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Green Infrastructure Enhancing Urban Resilience: Parallels between Vienna and Budapest

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1. Abstract

In densely populated cities with limited natural resources, finding strategies to restructure the existing urban territory has become a viable answer to make cities more integrated into the ecosystem and consequently more efficient and livable. Cities worldwide are adopting restorative measures to address disturbances in their structures, whether in the environmental, socioeconomic, or political spheres. Identifying urban voids and areas susceptible to extreme changes or diversification in their current land use distribution, urban forms, and connectivity is crucial to determining vulnerable urban patterns with the potential for transformation. Therefore, this paper aims to discuss the implications of promoting urban resilience, through the implementation of green infrastructure, as a sustainable way to create cohesive and more connected territories in the context of large cities with complex population dynamics. Thus, this study is a case study of two districts of Budapest and Vienna, located in the expanded centers of these cities, marked by their heterogeneity of land uses and the existence of industrial voids. The methodology applied emerged from a morphological appraisal founded on the concepts of Space Syntax theory, aiming to perform a comparative framework in terms of connectivity and territorial integration in renovated zones, using the software DapthmapX as a tool. The preliminary results indicate a clear connection between urban resilience, density management, and green infrastructure systems.

2. Introduction

Vienna and Budapest present relevant similarities in their urban structure, resulting from intensely articulated historical development processes, especially during the second half of the nineteenth century. Geographically, those cities played a prominent role in Central-Eastern Europe, sharing political concerns, characteristics of their public life, and the nature of their economic basis (Cohen, 1987). Despite the numerous similarities that are still visible, if analyzed from a comparative framework, these cities underwent significantly different political processes after the Second World War. For this reason, they also adopted different measures for a common problem: urban decay and increasing urban voids (Lichtenberger, 1994).

Between 1970 and 1990, several projects for the renovation of central urban areas emerged in both cities, although under different political perspectives, since Hungary and Austria were divided by the Iron Curtain (Michaela, 2008). At this historical moment, the communist bloc was already facing structural problems, a scenario that led to the fall of the regime in the early 1990s (Kocsis, 2015). The political instability experienced in this period is identified in the constant changes in the renovation and development strategies of the IX district of Budapest.

Unlike the guidelines adopted in Vienna, the tactic of combating urban decay in Budapest did not

focus on the extensive renovation of existing buildings (and, more specifically, housing) located diffusely in the urban fabric. Actions were taken more punctually, addressing solutions for areas of intense slums (Lichtenberger, 1994). In this scenario, the IX District of Budapest differs from the general context of interventions centrally delegated to other city areas. In the process of political transition, the renovation project of this district was submitted to relevant changes, gradually eliminating major demolitions and morphological alterations and bringing it closer to the Viennese renovation methodology.

In the late 1990s, this district of Budapest was still characterized by its heterogeneous land use, lack of territorial cohesion, and the existence of urban voids left by old deactivated industries (Locsmándi, 2011). Urban patterns like this have high transformative potential, especially in cities in the growing expansion process and acute real estate speculation, as is the case of the two cities under evaluation in this case study. Strengthening resilience in urban territories that are undergoing a process of decay and enabling the development of the socio-cultural sphere in contexts of vulnerability is a sustainable alternative for the development of urbanities (Reed, 2007).

In the case of the mentioned districts, to understand how those territories were able to resist and overcome disturbances in their urban structure, even in such unstable political, economic, and social contexts, it is necessary to evaluate the impact of planning the green infrastructure in these places (Ribeiro, Gonçalves. 2019). Furthermore, preserving and adapting morphological characteristics intrinsic to the territories, especially in renovation projects, can be a tool to encourage urban resilience. The aforementioned aspects are also directly related to the increase in territorial connectivity and consecutively result in the prevalence of urban cohesion, improving the performance of these areas both in terms of sustainability and user experience.

3. Background and Literature Review

The renovation of Budapest's District IX went beyond the emerging need to expand residential areas on the city's outskirts. At first, the intervention was planned under modernist standards, prioritizing the demolition of old buildings to create an entirely new urban fabric that would allow access to green areas, public buildings for community use with public services, and housing units with adequate natural lighting and building systems for comfort (Locsmándi, 2011). The design principles underwent transformations, also adapting to the new political terms. With the establishment of the market economy, the district's municipal government owned most of the properties in the region and managed to make the renovation process possible through public-private partnerships. New rules outlined the characteristics of public and private spaces and green areas, also stipulating measures for the preservation of a set of historic buildings, strengthening the urban landscape, as well as allowing the original population to remain in the neighborhood (Kovacs et al. 2012)

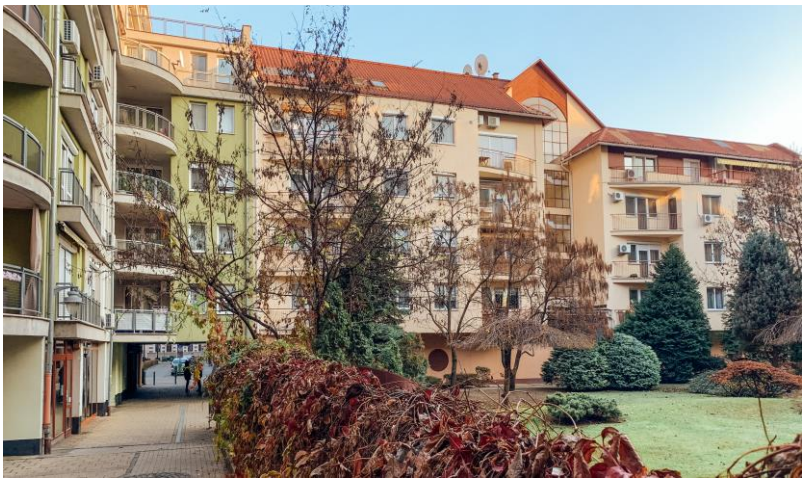

Figure *1*. Pedestrian path segregated from the green courtyard by a planted hedge at IX District, Budapest (2021) – by author

Vienna's Third District has also undergone significant transformations. As in the IX District of Budapest, this area is also marked by the heterogeneous occupation, predominantly middle-class residential use, and the existence of urban voids previously occupied by small industries and orchards. The densification of this area intensified in the early 2000s and was also characterized by rules stipulated by the city hall (Andexlinger, 2015). In 2019, a new block with mixed-use buildings and large, publicly accessible green areas was entirely erected in the region. This project meets similar guidelines to those found in Budapest's district. In this case, the design is mainly articulated by a substantially green public square that works as a connecting axis between the center of the neighborhood and the riverside of the Danube River. The rest of the public areas are distributed among the courtyards generated by the layout in which the buildings are implanted, functioning as green areas for leisure and contemplation designed for pedestrians, with no access for cars. Although the system of courtyards is based on the traditional typology of traditional buildings in the city, in this context, the areas are not enclosed, being interconnected with each other and with public roads (directly or indirectly).

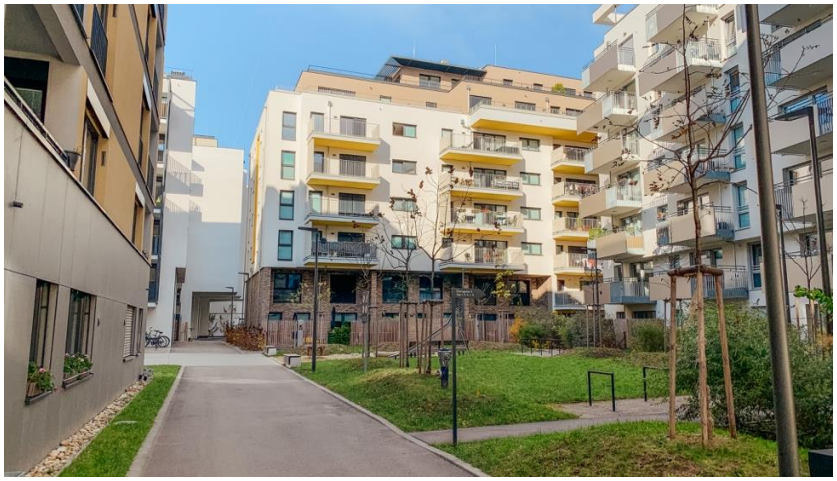

Figure *2*. Public pedestrian paths in the green shared courtyards, Vienna (2021) – by author

Both renovation projects used a network of green areas and pedestrian paths, whether entirely public or not, to improve the performance of pre-occupied areas already established within the city. In this way, the objective of the development plans was to promote population density in areas that were already highly integrated with the urban fabric and the city's infrastructure, fostering territorial dynamics increasing their connectivity and integration.

4. Method and Data

The methodology applied to this study relies on the comprehension that the spatial organization of a settlement is part of its "morphic language" (Hillier et al. 1976). In that conception, the space syntax theory is used as a tool to analyze the systematic production of patterns. The software DepthmapX was utilized to run multiple connectivity and territorial integration calculations in the renovated zones. Both urban stretches, in Budapest and Vienna, were submitted to evaluation two times: first, in a period corresponding to the first years of the 1990s, comprising the morphological status of the areas just after the significant political changes aforementioned, and currently, when the renewal processes are already in advanced conditions and the reorganized urban stretches are highly integrated to their contexts.

The angular analysis of the road axes, whether exclusively for pedestrian use or designated for the passage of cars, was performed following appropriate parameters for locomotion in urban areas, considering the accessibility of the public transport network or primary services either on foot or with motorized vehicles (Cirianni et al., 2018). The detailed investigation process in the DepthmapX took place in the following steps:

a) The active maps of the road network were converted into segment maps.
b) A Full Angular Segment Analysis was performed to obtain more refined results (although it makes the procedure considerably more complex and slower). The radii determined for this study were 400, 800, 2500, and 5000 meters.
c) The results concerning this survey are listed within the connectivity and integration tabs provided under the Attributes List.

In order to interpret the results obtained in the DepthmapX, it must be considered that this software utilizes a visual color scale to denote the levels calculated in each of the analyzed segments. In the case of this study, the warmer colors indicate a greater degree of integration and connectivity on the axis.

5. Results

For the first stage of the investigation, the road network (key spatial components for the Space Syntax evaluation) of both areas dating from 1990 was used as an input. At that time, the pedestrian paths and the road network coincided in almost all extensions of both areas - except for some minor pedestrian ways in existing public squares. Consequently, it is visible that the axes configuration founded settled the territorial integration to low capacity due to the morphological configuration of the areas, restricting pedestrian mobility to the edges of the urban blocks.

Since the areas are inserted in the perimeter of historical urban development, the urban blocks have typical measures that revolve around 120x70m, initially having a configuration of continuous facades and a dense and impermeable core (Benkő, 2011). This conformation can be easily identified in the road network, still practically unchanged in both examples in the early 1990s. As in Vienna, the analyzed area in Budapest had a limited number of green and recreational areas, especially compared to the general scenario. of cities. The two areas were densely occupied (albeit heterogeneously) and had few leisure facilities linked to a comprehensive green area system.

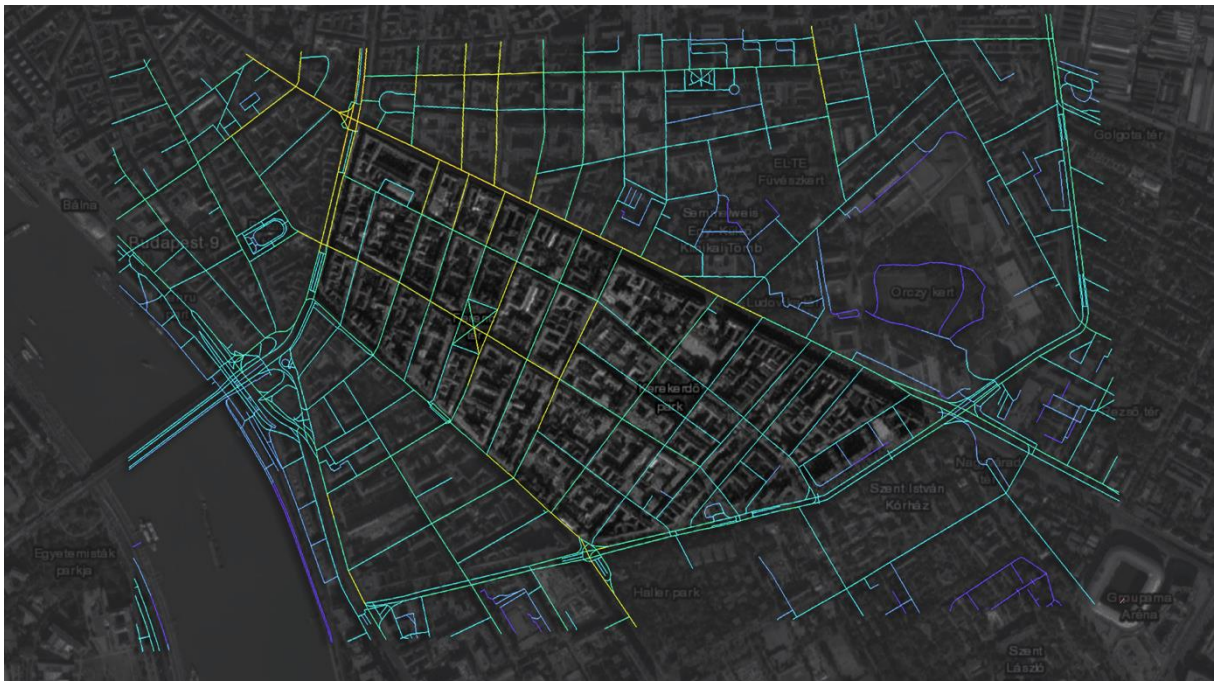

Figure 3. Global integration analysis of IX District of Budapest (1990); performed on DephtmapX– by author

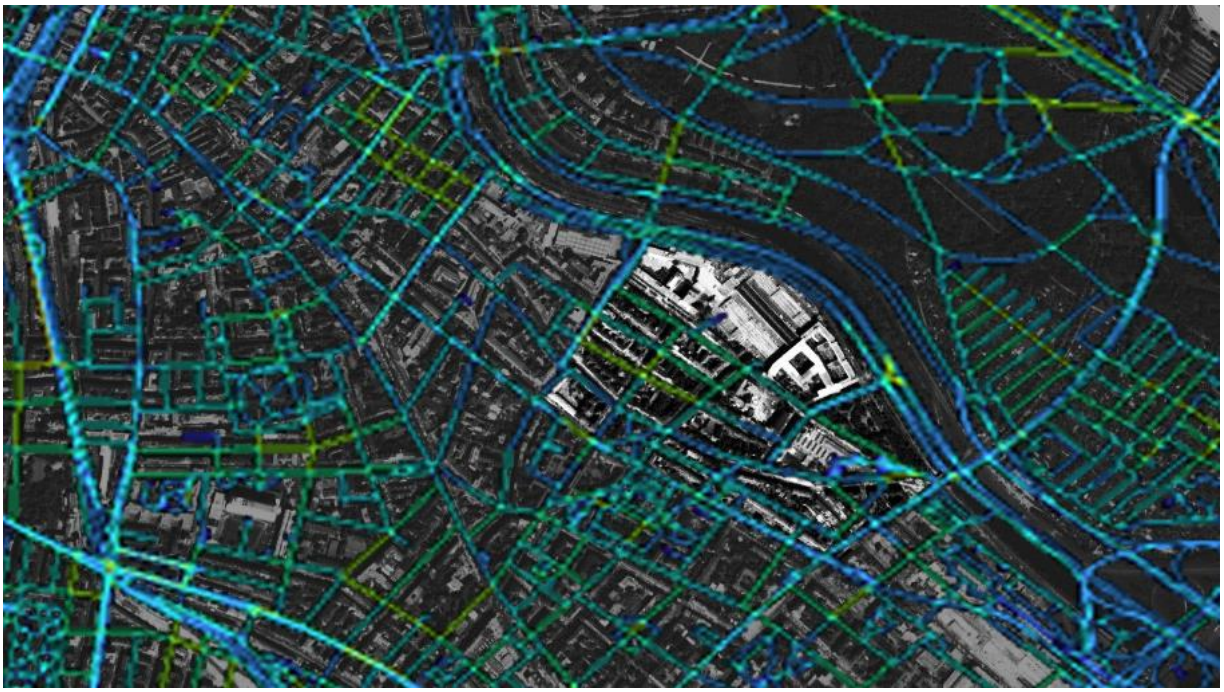

Figure 4. Global integration analysis of III District of Vienna (1990); performed on DephtmapX– by author

Although in the case of district IX of Budapest, the renovation process started from the central initiative of the city hall, and in Vienna, this is a more articulated continuous movement of expansion of the centrality and re-use of urban voids, the two cases are similar in many aspects. Foremost, they are innovative solutions that support the maintenance of the existing urban structure and simultaneously allow access to green infrastructure in areas lacking these systems. Vienna has been developing a sustainable development policy for decades, in line with the human scale of urban space use. For this reason, in this city, there are legal and financial mechanisms that facilitate the implementation of projects with these characteristics (Michaela, 2008).

In Budapest, in opposition to the scenario found in Vienna, despite the successful implementation of a green infrastructure (territorially cohesive in theory), in practice, some of the new green paths that cross the courtyards - publicly owned but privately maintained - were closed, with use restricted to the residents of the buildings. Therefore, although the results found in the evaluation of the road network dated 2020 indicate a significant increase in territorial connectivity in the renewed area of district IX, these data do not accurately reflect the reality of use currently found there. The city hall authorized the implementation of visually transparent gates and partitions in some points of the axial and nodular elements components of the green infrastructure network instituted. In some cases, the gates are not closed during the day, which leads to questions about territorial occupation political strategies, security requirements, and design solutions for space division (Benkő, 2016).

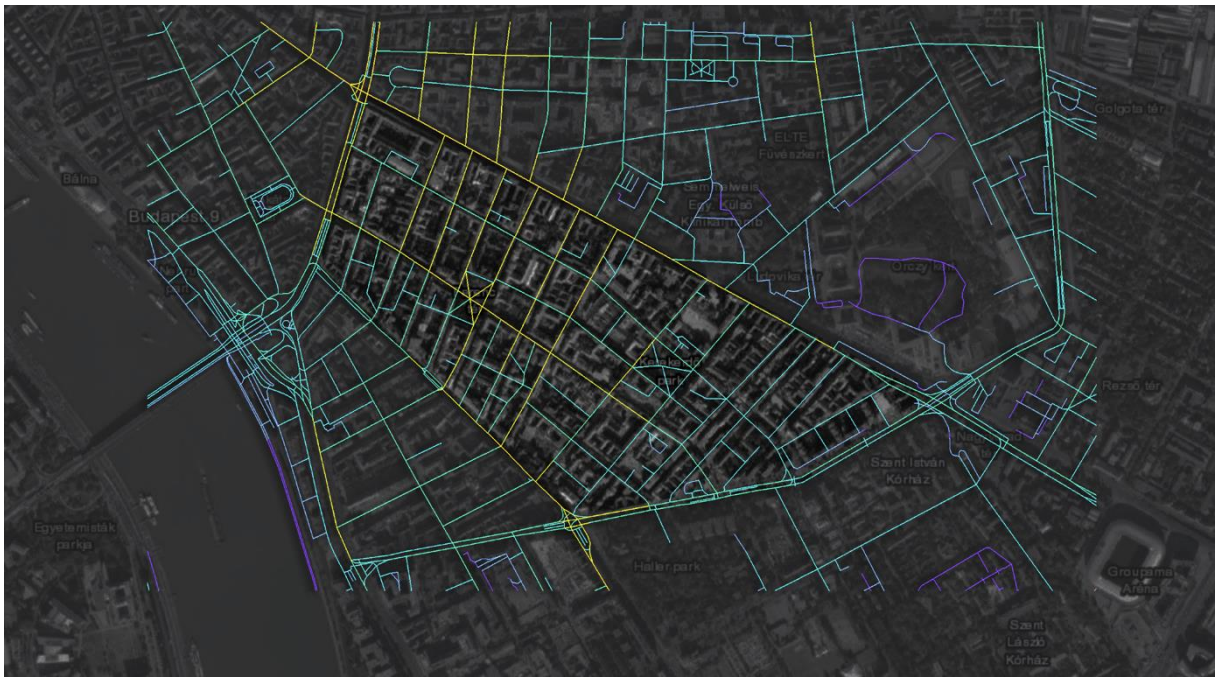

Figure 5. Global integration analysis of IX District of Budapest (2020); performed on DephtmapX – by author

The increase in connectivity at the intervention site is also evident in Vienna. In this case, the results directly reflect the use of space currently in terms of public accessibility. A significant portion of the increase in connectivity is due to the new public square that also works as a promenade connecting the Danube (an important structuring axis in the scenario of green infrastructure and mobility in the city) to the district's interior. This solution increased local and global connectivity and territorial integration in the region.

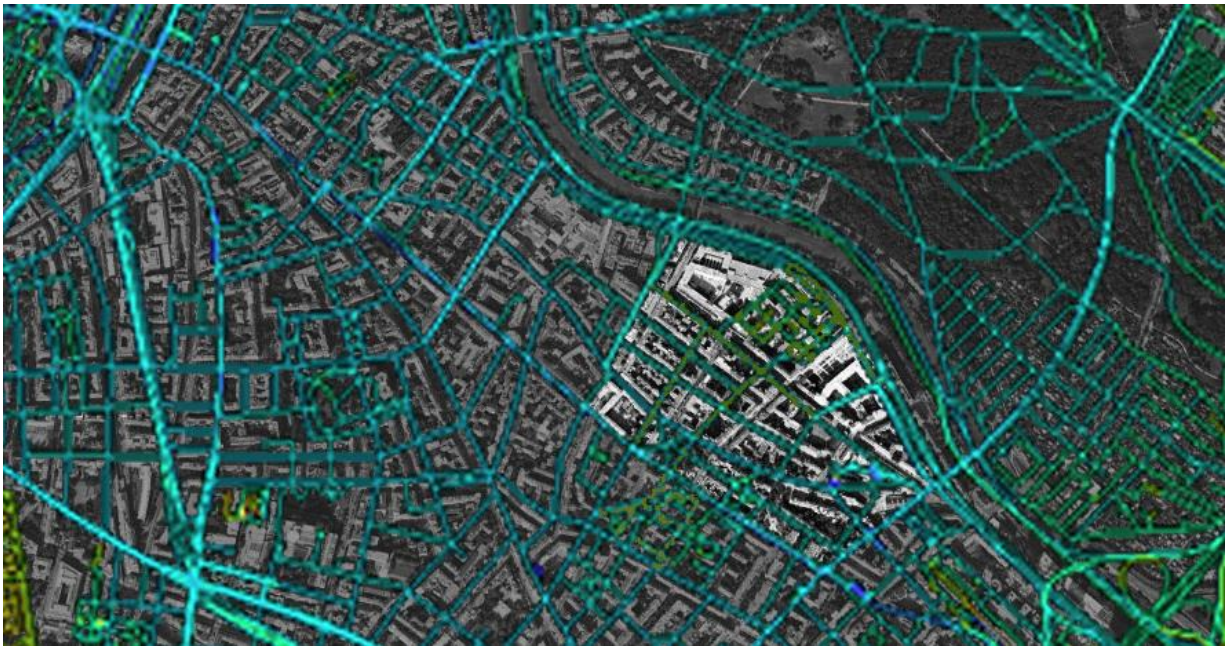

Figure 6. Global integration analysis of III District of Vienna (2020); performed on DephtmapX– by author

Although the full-angular analysis performed with the Dapht Map does not distinguish between the different types of use of the roads, it is remarkable that all the new roads identified in the maps between the years 1990 and 2020 are of priority use for pedestrians. In Budapest and Vienna, the new axes implemented during the urban renovation process are concentrated inside pre-existing urban blocks, ensuring new layers of permeability to the originally closed blocks (Benkő, 2011).

6. Discussion and Conclusion

Budapest and Vienna are cities that share many historical and cultural aspects, culminating in significant similarities in the morphological characteristics of the cities. Although it is challenging to establish comparative frameworks between urban centers immersed in such different political contexts in the contemporary historical period, it is possible to identify the reproduction of very similar patterns in specific regions of these cities.

The expansion movements towards the south of both cities have marked the renovation process and densified areas previously considered outskirts with heterogeneous occupation. There were many urban voids left by small and medium-sized industries and deactivated storage sheds leading to urban decay and a lack of urban connectivity. Regions with those characteristics in the III District of Vienna and IX District of Budapest are undergoing renovation processes whose backbone is the implementation of urban green infrastructure in conjunction with predominantly residential projects. This new configuration also presents new pedestrian paths that cut through the green areas of the newly built (and redesigned) courtyards. Moreover, the courtyards are essential morphological elements emphasized in both renovation processes, thus becoming symbols of the resilience of these historical urban fabrics.

The increase in connectivity and territorial integration followed by the implementation of green infrastructure is visible in Budapest and Vienna. However, it is worth emphasizing the different qualities of these territories in terms of accessibility to the public. Although the design conditions are relatively equivalent, the cultural and political particularities of the territorial management of each of the cities result in different user experiences of the public space.

The results found in this case study may also be relevant for other cities in a similar context, especially in Central-Eastern Europe, in many of which the process of suburbanization has also intensified in recent decades. Understanding strategies for the requalification of historically occupied urban fabrics, combined with public policies for land use and land cover, can be a viable path to cohesion and, consequently, to stimulate urban resilience.

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