current urban studies trends by focusing on plan quality assessment issues and related comparative analysis. According to our hypothesis, a cross-analysis of sustainability and climate aspects could reveal significant heterogeneity between the analyzed plans, as both aspects are highly locally specific. In summary, this paper can contribute to widening the existing literature in the following ways:

- integrating sustainability and climate-oriented analyses of urban plans can be identified as a literature gap that this paper tries to fill;
- the applied methodology is easy-to-adapt to other case studies and not sensitive to regional or local features;
- the selected urban areas are generally less studied, therefore, our results can contribute to deepening our knowledge about the sustainability and climate-preparedness of Hungarian cities.

2 Literature review

Plan quality assessment papers apply a quite diverse range of analysis frameworks to reveal effectiveness or the lack of it regarding strategic plans. Besides focusing on a given sustainability and climate-related aspect, analysis of integration is a new phenomenon in the literature [55, 56]. However, the literature consists of several papers dealing with sustainability-oriented analysis of strategic plans, distinguishing the considerable and crucial role of sustainability assessments regarding policies and plans [57, 58]. Examples of such papers include, but are not limited to: [59] defined the essential quality criteria (visionary, sustainable, coherent, plausible, tangible, relevant, and nuanced) for sustainability visions and guidelines since visions are directly linked to plans and strategies. In addition, they listed numerous plan-making techniques and emphasized the role of consistency analysis to uncover potential points of conflict and trade-offs. Jeon et al. [60] provided performance metrics to improve sustainability and assess trade-offs in the sustainability assessment of transportation planning. Eklund and Cabeza [61] emphasized the role of effective governance as a prerequisite for well-prepared and straightforward strategies and action-taking by linking local governance capabilities with management effectiveness. Liao et al. [62] examined the strategies of 651 US municipalities and evaluated the effectiveness of the actions taken based on the previously developed plans. The authors defined various factors that play an important role in the development of measures, such as resource commitment, public participation, political factors, coordination, and local socio-economic features. Finally, two recent publications focused on the mutual integration of climate-related aspects and broader sustainability issues: [63] found that incorporating climate change topics in sustainability plans made these strategies more focused and nuanced; moreover [64], analyzed the 100 Resilient Cities strategies from an SDG perspective, focusing on the consistency between resilience and sustainability themes.

In this analysis, while evaluating the impact of the sustainability objectives, the most pronounced positive influence can be observed by preserving and enhancing natural and built environmental values. These impacts exhibit evident positivity from climate adaptation and mitigation perspectives since nature-based solutions build climate resilience [65]. Examples have arisen wherein specific types of objectives exhibit divergent impacts on mitigation and climate adaptation. For instance, pursuing energy efficiency significantly contributes to mitigation benefits [66] but may not be inherently relevant to adaptation. Conversely, health preservation notably has positive impacts from an adaptation standpoint, giving special consideration to marginalized populations [67]. While certain instances might not entail relevance from a mitigation perspective, there are scenarios where co-benefits can be identified by integrating health considerations into climate adaptation [68]. Consequently, it might lack significance regarding mitigation; however, this is not universally applicable. Notably, there exists an objective that does not garner favorable assessments in either mitigation or adaptation aspects: tourism, for instance, lacks relevance in the adaptation context while concurrently exerting a markedly adverse influence on mitigation due to its potential for heightened emissions, as [69] highlighted that the expansion of tourism development reliant on fossil fuel-based energy sources leads to environmental harm due to the emission of greenhouse gases from fossil fuels. Paramati et al. [70] conducted panel econometric techniques to investigate the dynamic links between CO_2 emissions, economic growth, and tourism. It was pointed out that both Eastern and Western EU nations see economic development as a result of tourism, yet CO_2 emissions rise in the former while they fall in the latter. These findings highlight the risks associated with the growth of the tourist industry in the major Hungarian cities in relation to mitigation objectives, which were to lower greenhouse gas emissions.

Adaptation and mitigation objectives were collected regarding the climate aspect of the evaluation. These objectives delineated in the strategies, it is evident that climate adaptation includes a more diverse array of objectives, encompassing facets like rainwater management, readiness for extreme weather occurrences, adaptation to local agricultural conditions, preservation of health, and addressing social disparities. On the other hand, mitigation objectives primarily revolve around enhancing energy efficiency and reducing greenhouse gas emissions. While appraising the climate objectives, the augmentation of the fraction allocated to renewable energy sources or energy conservation as unequivocally advantageous from an environmental perspective has been identified. Simultaneously, the transition process causes economic burdens, prompting a detrimental economic impact has been highlighted. This proposition is corroborated by an investigation conducted by [71], focusing on the younger cohorts of the Hungarian and Slovak populations. Based on the results, it can be inferred, among other findings, that the substantial capital outlay associated with alternative energy sources and the scarcity of attainable subsidies serve as constraints to implementing alterations. Newell et al. [72] highlighted the financial benefits associated with renewable energy; however, they also pointed out the high initial costs and long payback periods, which can act as obstacles in local renewable energy developments. In the present analysis, several goals of the city strategies aim to reduce greenhouse gas emissions by influencing modes of transport. Although they positively affect the environment and human health, they can be divisive from a social point of view. Thøgersen et al. [73] conducted a representative survey of Norwegian commuters (N = 2607) to estimate the direct and indirect effects on the choice of using conventional internal combustion-engine vehicles (ICV) for commuting. Moreover, it was concluded that physical conditions, such as the distance between a house and place of employment or study and the transportation infrastructure, heavily influence people to use an ICV to commute and partly contribute to acquiring such a vehicle. In contrast, driving habits and ICV ownership are not only determined by physical factors. For them, supportive social norms are equally crucial. Chen et al. [74] surveyed household travel patterns in three neighborhoods near metro stations in Shanghai's core region to learn more about the motorization habits of the area's original inhabitants. The findings showed that nearly every household with a car has a member who chooses to drive to work. Based on that study, many factors impact people's decisions on car ownership: household income, workplace and metro station distance, and individual attitude toward metro commuting. Yet, the choice to purchase a car is not greatly influenced by the distance between the residential area and the metro station. The authors also revealed, among other things, that older people are more likely to commute by bus over cars. Additionally, in the case of a dense metro network, people's decision to own and drive a car is unaffected by the distance between their residence and the metro station. Zhou [75] found that students who live alone in Los Angeles are more likely to drive themselves to university, possibly because of their strong regard for privacy and ability to pay for it.

3 Material and methods

3.1 Study area

The scope of this study encompasses major Hungarian cities with populations exceeding 100,000 residents. Table 1 presents a compilation of the cities under scrutiny and their corresponding statistical information. A total of 9 cities (Fig. 1) were included in the assessment, with Budapest, as the capital of Hungary, notably standing out due to its significantly larger population compared to the remaining cities. According to the area size of the listed settlements, the picture is more homogeneous, and such a large-scale difference cannot be observed. Although Székesfehérvár falls short of the 100,000 threshold, it has been incorporated into our investigation as it fluctuates around it. Despite Budapest's status as the capital city of Hungary and its significantly high population density, we deemed it crucial to integrate it into the analysis since the methods and structure of the climate strategy documents present a homogeneous picture.

Starting from January 1, 2018, the Central Hungary region underwent a division into Pest and Budapest. Consequently, according to prevailing legislation, Hungary's territory is now delineated into eight distinct planning and statistical regions [81]; see Table 1. The NUTS-2 regions exhibit diversity in their geographical attributes, leading to climate and sustainability factors variations. Consequently, when formulating plans for the listed cities, it is imperative to account for these distinctions and tailor the strategies to suit the specific characteristics of each region.

3.2 Research method

Our study applied qualitative analysis to chart the efficiency of sustainability and climate planning within the major Hungarian cities. Figure 2 comprehensively illustrates the research steps, in which the two domain topics are sustainability and climate change. In Hungary, sustainability strategies commonly manifest through urban development strategies for settlements, called Integrated Settlement Strategies. Meanwhile, climate strategies and SECAPs (Sustainable Energy and Climate Action Plans) are accessible tools for guiding climate change-related planning. The climate and sustainability-related strategies include city-focused objectives/goals, outlining a more livable future vision for the citizens. Analyzing the strategic goals, we aimed to evaluate the degree to which sustainability and climate planning are harmonious. Specifically, we were keen on determining how much each topic area considers the other. Thus, two final values are represented in a coordinate system (Fig. 11): sustainability and climate efficiency scores. The higher these values, the more consciously formulated goals are included in urban climate

(SECAP and climate strategies, see Table 2) and sustainability (Integrated Development Strategies, see Table 2) strategies; thus, it represents a more consistent strategy-making process. From a sustainability point of view, the goals (altogether: 145) cover the environmental, social, and economic dimensions, while the climate goals (altogether: 98) cover adaptation and mitigation. It is important to emphasize that the number of goals is irrelevant to the results since our research aimed to analyze the coherence between the cities' sustainability and climate strategies. The comparison of the cities is solely based on their internal inputs, namely the consciousness of strategy design.

As previously introduced, based on the sustainability and climate objectives of the strategies (Table 2 lists the corresponding strategy with a source link), a cross-analysis was conducted to reveal the synchronized planning efforts between both topic areas. The qualitative analysis took place between January 2024 and May 2024. Subsequently, these objectives were systematically assessed using a framework comprising six predefined impacts -or effects- (++, +, 0, NR, –, ––), classified into three delineated categories: positive (++, +), neutral 0, NR), and negative (–, ––), see Fig. 3. A six-level impact analysis was required to assess the goals more nuancedly. However, it seemed more practical if the final results solely included the threefold division since deciding whether an impact is direct or indirect could affect our evaluation process more subjectively. The foundational concept of the application of impact categories originated from a study conducted by Nilsson et al. [76], wherein they examined the influence of one Sustainable Development Goal or target on another with a predefined scale, in which seven interactions -from the most positive to the most negative- were defined: +3 (indivisible), +2 (reinforcing), +1 (enabling), 0 (consistent), −1 (constraining),

Table 1 Statistical data of the major Hungarian cities (2020)

City	NUTS-2 region	Population size [capita]	Area size [km^2]
Budapest	Budapest	1,662,438	525.14
Debrecen	Northern Great Plain	199,856	461.66
Győr	Western Transdanubia	123,475	174.62
Kecskemét	Southern Great Plain	109,570	322.57
Miskolc	Northern Hungary	155,476	236.67
Nyíregyháza	Northern Great Plain	119,289	274.54
Pécs	Southern Transdanubia	145,468	162.78
Szeged	Southern Great Plain	160,927	281
Székesfehérvár	Central Transdanubia	95,093	170.89

Source: National Regional Development and Spatial Planning Information System (TEIR) [82]

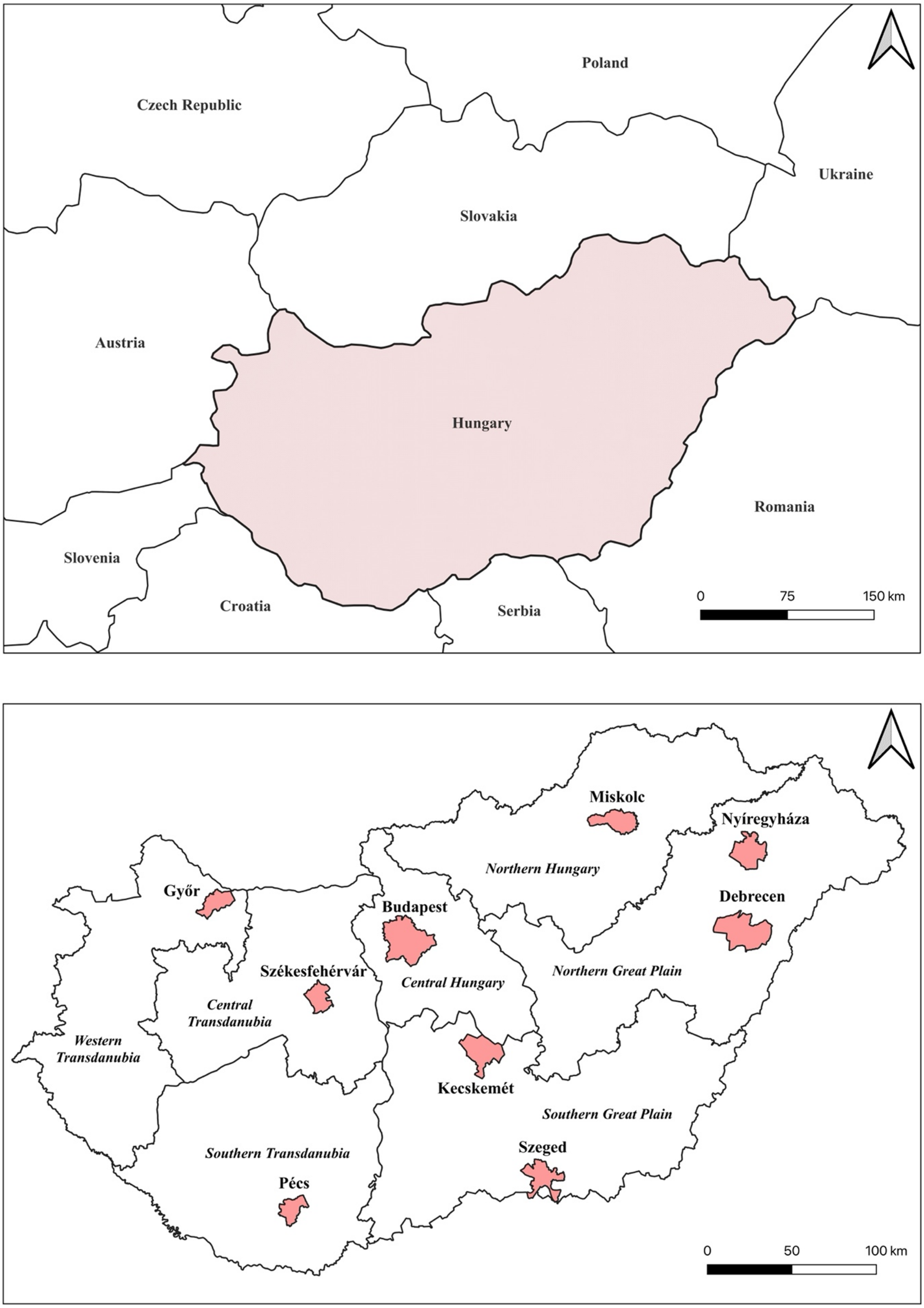


Fig. 1 Study area—Hungary and its major cities

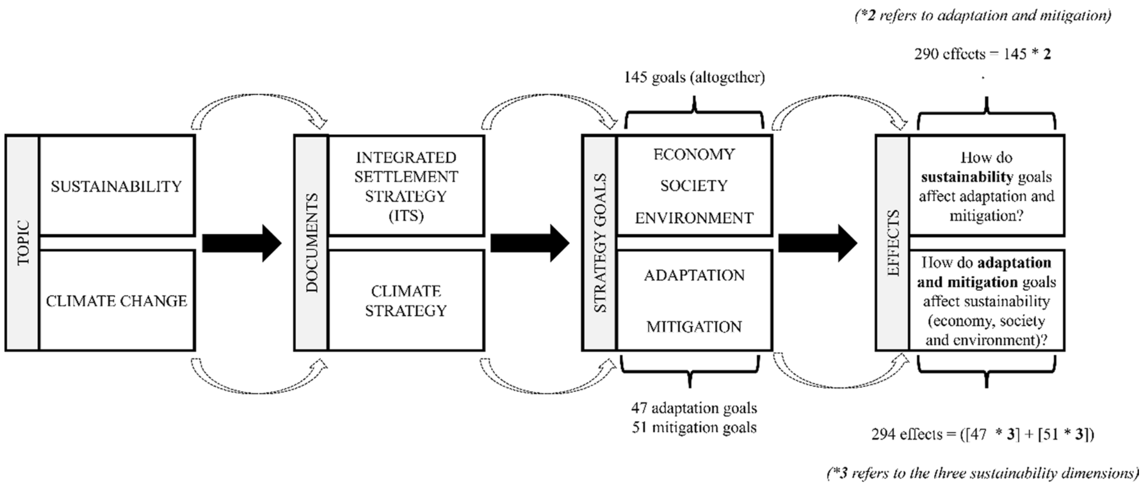


Fig. 2 Overall research steps

Table 2 Sustainability and climate strategy of the major Hungarian cities

City	Climate document, publication date	Source (link)	Sustainability document, publication date	Source (link)
Budapest	SECAP, 2021	LINK	Integrated Settlement Strategy, 2021	LINK
Debrecen	Climate Strategy, 2022	LINK	Sustainable Urban Development Strategy, 2022	LINK
Győr	Climate Strategy, 2021	LINK	Integrated Settlement Strategy, 2021 (modified version)	LINK
Kecskemét	Climate Strategy, 2021	LINK	Integrated Settlement Strategy, 2014	LINK
Miskolc	Climate Strategy, 2020	LINK	Integrated Settlement Strategy, 2018	LINK
Nyíregyháza	Climate Strategy, 2021	LINK	Integrated Settlement Strategy, 2022	LINK
Pécs	Climate Strategy, 2021	LINK	Sustainable Urban Development Strategy, 2022	LINK
Szeged	Climate Strategy, 2020	LINK	Sustainable Urban Development Strategy, 2021	LINK
Székesfehérvár	Climate Strategy, 2022	LINK	Sustainable Urban Development Strategy, 2022	LINK

−2 (counteracting), −3 (canceling) depending on the extent to which one goal helps or hinders the fulfillment of the other. We found it highly beneficial to incorporate an analogous rating scale to assess the impacts of the strategy goals; nevertheless, we merely employed this kind of segmentation of impacts based on the technique. During the evaluation process of the goals, the basis was provided by the literature analysis presented earlier. Using the information highlighted in the cited studies, we were striving to achieve an objective decision-making process as adding one of the predefined impacts.

The ensuing procedure was employed for assessing the impact of the climate and sustainability goals:

1. Listing all the goals from the strategies.
2. Assessing the impact of the goals.
    a. Assessing the impact of the sustainability goals from a climate (adaptation and mitigation) perspective.
    b. Assessing the impact of the climate goals (adaptation and mitigation goals) from a sustainability (economic, social, and environmental) perspective.
3. Calculating all the possible no. of impacts
    a. See Fig. 4 as an example: Budapest has 18 sustainability objectives, and thus, 36 (18*2) total impacts were defined by our procedure since we examined the impacts on adaptation and mitigation. The summative ratio of each impact can be readily computed (e.g., for "+ +" and "+," the positive category comprises 24 effects/impacts, yielding a final ratio of 24/36 in percentage terms, equivalent to 66.67%).

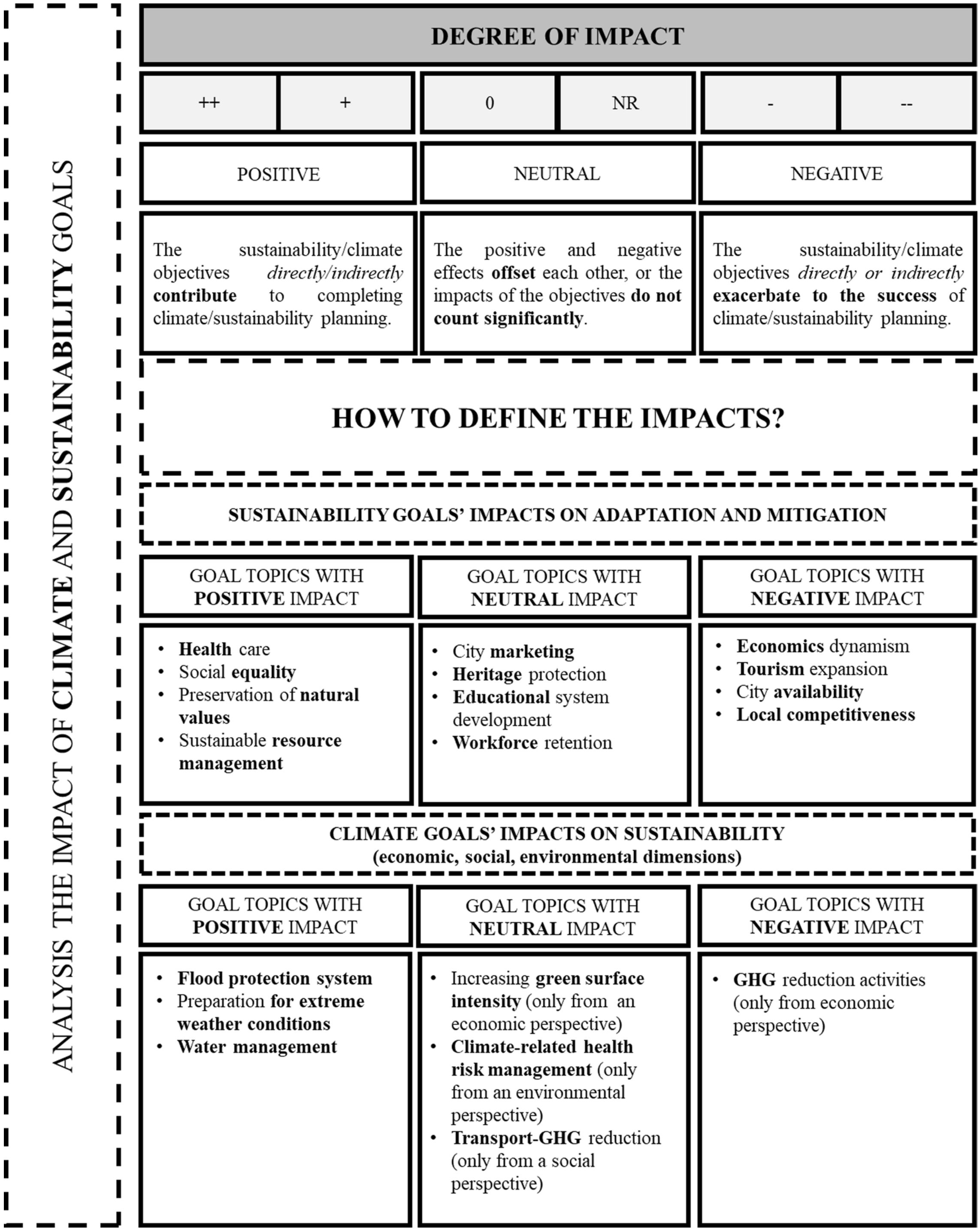


Fig. 3 Defining the impacts from sustainability and climate perspective

4. Given that the central aim of the study was to ascertain the effectiveness of sustainability and climate objectives, a foundational concept was to devise a coordinate system exclusively encompassing paired ratios only of the
5. Positive (++and+) impacts (see Fig. 11).

Even though the topic areas of the United Nations presented the Sustainable Development Goals (SDGs) go beyond the cities' competence in most instances - showing rather a national focus –, the analyzed objectives can be linked mainly to these focus areas. In certain cases, the objectives are concisely and briefly formulated (e.g., "digital service

				Sum and percentage (%) of the impacts in each category		
Budapest	Adaptation	Mitigation	Sum of the impacts	(++, +)	(0, NR)	(-, --)
++	6	7	13	24	11	1
+	6	5	11	66.67 %	30.56 %	2.78 %
0	1	0	1			
NR	5	5	10			
-	0	1	1			
--	0	0	0			

Fig. 4 Example of the computational process—The analysis of Budapest's sustainability objectives in terms of their impact on adaptation and mitigation

development" or "city of short distances"). At the same time, longer, complex sentences cover several urban sub-areas, such as "extreme weather events hurt the economy reducing its effects, mitigating risks and damage events by supporting climate-conscious planning and construction, as well as operation." As a result, some objectives can be assigned to several SDGs simultaneously. Most of the objectives classified as sustainability can be linked to the 11th SDG (Sustainable Cities and Communities), in which the promotion of sustainable and public transportation modes is an essential element, cultural and heritage protection, efficient land use, and the creation of an inclusive community also play a significant role. As was foreseeable, climate goals - adaptation and mitigation - have the highest proportion in the 13th SDG (Climate Action), focusing on preparing the urban population and physical systems for the adverse effects of climate change, as well as increasing adaptability in various ways (e.g., protection of natural and built assets, preparation for heat waves, increasing adaptation of tourist products). Not only are adaptation or mitigation goals linked to SDG 13, but some sustainability strategic goals also consider climate change and the associated problems to be solved on several occasions. These sustainability objectives generally aim to make cities more prepared against adverse effects or indirectly reduce emissions, which has a positive impact from a climate point of view. For example, "city of small distances," "green space development," and "use of renewable resources." It has occurred that certain SDGs could not be linked to any of the strategy objectives (SDG 2 (Zero hunger), SDG 5 (Gender Equality), SDG 14 (Life Below Water), and SDG 17 (Partnerships For The Goals));. However, these SDG goals seem to require a larger-scale intervention or are not even relevant in the context of Hungary. It was typical that the sustainability and climate goals covered some SDGs in approximately the same proportion (e.g., SDG 12 (Responsible Production and Consumption) and SDG 15 (Life on Land)). However, certain SDGs covered by sustainability were connected in an exceptionally high proportion (SDG 8 (Decent Work and Economic Growth and SDG 11 (Sustainable Cities and Communities)). On the other hand, there have been instances where climate planning addressed certain SDGs - SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action) - in higher distribution, while the coverage by sustainability fell short of this.

4 Results and discussion

In total, 243 objectives underwent evaluation, comprising 145 sustainability and 98 climate objectives (47 related to adaptation and 51 concerning mitigation). This outcome is not unexpected, given that the domain of sustainability objectives can be characterized as more diverse than that of climate adaptation or mitigation. This observation is especially true when examining the compiled objectives, as they span a broader spectrum. Due to our consideration of two dimensions for sustainability goals (impact on adaptation and mitigation) and three dimensions for climate goals (society, economy, environment), we discerned a cumulative total of 584 effects. In this section, the outcomes are presented in parallel with the discussion (like the methodology section), ensuring that the presentation of the results is not solely descriptive but also encompasses scholarly linkages within the researched subject.

4.1 Effectiveness of sustainability objectives

Quantitatively, the objectives outlined in the urban development and sustainability strategies of the nine cities present a distinctly varied depiction (Fig. 5) In terms of the number of objectives, Kecskemét and Nyíregyháza fall short of reaching

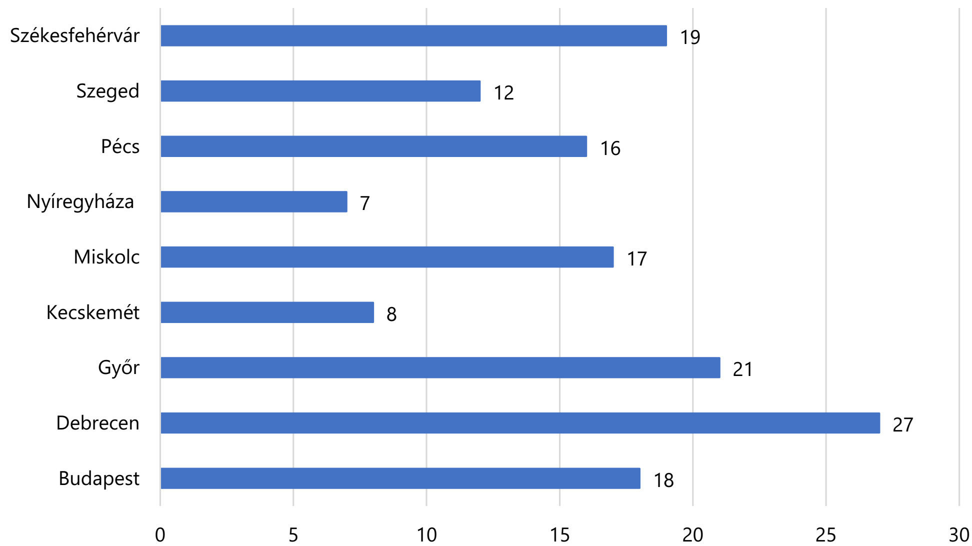


Fig. 5 The total number of sustainability objectives within the major Hungarian cities

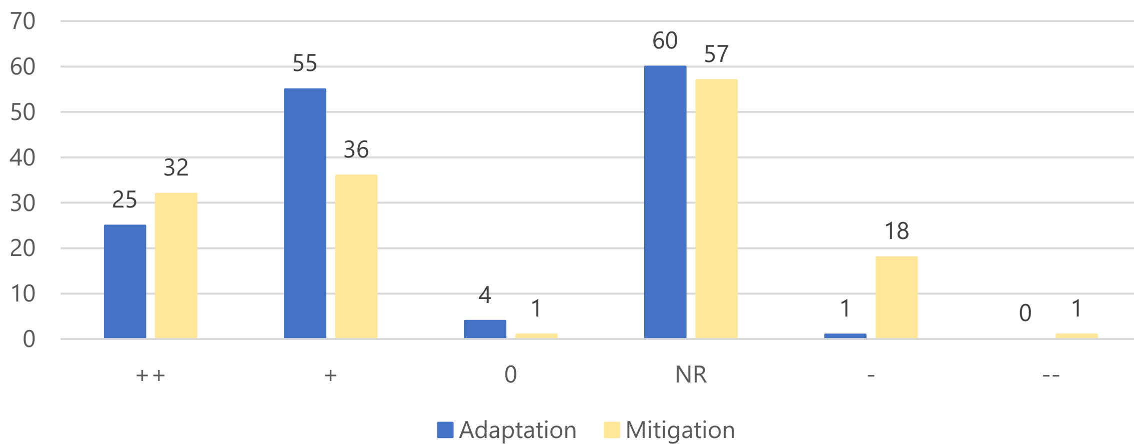


Fig. 6 The allocation of sustainability objectives concerning their impacts on both climate adaptation and mitigation. (No. of goals)

10, indicating a relative lag compared to the other cities. Nevertheless, Kecskemét's accurately outlined medium-term goals offer a level of compensation for the quantitative deficit, as they exhibit great detail.

The cities attempted to encompass the three sustainability dimensions (economy, society, environment) with defined objectives. In certain instances, the objectives were subdivided into distinct categories aligned with these dimensions (as observed in Budapest, Győr, and Miskolc). Notably, a common trait was the presentation of goals in a concise list format, often interconnected with overarching objectives that captured specific thematic areas (such as Pécs' "sustainable, developing society" overarching objective). Among the objectives, prevalent themes encompass fostering an inclusive and collaborative society, enhancing natural and constructed environmental assets, advancing tourism, bolstering local economic competitiveness, and improving transportation infrastructure. Throughout the evaluation of the objectives, it becomes evident that many of the utilized goals lack relevance regarding adaptation and mitigation. Conversely, the other identified impacts tend toward positivity rather than negativity (Fig. 6).

The objectives that had the most substantial positive impact on advancing climate goals concentrated on improving the natural environment, fostering the growth of public transportation, promoting circular economy practices, and increasing the adoption of renewable energy sources. We assessed the objectives about industrial park expansion, entrepreneurial ecosystem enhancement, and tourism development as lacking relevance in adaptation and carrying negative implications concerning mitigation. Additionally, we encountered goals that appeared relatively superficial in nature, lacking complex details, such as "establishing a modern education system aligned with the economy" or "innovative education development program at the University of Debrecen"; we deemed these objectives not pertinent to either adaptation or mitigation perspectives.

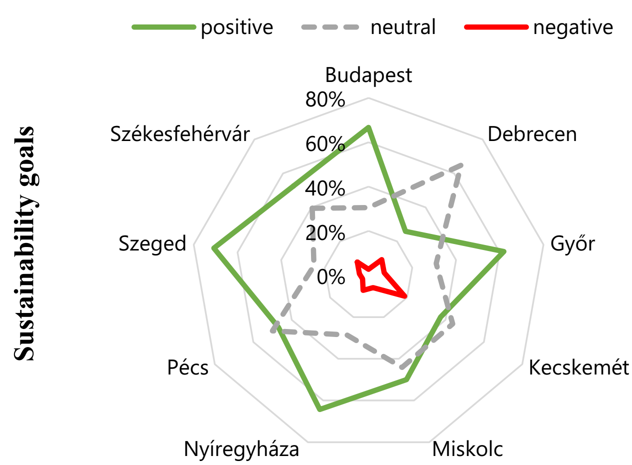
As previously outlined, we categorized our six-level evaluation impact system into three groups: positive, neutral, and negative. The outcomes manifest a notable variation across cities after scrutinizing the percentage distribution of sustainability goals (Fig. 7). A significant share of objectives from Szeged (70.83%), Nyíregyháza (64.29%), Budapest (66.67%), and Győr (61.90%) yielded a positive impact on climate goals, a trend not as prominently observed in the remaining cities. Notably, the objectives of high-performing cities stand out in that they cover a wide range of topics aimed at improving environmental conditions. This attribute bolsters the cities' capacities for adaptation and mitigation. The distribution of negative effects exhibits a comparatively more consistent pattern, yet in the context of Kecskemét (18.75%), the value stands out as higher than the other cities. This phenomenon can be attributed to the fact that most of its objectives revolve around economic advancement, regional relationship enhancement, and tourism development, all of which we identified as having a relatively more negative impact from a mitigation standpoint.

4.2 Effectiveness of climate objectives

For the climate goals, our approach involved examining the more comprehensive objectives of the climate strategies. Figure 8 illustrates a relatively homogenous sample size distribution, apart from Pécs. The values exhibit a notable increase for Pécs due to our approach of considering the corresponding sub-objectives within its climate strategy's mitigation objectives, a decision to better assess their impact on sustainability. If a sub-objective existed beneath an overarching goal, solely the sub-objectives were enumerated. Conversely, when no sub-objective was present, the overriding goal itself was considered. Nonetheless, this approach does not introduce any disparity compared to the other instances, as we computed the ratios for each impact uniformly across all cases. The 47 climate adaptation and the 51 mitigation objectives broadly address overlapping themes: for adaptation, topics such as green and blue infrastructure development, flood protection, readiness for extreme weather events, rainwater management, and mitigating the heat island effect are recurrent, whereas mitigation objectives predominantly focus on augmenting and conserving natural green spaces, alongside reducing greenhouse gas emissions—whether about transportation, buildings, or waste utilization. As anticipated, we observed many positive impacts linked to the natural and constructed environment. This outcome is not surprising, as achieving the stipulated goals would significantly curtail the environmental burden, consequently bolstering the cities' resilience over the long term. This, in turn, contributes to enhancing the residents' mental and physical well-being [77]. This trend is depicted graphically (see Fig. 9), underscoring that mitigation and adaptation goals notably engender positive impacts in the environmental dimension. Meanwhile, the positive effects on the social dimension primarily manifest in the context of adaptation goals. Typically, these goals do not entail individual and societal sacrifices or costs. Enhancing energy efficiency and elevating the share of renewable energy sources can trigger apprehension among residents due to the substantial implementation expenses [71, 78]. Therefore, the mitigation objectives tend to exhibit adverse economic effects while leaning more towards neutrality from a social perspective. This is because, alongside the anticipated advantages, the initial challenges bear high significance.

As illustrated in Fig. 10, in contrast to the sustainability objectives, the distribution of climate goals among the positive, neutral, and negative impact categories demonstrates less variation when comparing outcomes across cities. Taking average results into account, positive effects represent the predominant portion of all potential outcomes (58.69%), succeeded by neutral effects (31.06%), and lastly, negative effects (10.25%). Győr and Miskolc have achieved commendable

Fig. 7 What proportion exists among the three categories (positive, neutral, negative) covered by the cities' sustainability goals?



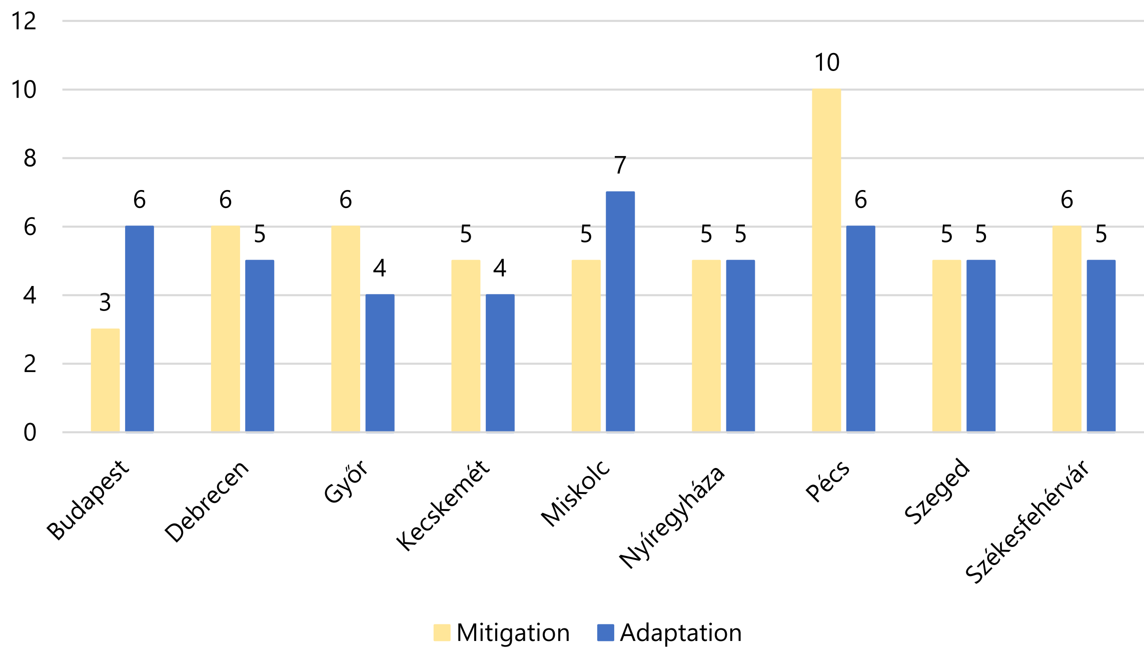


Fig. 8 The no. of adaptation and mitigation objectives within the major Hungarian cities

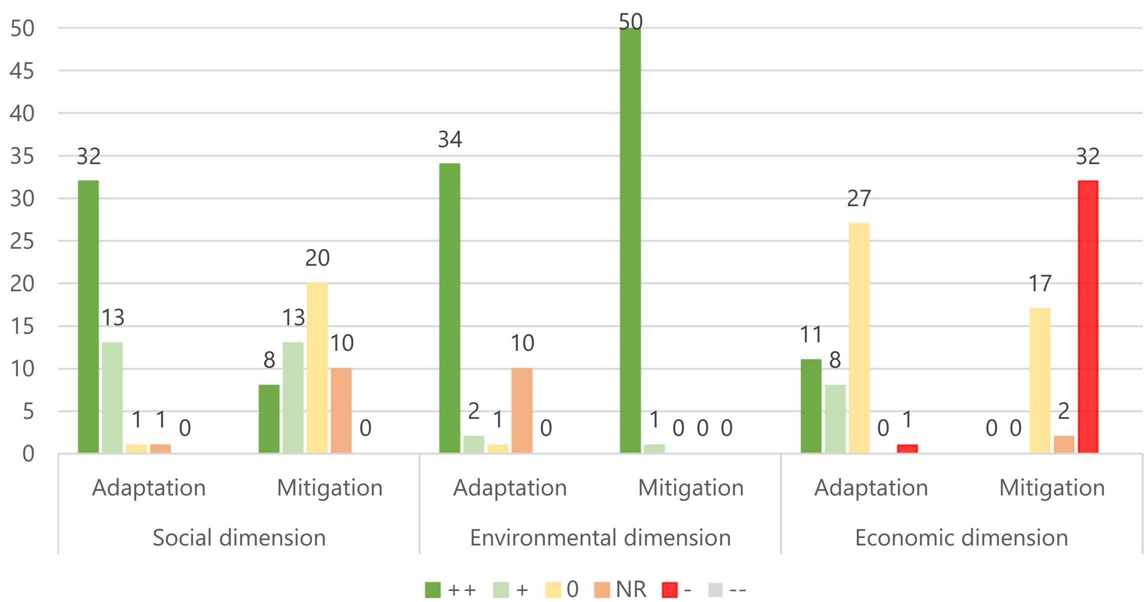


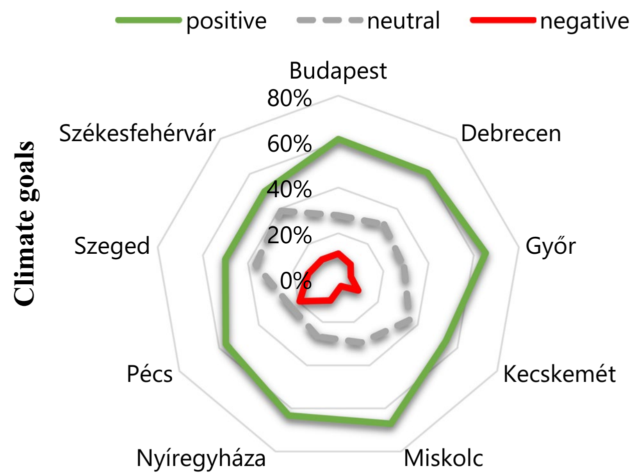
Fig. 9 The allocation of climate (adaptation and mitigation) objectives in relation to their effects on the three sustainability dimensions. (No. of goals)

outcomes in formulating their climate goals. Not only do their objectives exhibit a substantial share of positive effects on sustainability dimensions, but they also showcase a below-average proportion of adverse effects on the exact dimensions.

4.3 Simultaneous assessment of the effectiveness of sustainability and climate objectives

As was introduced in Section 2, the main goal of this paper was to introduce the major Hungarian cities' performance in terms of their sustainability and climate planning efficiency. Applying the outcomes of the calculation procedures,

Fig. 10 What proportion exists among the three categories (positive, neutral, negative) covered by the cities' climate goals?



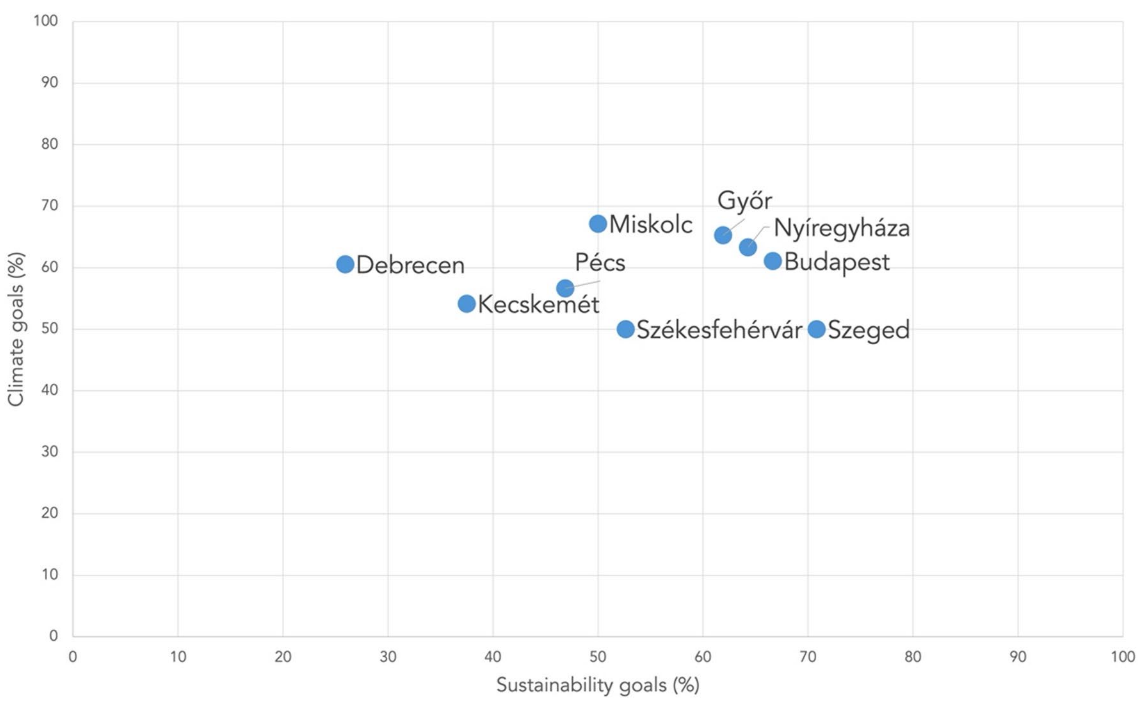


Fig. 11 The efficiency of the sustainability (X-axis) and climate objectives (Y-axis) in the major Hungarian cities

we specifically emphasized the proportion of favorable outcomes. Consequently, among all the discerned impacts, we exclusively retained the proportion representing the category of positive effects (++ and +). Hence, we also considered the neutral and adverse effects, as they inherently constitute the remaining percentage for each city, albeit without distinct visual presentation. Figure 11 proposes the results of our investigation; the X-axis depicts the share of the positive impacts of the sustainability goals on climate planning (adaptation and mitigation), while the Y-axis represents the share of the positive impacts of the climate goals on sustainability (economic, environmental, social dimensions) planning, thereby helping the visual comparison and analysis of the results of the cities.

To get a more precise understanding of the results Table 3, shows the sustainability and climate planning efficiency scores and the average value of the two. The grey shading emphasizes the outstanding performance of Budapest, Győr, and Nyíregyháza as having high percentages (above 60%) regarding sustainability and climate objectives. Budapest's precious place is not surprising since, in the research of [16], which assessed the progress of urban adaptation planning in 327 European cities between 2005 and 2020, Budapest accomplished a relatively outstanding adaptation performance. Budapest is remarkable throughout Europe as well as inside its own country. The achievement of climate objectives in

Szeged and Székesfehérvár can be described as 50%, marking the lowest rate among the cities under consideration. However, Szeged's sustainability planning efficiency exceeds 70%, which thus improves its average value. Szeged's outstanding score in sustainability planning can be mainly attributed to the fact that with the city's medium-term objectives, they pay remarkably high attention to both the built and natural environment (e.g., efficient use of resources, complex development of urban areas). Debrecen and Kecskemét performed relatively weaker than the other cities according to their sustainability efficiency scores, and due to the low climate planning efficiency score, they did not reach their average score of the 50% benchmark. Debrecen's sustainability goals included several goals aimed at economic development, and there were many cases in which the topic covered was irrelevant from an adaptation or mitigation point of view. From Kecskemét's perspective, the goals for sustainability either benefit adaptation or, in the worst-case scenario, are irrelevant; on the other hand, the objectives aimed at improving the regional role and tourist attraction harm the city's mitigation planning. Table 3 also presents the SD and average values of the efficiency score of sustainability and climate planning. The standard deviation of 14.71 in sustainability planning emphasizes the diversity of sustainability planning. On the other hand, the standard deviation of 6.34 for climate planning underlines that adaptation and mitigation goals can present more similar planning with greater homogeneity.

The topic of sustainability and climate change undoubtedly demands collaborative research. This is because when formulating a city's medium-term objectives regarding the economy, society, and environment, it is crucial to factor in their influence on both the capacity to adapt to climate change and the pursuit of mitigation goals. Indeed, when shaping climate objectives, it is equally important to consider their impacts on sustainability processes. Kata et al. [79] discovered that climate change could potentially undermine efforts to attain 72 targets spanning 16 Sustainable Development Goals (SDGs); however, synergies and trade-offs were simultaneously observed between the climate actions and SDGs. The analysis we carried out also demonstrates that, in numerous instances, it is important to weigh both the benefits and drawbacks since the objectives do not merely result in a straightforward positive or negative impact. Fuso Nerini et al. [80] highlights that integrating climate change actions into sustainability plans proves advantageous as cities gauge and benchmark the outcomes of climate initiatives, and further research is necessary to analyze how sustainability plans impact the attainment of climate policy outcomes. Sustainability planning involves thinking in three dimensions - economy, society, and the environment - and thus demands even more excellent care in formulating precise and practical goals. Economic objectives should primarily consider natural values, especially when the city plans to expand tourism or improve its regional role, i.e., to increase its economic dynamism. Thus, with carefully constructed planning, we can also improve cities' preparedness against climate change.

Our findings revealed that several sustainability objectives exhibited a neutral or positive stance from a climate perspective. Conversely, the representation of negative impacts was comparatively minor. Examining the climate-related objectives, it became evident that they yield notably favorable outcomes in the environmental dimension. However, from an economic standpoint, the mitigation goals can potentially lead to adverse effects. When comparing the outcomes across cities, it is apparent that the impact of sustainability objectives exhibits significant variance among the examined cities, particularly concerning positive and neutral effects. On the other hand, this disparity is less pronounced

Table 3 The efficiency of the major Hungarian cities' sustainability and climate planning[a]

Cities/SD/Avg	Efficiency score of the sustainability goals (%)	Efficiency score of the climate goals (%)	Average efficiency score (%)
Budapest	**66.67**	**61.11**	**63.89**
Debrecen	25.93	60.56	43.24
Győr	**61.90**	**65.28**	**63.59**
Kecskemét	37.50	54.17	45.83
Miskolc	50.00	67.14	58.57
Nyíregyháza	**64.29**	**63.33**	**63.81**
Pécs	46.88	56.67	51.77
Szeged	70.83	50.00	60.42
Székesfehérvár	52.63	50.00	51.32
Standard deviation	14.71	6.34	8.01
Average	52.96	58.69	55.83

[a]The bold indicates the performance above 60% regarding sustainabiltiy and climate planning

in the analysis of climate objectives, with a more modest discrepancy in terms of positive, neutral, and negative effects observed among the cities. The effectiveness of sustainability and climate planning did not reveal a distinct regional pattern among the cities. However, Budapest, Győr, and Nyíregyháza achieved commendable results, placing them at the top of the ranking list.

A total of 9 cities were assessed, undoubtedly portraying differences from a social, economic, and environmental point of view, which need to be considered when designing local strategies. Nonetheless, the strategy exhibits a degree of uniformity, suggesting a considerable level of strategic standardization across various instances. However, it is also important to underline that detailed local characteristics are predominantly considered in the exact actions of the objectives; thus, it would be beneficial for future research to analyze these actions. Considering local characteristics is a primary concern in urban sustainability and climate planning. This approach enables cities to learn from one another's successful practices while considering the unique attributes of each locality, determining successful future policy-making directions.

Finally, it is important to note some limitations of this study. First, the number of involved strategies is limited to nine. While this number could be increased by collecting and analyzing additional strategies, our primary focus was on the largest Hungarian cities as their populations are comparable to those of other European cities. Second, despite our efforts to improve objectivity in plan quality assessment, the applied methodology relied on subjective assessments. However, given the qualitative nature of the analysis, it is recognized that such analyses necessarily retain a degree of subjectivity. Furthermore, the applied methodology is not strictly specific to Hungary and, thus, universally, can be used, even in cross-country comparative analyses. However, it is worth managing strategic documents that were prepared based on identical or closely similar methodologies, for which SECAP documents may be suitable, for example. On the other hand, sustainability strategies are less uniform internationally, complicating the selection of uniform source material. The strategic documents included in the analysis must demonstrate similarly defined objectives (e.g., detail, timeframe); thus, it simplifies the comparison and enables us to draw more realistic conclusions.

5 Conclusions

The study aimed to analyze the major Hungarian cities according to the efficiency of their climate and sustainability objectives. We gathered and examined 243 objectives, comprising 145 sustainability and 98 climate goals. Consequently, our evaluation process delineated a total of 584 impacts. While presenting the results, we displayed the distribution of the number of objectives across cities. However, this aspect did not hold significance regarding the ultimate findings. We assessed the percentage of effects attributed to the predefined levels in the cities' formulated goals. Thus, the number of objectives was not regarded as an advantage or a disadvantage. Moreover, variations emerged in the qualities of the objectives: greater detail in an objective allows for a more comprehensive understanding of the impact it can trigger. Thus, if the goals were presented in a more succinct way, this would also function as the research's limitation. In future research, we consider evaluating the measures described in more detail related to the goals as appropriate.

One of our most striking findings was that the effectiveness of sustainability goals showed a higher standard deviation in its results than the effectiveness of adaptation and mitigation.

This shows the diversity of sustainability topics and means that the climate goals move on fewer dimensions. All this affects the outcome of the research; if the goals cover several urban sub-areas, both positive and negative effects are more likely to occur, but at the same time, there is a likelihood that the results will be diverse. The variability of the sustainability goals also suggests the complexity of the topics, and at the same time, in addition to the numerous planning possibilities, it also contains a risk. On the contrary, a good strategy and thoughtful planning can create an effective sustainability plan, in which we can also include our climate goals, striving to achieve synergies.

The results show that sustainability objectives have the most positive effect on adaptation; at the same time, the difference is not high since while 80 sustainability goals achieved a beneficial effect on adaptation, 68 goals were considered favorable on mitigation. The climate goals achieve the most desirable effects on the environmental dimension, as 36 adaptation and 51 mitigation objectives have a particularly positive effect on this dimension. In contrast, the number of objectives with an adverse effect is negligible. Regarding the social dimension, the results still show a positive picture; 45 adaptation objectives positively affect the social dimension, while 21 mitigation objectives also have a positive effect, and the remaining mitigation objectives are more neutral than adverse. It is worth paying attention to the economic dimension, as 32 mitigation objectives negatively affect this dimension, while most adaptation objectives have a neutral effect. Summarizing the conclusions, many possibilities exist for increasing efficiency during multifaceted sustainability strategic planning. First, we detecetd many positive effects during the analysis of the objectives. However, at the same time, a high number of negative ones could be observed (122 objectives), so it is worth reshaping them to turn in a more positive direction. In addition, when defining sustainability objectives, it is essential to pay attention to the impact on mitigation, reflect on them, and reformulate them accordingly to reduce unfavorable outcomes. There is great potential in the social and environmental aspects of the climate goals, as they have a high proportion of positive effects on these dimensions; at the same time, the impact of the mitigation objectives on the economy is already less favorable, so it is worth paying more attention to this during future strategy creation and formulating mitigation objectives that have at least a neutral, but relatively positive, effect on the economic dimension as well.

6 Declaration of Generative AI and AI-assisted technologies in the writing process

While preparing this work, the authors used Grammarly to improve readability and language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Author contributions Bettina Szimonetta Beszedics-Jäger: conceptualization; methodology design; software; formal analysis; investigation; data curation; writing—original draft; writing—review and editing; visualization. Attila Buzási: conceptualization; methodology design; validation; resources; writing—original draft; writing—review and editing; supervision; funding acquisition.

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Data availability The authors have provided all data and materials within the manuscript. There is no supplementary file.

Declarations

Competing interests The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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