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Long-Term Urbanization Dynamics and the Evolution of Green/Blue Areas in Eastern Europe: Insights from Romania

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Abstract: Urbanization is a dynamic process performed at the expense of natural and/or semi-natural areas, with direct impacts on the ecosystem services provided to human society. The increasing population density in urban areas and the associated demand for housing and public services have led to progressive changes in the structure, architecture, and design of urban areas. The present study analyzes long-term urban development in Western Romania, focusing on green/blue areas' strategies in Timisoara over centuries. The empirical results of a literature review carried out with a historical perspective have delineated the time periods that favored “urban green development” (1716–1918 and 1918–1940) and those restricting their development (1940–2000), as well as the factors that influenced long-term urbanization dynamics and the evolution of green/blue areas. These factors can be generalized to other socioeconomic contexts in Eastern Europe. Characteristic issues of this geographical area impacting the evolution of urban green/blue areas include (i) common historical aspects (e.g., the influence of geo-political and strategic dimensions, the dominations of former great empires such as the Turkish empire and the communist period) and (ii) population migration after 1990.

Keywords: urban development; urbanization; green areas; blue areas; Western Romania



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1. Introduction

The relationship between urbanization and environment is complex and difficult to be defined and quantified [1–5]. Urbanization, mainly through spatial planning, influences the environment at different operational and geographic scales, having the potential to affect ecosystem services [6–14].

Urbanization in Europe has been relatively well studied, despite important differences at the regional scale [15–17]. It is probable that the less studied urbanization processes came from Socialist countries in Eastern Europe, where urbanization was strictly planned in the aftermath of World War II, under substantially different conditions (e.g., property regimes) compared with Western Europe [18–22]. In this sense, the relationship between urbanization and the environment in Eastern Europe has been poorly investigated. An emblematic case of urbanization in Eastern Europe is Romania [21,23–25]. Romanian cities underwent massive urbanization in the second half of the 20th century, following the predominant model in this part of Europe (typical of the former socialist countries), thus realizing the migration of the Romanian society from rural areas to industrial settlements [26]. As a result, soil sealing in Romania increased by 19% in only 5 years (1989–1994), representing 20% of total urban land [27].

This process should be approached from a political and regional perspective [28], taking account of the spatial development in communist space. The rapid development of

industrial and agricultural sectors, after gaining access to the European Union in 2007, led to the implementation of socioeconomic policies promoting urbanization in rural districts, and a different approach to urbanism. However, the planning strategies of cities favoring wider metropolitan areas [29] are still unfamiliar to the post-communist Romanian administrations and local governments. In addition, in countries such as Romania, urbanization has been promoted in a mostly informal way (e.g., lack of a statutory urban infrastructure, lack of a sustainable perspective on local development). This expansion mode has been emphasized in specific areas related to education, culture and the psychology of local communities, reflecting the intrinsic desire of being a town resident instead of a “peasant”—a term perceived as making a specific reference to lower social classes [30–32]. In an urban political context that has not resolved its rivalries and areas of influence—where the dichotomy between the centralized system and the local autonomy persists—it is still difficult to approach spatial planning from a truly strategic perspective.

Over decades, urban development has led to environmental conflicts, such as increasing flood risk, as reported in other cities worldwide [33,34]. In Western Romania, floods have particularly affected rural areas, since urban settlements have the necessary protective infrastructures (e.g., dams). However, over the last 30 years, a relatively large number of localities have been transformed into urban areas, irrespective of their compliance with minimum development standards (e.g., the existence of water supply and water sewage systems), which has increased their intrinsic vulnerability to floods. In addition, the conversion of urban green areas into residential, commercial or service infrastructures has contributed to reducing the capacity of cities to face extreme rainfall events, such as in other European cities [35].

In urban areas, green and blue areas include several natural and semi-natural areas, such as urban forests, wetlands, gardens and lakes, extending over different spatial scales [36]. During the last few decades, these areas have been increasingly recognized as multifunctional areas providing important ecosystem services, including, for example, carbon sequestration, climate regulation, water purification and flood mitigation [14,37], thus contributing to the achievement of some Sustainable Development Goals. Green and blue areas have the potential to provide an adaptive response to the issues raised by social challenges, making key contributions to human well-being, socio-environmental justice, biodiversity loss, climate change adaptation, and mitigation and ecosystem services preservation [38,39]. Achieving these benefits requires careful consideration of several key aspects covering a wide range of scientific fields, from environmental psychology to ecosystem engineering and ecological education [40]. Despite the increasing acknowledgement of the benefits of and the need for urban green and blue areas by several international organizations, such as the United Nations [41] and the European Commission [42], over the last few years, urbanization has resulted in their fragmentation and decreasing extent [22].

The present study investigates the evolution of urban areas and associated green and blue areas in Western Romania, with Timisoara and its neighboring peri-urban zones as the study area. The specific aims of this study are (i) to investigate the evolution of green and blue areas throughout the history of Timisoara city, and (ii) to delineate economic, social, political, and cultural factors that have influenced such long-term evolution. Covering a relatively long time period (two millennia), from the ancient Roman colonization to today, the approach in this study is eminently based on the analysis of historic documents and sources of earlier times, together with a more traditional literature review covering recent times. Based on the descriptive analysis of multiple sources, the historical approach developed in this study provides the necessary knowledge base required to contextualize (or re-contextualize) urban green/blue area development vis à vis long-term urbanization dynamics. The strengths and limits of this approach are also discussed.

2. Study Area

As Romania's third most populous city, Timisoara is the economic hub of Western Romania, with over 320,000 inhabitants (based on the 2011 census) and almost a half-million inhabitants in the metropolitan area.

2.1. Climate

The climate is characterized by a moderate humidity throughout the year, relatively mild summers and distinctive cold and warm seasons. The annual rainfall is typical of continental–temperate climate regimes (around 600 mm/year), with periods featuring heavy rainfall accumulating in short intervals, which have significantly increased in recent years [43–45]. The spatial precipitation pattern has shown a slight decrease during the last two decades, but summer seasons are predicted to be characterized by a pronounced shortage in total precipitation [46–50]. Average annual temperature has been increasing over the last few decades, from ~10.5 °C in the 1970s to ~12.0 °C in the 2020s. Warming is expected to continue in Western Romania (as part of Eastern Europe) and an increase in mean annual temperature of up to 5 °C by 2100 is projected [49,50].

From the phyto-climatic point of view, the plains around Timisoara mostly fall within the boundaries of the forest–steppe zone. The climate, characterized by an Atlantic influence, with modest precipitation and a very high phreatic level in the soils (because of their marshiness soils), has ensured the spread of deciduous forests. Urban and peri-urban settlements expanded at road crossings and confluences of valleys because of strategic and commercial interests, being primarily located in dominant positions on the terraces' promontories, on hill slopes, and where lacking, in the proximity of secular forests, marshes and water networks, which constituted a good natural defense.

2.2. Hydrography

Located on a low, former swampy plain, Timisoara's urban development was strongly influenced by the local geographical conditions. The relief of Timisoara is of remarkable monotony, marked by modest elevations ranging from 95 m above sea level in downtown Timisoara to 84 m in the western neighborhoods of the city. Timisoara has a rich hydrographic network (Figure 1), consisting of rivers, lakes, and marshes. Except for the Bega and Timiș Rivers, the other rivers are often dry during the summer.

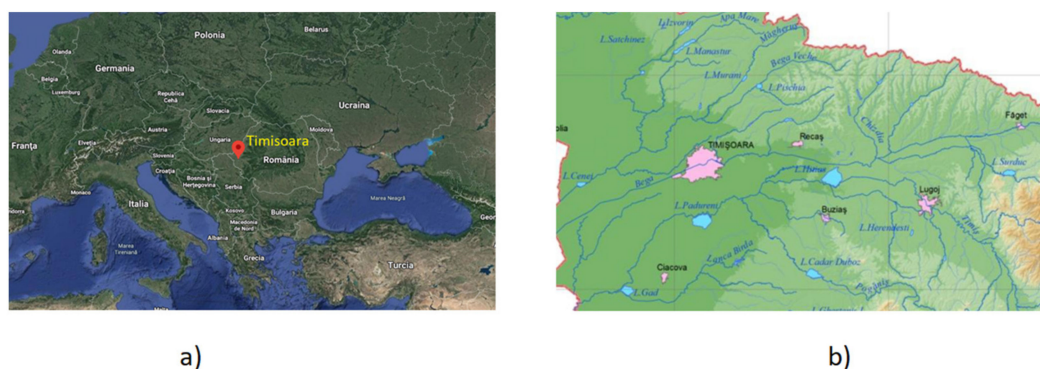


Figure 1. Position of Timisoara in Europe (a) and the hydrographic network around it (b).

Springing from the Poiana Ruscă Mountains (East of Timisoara), the Bega River is channeled and partially arranged for navigation (over a total extension of 115 km). The Bega Canal was built between 1728 and 1760. In order to regulate its flow within limits that allow navigation, a hydrotechnical node was built in Coștei to ensure the transfer of water quantity, from Timis to Bega, depending on water demand and the volume of precipitation taken on by the two upstream rivers. The Coștei Hidrotehnic Node is of great importance for the flat area of Western Romania (including the city of Timisoara). First, the hydro-technical works in Coștei supply water to the Bega Canal, thus decreasing the probability

of drought in the municipality of Timisoara. At the same time, the supplementation of the water flow from Timiș to Bega is also favorable to navigation on the Bega Canal, which can be carried out all year round.

3. Long-Term Urbanization Dynamics, Flooding and Evolution of Grey Areas in Western Romania

The information about floods developed in what is today Western Romania; their impact and the measures taken to mitigate their effects are lacking when we refer to the period prior to the occupation of Timisoara by the Ottoman Empire. The few historical sources from this period (before the 18th century) indicate floods that occurred in western parts of Romania, especially in the South of the region, along the Danube. At the beginning of the 16th century, floods were recorded throughout Transylvania. The last great flood of the 16th century also occurred in Transylvania in January 1598—the Mures river as well as the other rivers in this region came out of the stream flowing over the plains. The snow in the mountains suddenly melted because of the rain, and the mountain rivers quickly flowed [51,52]. Based on this information, we can conclude that the Western part of Romania (including Timisoara area) was affected by periodic floods.

Unfortunately, these historical sources (see Table 1) refer especially to the causes and impact of floods, and less precisely to potential measures taken to combat their effects. However, in the case of the Ottoman Timisoara, there were plans to reduce the volume of lakes, ponds and marshes around the Citadel through a centralized water supply and a sewerage system to evacuate wastewater. Around 1670, the Ottomans captured an Italian architect and brought him to Timisoara, to regularize the course of Timișul Mic (the river known today as Bega). The works executed by him are not known precisely, but his presence here is certain, and the fact that he worked for a few years in Timisoara is widely documented [53]. Thus, the history of the “grey” areas as a solution against the effects of the floods begins with the liberation of Timisoara from the occupation of the Ottoman Empire (beginning of the XVIII century).

Table 1. Information sources adopted in the present study.

Period	Covered Interval	Information Sources
Nature as usual	Up to 1716	Historical sources, documents of historical character (e.g., censuses), national and international literature
Urban consolidation	1716–1918	Historical sources, administrative and military maps, documents of historical character (e.g., censuses), national and international literature
Aesthetical age	1918–1940	Historical sources, statistical documents, national and international literature
Intense urbanization	1940–2000	Statistical documents, local, regional and national administration documents, national and international literature, local and national policies
Planned development	Since 2000	Statistical documents, local, regional and national administration documents, national and international literature, local, regional, national and European policies

In 1728, under the supervision of Count Florimund de Mercy, the military governor of Banat, work began to regiment the Bega river and rehabilitate the marshes around Timișoara. These works were also started due to the fact that the Ottoman power was no longer a threat to Timisoara, and therefore the marshy areas had lost their strategic value of stopping or slowing down the enemy’s advance. In this way, the economic recovery of the old marshes has been attempted. Between 1728 and 1756 the Bega river was regularized, its course was moved laterally south to the old riverbed and the surrounding marshes were dried up. It should be mentioned that on the map from the atlas published in 1730 in Vienna by Homan, the current course of the Bega River passed under the name of Timisel.

An important role in the rehabilitation of the swamps around Timișoara and in its defense against floods was played by the double connection Coștei–Topolovăț, the work of the Dutch engineer Maximilian Fremaunt. In 1728, he constructed a draft of a sewage plan

for the Bega–Timiș connection, in order to improve the channel started by Count Florimund de Mercy and to ensure a flow that would allow Bega to be navigated. The project foresaw the construction of a lock on the Bega canal in Coștei, in Lugojului district, and a wide and deep ditch, 10 km long, up to Timiș. Moreover, the name of the current Bega channel, before the regularization, was Timișel or Timișul Mic.

The creation of the Timiș–Bega hydrotechnical system precluded the possibility of flooding the urban area of Timișoara, and significantly lowered the standing water around the city. Despite these works, on 23 March 1745, the district administrator in Timisoara recorded that most of the villages were isolated due to the great floods. The canal has undergone several changes over time. Worth mentioning are the changes performed between 1753 and 1754 (following the catastrophic floods of 1753), which were designed by the engineer Johann Karl von Stockhausen, who directed the fortifications of the city of Timisoara. The work became necessary because, in the first phase, any surplus of water in the Bega channel flooded the lands and localities between Bega Veche and Bega. For the discharge of the surplus of water, an opening of 2 km in the dams was established, and a portion of floodable land between Bega and Bega Veche was initially left near Itebej. Bega Veche was intended to carry only the water of Beregsău and its tributaries, as well as the rainwater.

The effect of these hydrotechnical works was first of all the drying of the land from the river/Bega channel, which had a disastrous effect on the Timis meadow, often causing catastrophic floods. This is why the improvement of the hydrographic system designed in the 18th century was and remains a permanent concern of the authorities of the county [54]. In 1783, the sudden melting of the snow caused spillovers of the Bega river in Timisoara. In 1799, both western and central parts of Romania experienced the last floods of the century; after a cold and rainy winter, the snow suddenly melted, so that the suburbs of Timișoara were completely flooded [55].

A critical year for Romania was 1970. The spring–summer floods of 1970 are now included in the category of the most serious natural disasters that hit Romania in the 20th century. The overflow of the main rivers, their tributaries, and the Danube was caused by the sudden melting of the snow and the heavy rains that fell in May–June [51,52,56]. Other massive floods occurred 30 years later. Since 2000, floods have become more frequent in this area. However, Timisoara was not affected by the overflowing of surface water courses thanks to the Costei hydrotechnical node and the entire hydrotechnical system developed since the Habsburg empire.

4. Methodology

In order to investigate urbanization and the evolution of green/blue spaces over centuries, this study has adopted an approach based on the analysis of the existing national literature and policies, as well as statistical data regarding different urban periods of Timisoara. Unfortunately, the lack of reliable historical information does not allow one to accurately track the evolution of the boundaries of the city of Timisoara throughout history. In this sense, however, estimates based on various documents of historical character (e.g., censuses) can be used regarding the increase in the number of inhabitants.

Analyses of maps (some of them being developed for military purposes and therefore having a rather high accuracy) also allow the study of land use changes in the area. By overlapping several maps, starting with the end of the Ottoman period (early 18th century), we can assess the extent of the habitation of areas to the detriment of the arable land and, in some cases, with the consequent reduction in forest land. Urban expansion over the last two decades was evaluated using statistical data at the level of local and regional authorities (see Table 1).

5. A Historical Profile of Long-Term Green/Blue Areas Dynamics

The development of the inhabited areas belonging today to the metropolitan area of Timisoara was closely linked with the dynamics of green areas (Timisoara forests and

parks) and blue areas (the courses of the Bega and Timis Rivers). Developed on a marshy area, often at the confluence of strategic interests with those of a socioeconomic nature and, more recently, under the impact of climate change, the metropolitan area of Timisoara has a history structured on several clear, unique but also challenging stages. The dynamics of the green and blue areas also pose a challenge in adapting the city and its related peri-urban areas to water hazards (namely droughts and floods).

Throughout history, five main periods (stages) of green and blue area development have been identified:

- A “nature as usual” period, which overlaps, from the historical point of view, with ancient and medieval times;
- Urban consolidation overlapping with the modern period (1716–1918);
- An “aesthetical” stage corresponding to the interwar period (1918–1940);
- Intense urbanization corresponding with the second half of the 20th century;
- Planned development starting at the beginning of the 21st century.

The main characteristics of each period are presented in Table 2.

Table 2. Main reasons for selecting the five main historical periods (stages) of green and blue infrastructure (areas) development.

Period	Covered Interval	Motivation for Selecting the Age Interval
Nature as usual	Up to 1716	The period corresponds to ancient and medieval times poor in sources of information. Throughout the period, the city has known various occupants, so that there is no uniformity in the urban development from the point of view of the urbanism–environment relationship.
Urban consolidation	1716–1918	These two centuries are characterized by the development of the city within the Habsburg monarchy and later the Austro-Hungarian monarchy. It is generally urban development driven by a Western European model that takes into account both socio-economic needs and aesthetic and environmental aspects. From this period, Timisoara became known as Little Vienna.
Aesthetical age	1918–1940	The city becomes part of today’s Romania, under Romanian administration. However, the large number of inhabitants of German origin contributes to the preservation of aesthetic sense and as a consequence to the preservation of green areas.
Intense urbanization	1940–2000	The installation of the communist regime (1945) leads to the imposition of an intensive urbanization system. The period 1990–2000 is known in Romania as a period in which the setbacks and subsequent economic stagnation, and the lack of a clear and efficient post-communist legislation, did not allow significant steps regarding urban development and/or harmonization of the urbanism–environment relationship. Thus, we can say that the first 10 years of post-communism in Romania were not delimited by the communist period in terms of a positive dynamics of green urban areas—on the contrary, a downward trend was maintained in these areas.
Planned development	Since 2000	Starting with the year 2000, Romania entered a period of economic growth and stability, with access to the European structures that allowed the adoption of an urban planning system in accordance with European standards.

5.1. “Nature as Usual” Time

This period corresponding to ancient and medieval times is lacking in historical literary sources related to green and blue areas’ development and/or their management. However, some information is available on how local communities used the green and blue areas to cope with conditions characteristic of political and climate crisis (e.g., floods).

The first information available about using natural techniques against floods comes from the Neolithic period (10,000–4500 BCE). A group of houses, located near a surface water resource, formed a hamlet that, in the Neolithic plain settlements, was surrounded by a ditch with the function of fencing and collecting rainwater from the premises, a precursor of the later drainage channels. These ditches—the so-called “fossatum”—were characteris-

tic of the Dacian and later Dacian-Roman villages, as corroborated by the archaeological excavations performed in Romania [57,58].

Many of what we call today urban areas are located mainly in hilly areas, where the forests represent not only an important resource for living purposes, but also an important “ally” in preventing territory invasions. In 75–74, before Christ, the proconsul of Macedonia, a province belonging to Roman Empire, C. Scribonius Curio touched with his army the river Danube, in front of today’s Banat region, but he did not dare to cross the river because he feared “the darkness of the forests”, since he could not see to the other bank. The central and eastern parts of the Banat region (including the area that is now Timisoara) were covered by forests. To the west, several plains and valleys stretched, caused by the overflows of the Tisza and Timis Rivers [59].

During the wars between the Roman Empire and the Dacia Kingdom (101–102 and 105–106 after Christ), the Dacian king had an ally in the forest. The Column raised in Rome by the Roman Emperor Traian shows the Dacians fighting near the forest. The ancient historian Cassius Dio, who gives us details on the wars between the Dacians and the Romans, stated that after a heavy battle in Banat, in which both armies encountered significant losses, Decebal, the Dacian King, in order to deceive the Romans, ordered his forces to cut down the trees of a young forest at breast height, and camouflaged them with clothes and Dacian weapons, to give the impression, from distance, of having in reserve another army. Thus, the Roman Empire encountered difficulties in conquering what we call today the Banat area due to the harsh geographical conditions (swampy areas), but also because of the residents’ skills in using nature.

The occupation of Dacia by the Romans brought into these lands the technology of the great Empire. It is known that besides the supply of cities with water, the needs imposed by hygienic and sanitary standards posed the problem of eliminating the surplus water from human activities or from heavy rainfall. For this purpose, the cities were equipped with a network of drainage channels.

The subsequent times, until the mid-16th century, are lacking in written sources about urbanization and the related green and blue areas. However, we know that Timisoara, first mentioned in the historical sources (i.e., medieval documents belonging to King Stefan of Hungary, which mention the “Tymes” Fortress together with other settlements and feudal domains in counties included nowadays in western Romania) at the beginning of the 13th century, became the headquarters of the Hungarian feudal kingdom between 1307 and 1323 post-Christ. This aspect denotes a level of development capable of offering certain higher living standards, specific to a royal residence. The presence of the royal family between 1316 and 1327 in the newly built castle justifies the existence of a royal park in Timisoara [60].

Even if for the period prior to the Ottoman occupation (1552–1716) we have no concrete evidence of the existence of gardens in, or around, the city of Timisoara, we find it particularly interesting that on one of the first engravings of the 17th century city appears a building, a noble residence or a pleasant palace, called the Adelsitz or Lustschloss building, which can be associated with the existence of a garden due to the fact that in German, the names Lustgarten, Lusthaus, or Lustgebäude have been consistently used as names for buildings surrounded by gardens that no longer have economic purposes [61]. On a second engraving, which recounts the siege of Timisoara in 1596, attributed to the artist Hans Johann Siebmacher, we can observe again the existence and location of a noble residence in the suburb of the city surrounded by a garden [62].

During the Ottoman occupation of Timisoara, the few references to urban green areas were provided mainly by Turkish emissaries, and Timisoara represented from the middle of the 16th century one of the most important urban areas in this part of Europe. Traveling to Timisoara (1660), Evlia Celebi recalled in his memorial the gardens located at the edge of the Citadel; in the summer, the pasha himself used to move away from the city to Mehala (currently, one of Timisoara’s districts), into a house surrounded by oriental-type gardens. Starting from the description by Evlia Celebi, some historians assume that in the Ottoman

era, Timișoara would have been an almost ideal settlement surrounded by rose gardens [63]. Other contemporary sources with Celebi confirm the existence of gardens and orchards of wealthy citizens or officials of the Muslim era, located in the areas behind the citadel [64].

More information about the blue areas is provided by Western European emissaries who came from countries with a strong expertise in managing water surplus. Thus, Filippo Pigafetta, an Italian emissary and a participant in Sigismund Bathory's siege on Timisoara (1595), described the city as follows: "[...] Timisoara is closed by a wall of ground and wood according to the custom of this country and from the side it has vast marshes, and ditches, and very large waters are around for more than half a mile: it is surrounded by the river Timiș (actually it was river Bega or Timișul Mic, for a period of time this being the name of the river which flows through Timisoara) from which it takes its name". The fact that Timisoara was located in the middle of a large swampy area, usually flooded by two rivers, forced the inhabitants to find solutions to improve their general living conditions. The habit of Timisoara's inhabitants to plant trees, shrubs and flowers in a region dominated by large areas periodically covered by the flood waters of the Bega and Timis Rivers was a relevant step in gaining the reputation of the city of flowers, parks, and gardens [65–67].

5.2. The Modern Period (1716–1918)

After the elimination of the Turkish occupation, a new period of urbanization started in Timisoara. The interest in green areas and better living conditions increased. Starting in 1728, under the supervision of Count Florimund de Mercy, the regional military governor, the regularization of the Bega River and the rehabilitation of the marshes around Timișoara for economic valorization began. Draining the marshes, however, brought about negative effects associated with catastrophic floods. This is why the improvement of the hydrographic system conceived in the 18th century was and has remained a permanent concern of the authorities in the country.

In the same period, Austrian military engineers drew out large spaces (Palanca Mare and Palanca Mica) for urban parks. In the 18th century, the city's plans included areas with forest plantations (e.g., the Valahe Maori, the German Mairens and the Citadel). Additionally, all major city residences were surrounded by small parks, gardens and tree plantations [54,57,65]. After the expulsion of the Turks, for a long time, the Garden of the Pasha, named "the Garden of the President of the Administration" after 1717, came under the management of the Jesuit order, which installed a pond.

The measures for expanding the green areas were extended outside the limits of Timisoara fortress (today an urban area). To support the growth of silkworms, the Banat Administration initiated the acquisition of mulberry seedlings, which would be planted around several urban areas such as Timișoara, Ciacova and Becicherecul Mare. At the same time, it was brought to the attention of inhabitants that the destruction of these seedlings would be punished with death [68]. In order to ensure the supply of mulberry leaves, in 1734, the Provincial Administration council requested the approval of the military command to plant 143,000 mulberry seedlings between the Citadel and the Hunting House from the Green Forest (which still exists today in the northeastern part of the actual city) [69]. However, one century later, these trees were cut by order of the Citadel commander, because they impeded the firing of imperial artillery during another siege [70].

Following these turbulent times, marked by wars and political instability, the fortress of Timisoara underwent a process of fortification system development. After the construction of the city's defense system was completed, the ditches of the fortress were filled with water. This decision, despite its military necessity, contributed to several problems for the inhabitants of the city, such as the odor and the mixture of water and dejections. The depth of the ditch was not sufficient to provide the necessary slope for the mixture to reach the sanitary channel of the Bega River. The problem was prevented by the Military Command of the city, who rejected all the proposals of the city for demolishing the defense system. Towards the end of the 19th century, several proposals were issued aimed at drying the ditches by transforming them into gardens. The master plan was to divide the trenches

into smaller canals which, when tied together, would have facilitated the leakage of the collected water.

Another proposal aimed at using the fortress area and walls, improving the health of this area. This condition was precarious because small ponds and swamps were formed in the canals around the fortifications, as they did not benefit from proper drainage. In these places, all kinds of odorous debris gathered, and the water brought from the Bega River for the cleaning of the channels could not completely remove it. In order to prevent the formation of ponds with stagnant and polluted water, the proposed measures aimed at the development of a complete system for the purification of these sewers, including increasing the channels' slope to facilitate flow, and using bio-drainage (planting small plots with plants whose roots could absorb the decaying organic matter and water). Through the canal system, the accumulation of water was prevented and waste was spread over larger areas. Among the plants that would meet the criteria listed above, the project mentioned willows and vines. It was estimated that planting a surface with around 0.5 ha with willow could absorb a lot of water, at the same time as releasing oxygen. Another positive effect expected to be derived from the vine planted vertically on the walls was its air-freshening, greening and cooling effect in hot summers. In addition, there were other economic benefits, such as grape harvesting and an indirect stimulus for the basket weaving industry [71].

The first large urban park of Timisoara (covering more than 40,000 m²) was created by Count Johann von Coronini-Cronberg, Governor of the Serbian Vojvodina Province and Banat Timisoara, around 1852. This was a seminal moment, given that the afforestation was carried out on the so-called "esplanade". A cordon surrounding the walls of the fortification, with a width of 950 m and where, for strategic military reasons, constructions were not allowed, in turn became a huge meadow around the Habsburg fortress [72].

The current Central Park of Timisoara is one of the oldest parks in Timisoara, established in 1880 at the direction of General Anton von Scudier. As military commander of the Banat, he decided to transform the old civil and military cemetery located between the current course of the Bega River and a former sanitary ditch in a park. The park, which occupies an area of over 9 ha, was taken under management by the municipality at the beginning of the 20th century, to be cared for and enhanced with decorative species.

Another park developed in this period was that which we call today the Roses Park. In 1891, Timisoara hosted a large industrial, commercial and agricultural exhibition of the entire area, and the organizers had to find a space for all the exhibits. As the land between the Coronini and Scudier parks was free, the mayor's office set up, with the support of the population, a new park, on an area of over 9 ha. Floral arrangements of great beauty were set up by some famous gardeners of that period, whose gardens stretched for tens of hectares. They created new assortments of shrubs and flowers, especially roses, which were admired by everyone, including Emperor Franz Josef, who visited the exhibition. The park, arranged in English style, was named after the emperor, and after the first war was named Rosarium. Over 1200 species of roses were planted, and all their information is listed on tables [60,73].

The industrial development of the city, but also the increasing education of resident inhabitants, indirectly stimulated the extension of the green areas. Thus, the number of planted trees grew, within frequent planting schemes, establishing true filters, protective green curtains against industrial smoke, urban dust, and high summer temperatures. Many green areas (forests) were identified outside Timisoara. Several military maps of that period indicate with some accuracy several forest patches that, unfortunately, have disappeared altogether.

The largest forest patch that disappeared in the last century was located in the southern part of the city and covered around 4000 ha (at present, here, there are several villages dating from the beginning of the 20th century). The unplanned development of a civilization that ignored ecological balance and had only economical interests led to the destruction of nearly 6000 ha of forests close to Timisoara in just a century (see Figure 2).

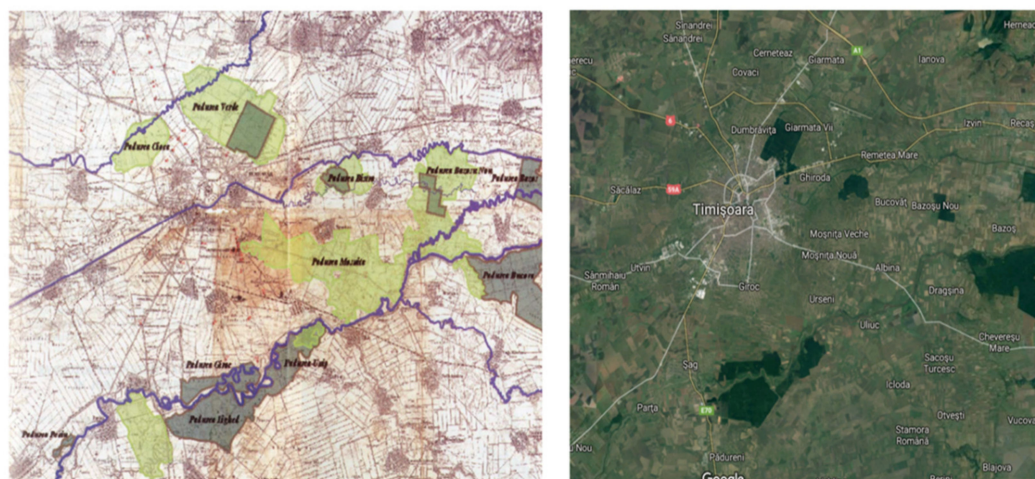


Figure 2. In light green, the forests that used to exist around Timișoara, and in dark green the forests that still exists (Source: Natural and Landscape Framework of Timișoara Municipality).

Under the laws in force during that period, for health reasons, these areas should have been maintained as forests, and the deforested areas should have been replanted within an interval of 15–20 years. Since the forest (Cioca forest, which was in the city’s ownership) as such did not bring any important annual income, and since grubbing up was advantageous for agriculture, with a 6–8-times higher income, there was a permanent trend within the city of obtaining clearcutting permits. Proposals to sell the forests around Timișoara to the municipality became increasingly frequent in that period [74].

5.3. The “Aesthetic” Stage (1716–1918)

The interwar period represents an apogee for the city of Timișoara regarding the area covered by green patches (around 200 ha). In the press of that period it was emphasized that Timișoara was one of the greenest and cleanest cities of Central and Southeastern Europe [75].

However, gaining this title was not easy, since the process was marked by many challenges and scandals. In 1922, one of the most important figures of Timișoara history, the engineer Stan Vidrișin, came under the management of the city’s mayoralty. In a few months, a scandal broke out due to the abusive attitude of some landlords in complicity with the town hall, which allowed them, in exchange for receiving some money, to fence off parks and green spaces with barbed wire for the cultivation of hay. Thus, kindergartens, parks, and leisure areas were transformed into hay-growing areas [76].

Several years later, the Horticultural Service of the Municipality established a nursery, in the eastern part of the city, with an area of 130,000 m², which delivered 1 million flowers for parks, streets and green spaces annually [73,77]. Just before the beginning of the Second World War, a forest was planted along the Timișoara–Lugoj road. The “National Renaissance Forest”, as it was called, was set up on an area of 65 ha. Another important event that took place in this period was the establishment of the “National Rosary”. The Roses Park, covering a surface of over 2.5 ha, was maintained until 1938 with the help of the garrison military in Timișoara. After 1938, the park came under the city’s administration. Between August 1940 and the end of the war, the Rose Park was under the supervision of the Botanical Garden in Cluj, temporarily relocated to Timișoara after the Vienna dictatorship. In addition to the Roses Park, smaller parks were set up in the area on the left bank of the Bega River. The most important of these was the Alpinet Park, created on an area of over 2 ha, and executed in 1926. On the right bank of the Bega river, between the Roses Park and the Capitol Cinematograph, on the area reserved initially for the construction of the Palace of Justice, the “Justice Park” was created [65,66,73,77,78].

5.4. *The Urbanization Stage (Second Half of the XX Century)*

Between 1960 and 1989, huge “bedroom neighborhoods” were built, consisting of blocks of four, eight or ten floors, of large prefabricated panels. At the end of the 1980s, over two-thirds of the population of Timișoara lived in such neighborhoods. The blocks had the technical and public facilities needed for housing, but now have a sad plastic appearance, making them completely unsightly, contrasting with everything that was built earlier in Timișoara. Many green areas have disappeared because of the low awareness of the importance of these.

The co-ownership regime placed a series of obstacles in the way of the efficient management of the buildings and of the execution of the rehabilitation works. These neighborhoods were characterized by the existence of a small number of green spaces, leisure spaces and playgrounds arranged for children, as well as their transforming of many plant surfaces into spontaneous parking spaces, due to the high density of buildings and the insufficiency of spaces set up for parking.

5.5. *Planned Urban Development (the 21st Century)*

The beginning of the 21st century coincided with a marked reduction in the green spaces in the metropolitan area of Timișoara. Real estate development, population immigration from surrounding rural areas thanks to the improved living conditions in the city, as well as the existence of legislative gaps to maintain green areas as vital for urban sustainable development, have led to the gradual reduction in green areas by their destruction, clearing some lakes and ponds and transforming them into what we call grey areas.

In the southern part of Timișoara, two ponds surrounded by vegetation represent two attractive leisure locations. The smallest pond, with a total surface of almost 4000 m², was three-quarters surrounded by a park (mostly used as a playground), a green area in the middle of an urban communist-type residential area. The pond was fed from the groundwater, with a depth ranging between 1 and 3 m. According to the statements of the residents of that area, the pond has never dried over the last 40 years. There is no evidence regarding the existence of communication channels with any running water, and there was no water spillover into other bonding channels.

Although, on the one hand, we can identify certain hygienic–sanitary measures that need to be taken because of the inappropriate maintenance of these pools (the presence of mosquitoes, the use of certain portions of the pond as a place for household waste storage), the transformation of the surrounding green area meant, for the residents living in that area, losing a leisure area.

A special impact, at least visually, was created by the restoration of one of the central markets of the city. The systematization of the Freedom Square led to the removal of a significant number of trees, which offered both protection during hot days and the image of a green place downtown.

Thus, the nearest villages (Giroc, Dumbrăvița, Ghiroda) experienced a marked densification after changing the destination of the gardens and transforming them into small (under 400 m²) lots intended for construction. The street plots have become denser as a result of multiplying the number of streets created to allow access to the newly built houses. The residential dynamics achieved in the absence of strict urban planning regulations (or in the context of not applying them) resulted in a composite, incoherent morphology, associating houses that are very different in style, height, and volume regime.

6. Factors Affecting Green/Blue Areas Dynamics

Throughout the history of the city’s development, we have been able to identify several factors affecting the dynamics of green and blue areas. These factors include:

- the existing hygienic–sanitary conditions;
- climate hazards;
- military conditions;
- political conditions;

- rural–urban and urban–rural migration;
- real estate speculation;
- socioeconomic development;
- aesthetic interests.

In the following sub-sections, we briefly explain the influence of each factor.

6.1. The Existing Hygienic–Sanitary Conditions

Timisoara was formed as a settlement in the middle of a swampy area fed by the Timis and Bega Rivers. The difficult living conditions of the 14–18th centuries required drastic measures for the creation of habitats proper to the further development of the city. In this sense, some green and blue areas were implemented during the medieval period (drying marshes, planting trees, diverting rivers, developing and implementing parks and leisure areas). Later, similar measures were taken in the 20th century. The low education of the inhabitants led to situations wherein small ponds became outbreak areas of infection. The restoration of these small lakes did not improve the situation, with some of these lands remaining places for storing household waste, it being land without any public use and with an unpleasant appearance. However, regardless of the historical period to which we refer, hygienic–sanitary conditions and needs were important factors that significantly influenced, mostly positively, the dynamics of urban green and blue areas from a quantitative perspective.

6.2. Climate Hazards

The foundation of Timisoara on land with a very high groundwater level inevitably led to situations in which floods and the city came into conflict. The flood problem was addressed in the first part of the 18th century when the engineers of the Habsburg Empire created the hydrotechnical knot, which later made Timisoara safe. Other measures with an impact on the watercourses, especially in the Bega River, included the sewage works on the embankments (with more on the Timis River). Thus, Timisoara became less vulnerable to floods, mainly due to the river diversion scheme upstream, which protects the city from floods. Nowadays, flooding problems remain in the south of the city, due to inappropriate regulation of the Timis, but this does not affect the urban area.

The current vulnerability of Timisoara to floods is mainly caused by abundant precipitation (Figure 3). Climate change effects, soil sealing and natural hazards are all compromising the sustainability of the Timisoara urban areas. Ecological soil functions are severely impaired in sealed areas, with soil buffering features being affected, producing negative effects on water flow patterns and accumulation. We should mention here the lack of forest curtains at the borders of urban areas. This lack of protective curtains results in increases in the impacts of storms on urban infrastructure.



Figure 3. Streets of Timisoara after heavy rain in 2014 (Source: <http://pompiertiitm.wordpress.com> (accessed on 17 May 2021)).

6.3. Military Conditions

Timisoara, the capital of the historical Banat region, has always been located at the conjunction of the interests of great empires. The dynamics of green as well as blue areas have been influenced by political–military, tactical, and strategic interests. Over a long period of time, these interests conflicted with hygienic–sanitary objectives since the marshes around Timisoara were a good defense against potential attackers. On the other hand, the city of Timisoara required, also for tactical–strategic reasons, an area free of construction (and any other obstacles—including trees) around the walls for a better defense. Thus, in a radius of nearly 1 km around the walls, the trees were cleared. These restrictions were removed in the second half of the 19th century. The weapons used in that period advanced technologically so much that the walls of Timisoara were no longer a sustainable investment. Subsequently, this area was urbanized, and is currently part of Timisoara city center.

6.4. Political Context

Changes in the political regime have always had a visible impact on green and blue areas' development in Romania. These changes were more visible at the beginning of the 18th century (Habsburg Empire occupation of Timisoara), with the interest in urban areas significantly increasing. This trend continued until the second half of the 20th century.

The situation changed under the communist regime. Land was considered to have no intrinsic value except to serve, at least theoretically, human needs [79]. Given the types and numbers of human needs considered in the directives given by the Communist Party, the aspects related to the relevance of green areas were disregarded in favor of those in the category of intensive industrial and social development (the development of large block neighborhoods for working people). This period encompasses the last 50 years, although the trend over two decades was driven by different reasons (see below).

Only with Romania's accession into the EU structures (2007) has the political interest in urban green areas begun to increase. However urban green areas development (or at least conservation) did not meet the desires of the population. Thus, at the city level, strategies were developed for the conservation and development of green areas, organized by decade, and in correlation with the values and principles of environmental protection established at the European and international levels.

These strategies included some promising measures regarding the protection and extension of urban green areas. One of these measures stated that, within the Municipality of Timișoara, individuals or legal entities aiming to cut trees (deforestation) for objective causes (e.g., drying, damage to buildings) were obliged to plant at least two ornamental trees. The protection of some trees with special decorative value was also considered within the municipality of Timișoara, making it forbidden to cut down or degrade them in any way (in 2010, over 1000 trees were thus protected) [80].

Unfortunately, the results of these strategies were not satisfactory, with the surface area of (per capita) green space in Timisoara being approximately 18 m² (in 2013), a value under the European regulation that foresaw a minimum of 26 m² of green space per inhabitant, a value that is also given by the national legislation in force [81,82].

6.5. Rural–Urban and Urban–Rural Migration

Economic downturns have always led to population movements between urban and rural areas. These migrations place additional pressures on both areas, leading, in time, to the often uncontrolled and unsustainable development of peri-urban areas. In these areas, soil sealing leads to flooding that results from intense rainfall. These floods cause only material damage.

In Dumbravita, a commune near the city of Timisoara, the population has increased in the last 15 years from 2000 to over 16,000 people, according to the latest estimates [83]. This massive population increase has led to the transformation of many gardens into residential areas, and a significant reduction in some essential ecosystem services. A frequent result of this change is streets and gardens flooding after rains of medium intensity. Real estate

development, necessary in the case of massive population movements, has almost always been carried out to the detriment of the green areas.

6.6. Real Estate Speculation

In Romania, according to the National Law no. 24/2007 on the regulation and administration of green spaces within urban localities, local authorities have the obligation to keep records of the green spaces by establishing the Local Register of Green Spaces (RLSV), updated whenever changes occur. Basically, the registry is a database that sets out in detail the situation of each piece of land defined as green space, including information about the surface area, the species of trees, the size of the trunk and the crown, the state of viability and any risks.

Due to the limited interests of local and national authorities, and some interest from the private commercial sector, the register in some cities (including Timisoara) was defective, having incomplete coverage. This register covered less than 15% of the total area of green spaces (mainly urban parks) in Timisoara. Environmental activists, who have attacked this registry in court, claim that the green areas that were not included in the registry are not recognized by the administration, and do not benefit from legal protection and the protection measures established by law. Thus, the green areas not included in the records are vulnerable and exposed to real estate pressures and grey area development. However, real estate speculation is not new, and similar situations have emerged since the end of the 19th century.

6.7. Socioeconomic Development

The socioeconomic development of the city has led to a significant migration of the population to this area, leading to the need for building more and more houses, and thus placing significant pressure on the green surfaces. In addition, real estate development, against the background of development forecasts, has built housing blocks and commercial/service spaces, based on the estimation of a larger number of inhabitants and the premise of increasing their purchasing power. Two examples can be presented here. First, the increasing extension of residential areas in the communes adjacent to Timisoara has practically determined the disappearance of green areas between localities, leading to the developing of a very compact peri-urban fabric. Second, the development of a shopping center close to the city center can be mentioned, which occurred in an area that was previously a huge green park created, during the communist period, surrounded by some radio and television antennas.

Socioeconomic development has clearly led to soil sealing. In Figure 4, showing the expansion of Timisoara over the last 30 years, we can see the spread of waterproofed areas (white/grey surfaces). In addition, it can be observed that in the north of the city, but also in the east and southeast, Timisoara has become physically joined with adjacent settlements. Although there are no official statistics on this issue, it can be easily observed that the green areas affected by urbanization cannot be neglected.

According to ESPON (2014), Timisoara is one of the Romanian cities with the highest percentage of urban area covered by impervious materials [84]. Land use changes have been particularly rapid in the last three decades, with many arable lands passing into private ownership and removed from the agricultural circuit for the development of residential and commercial settlements because of a growing demand for buildings. Unfortunately, the development of commercial areas in the center of Timisoara was achieved by the elimination of a large green area (the former “antenna” park extending more than 12 ha). Despite the efforts of the developers to introduce green spaces in the development of commercial areas, their surface and quality can only compensate to a small extent for the disappearance of the green area.

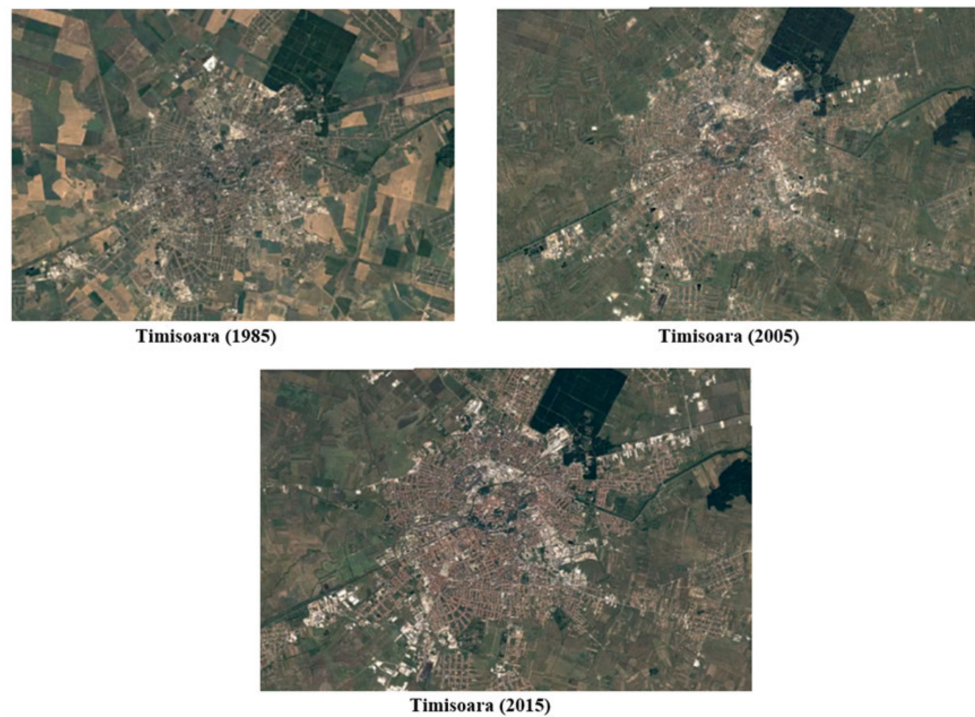


Figure 4. Timisoara morphology from aerial photographs between 1985 and 2015. (captures adapted from earthengine.google.com, (accessed on 16 May 2021)).

6.8. Aesthetic Interests

The interest of Timisoara inhabitants in green areas has been persistent over time. Unfortunately, at least in the last six centuries, this interest has often conflicted with military and political priorities (e.g., urbanization during the communist period), aspects that have sometimes led to a shrinkage of green areas. However, the existence of some famous flowering families and gardeners in Timisoara, as well as the support they have found from the local and central authorities (at least in some periods), helped Timisoara to gain in time the reputation as a “city of flowers”.

In addition, solutions for the better integration of the Bega channel, and the parks that border it, into the urban complex should be found. Public parks should be set up around the neighborhoods of blocks and within the new external residential areas, associated with some neighborhood buildings, providing an informative example of good practices in green–blue areas at the local level in Romania.

The importance of these factors, which influenced the dynamics of the evolution of green and blue areas, has changed throughout the historical periods that the city has gone through. In Table 3, we present how this role evolved during the historical periods analyzed in this work. The most positive period for the evolution of green and blue areas was 1716–1940. During this period, most of the optimal landscape conditions were met for the development of green areas. On the other hand, 1940–2000 was the period during which the development of green and blue areas was negatively affected by several factors. Currently, we can identify a mix of positive and negative factors influencing the evolution of green and blue areas. Rural–urban migration, real estate speculation and socioeconomic development are still major issues that need solutions in order to support the positive development of green and blue areas, or at least reduce their negative impact.

Table 3. The influence of different factors on the dynamics of green and blue infrastructure throughout the historical periods that the city has gone through.

Factor	→1716	1716–1918	1918–1940	1940–2000	2000→
Hygienic–sanitary conditions	Positive	Positive	Neutral	Neutral	Positive
Climate hazards (including flood evolution)	Neutral	Positive	Neutral	Neutral	Positive
Military conditions	Negative	Negative	Positive	Neutral	Neutral
Political conditions	Positive	Negative	Positive	Neutral	Positive
Rural–urban migration	Neutral	Neutral	Neutral	Negative	Negative
Real estate speculation	Neutral	Neutral	Negative	Negative	Negative
Socioeconomic development	Neutral	Positive	Positive	Negative	Negative
Aesthetic interests	Positive	Positive	Positive	Neutral	Positive

7. Concluding Remarks

The dynamics of green/blue areas in metropolitan areas is a complex issue that merits further investigation by mixing quantitative analyses of recent times with a more qualitative analysis approach covering past periods. Urbanization processes can be approached from several perspectives, each of which involves several factors defining the relationships between urbanism, environment and society. The historical approach provides an appropriate knowledge base that can be refined in further studies focusing on more restricted periods with improved data sources, e.g., recent times. The limits of historical approaches are intrinsically related to the heterogeneity of the information sources, and the latent difficulty in profiling homogeneous time intervals with similar socioeconomic, political, cultural and strategic characteristics. However, a historical approach covering a long time interval allows the appropriate conceptualization of the long-term drivers affecting the development or shrinkage of green/blue areas in regions with a consolidated urban tradition, such as Timisoara city.

The factors that influence the dynamics of urban green/blue areas, and which have been analyzed in this study, can be generalized to many urban areas in Eastern Europe. The defining elements of this geographical area, with strong impacts on the dynamics of urban green/blue areas, are the common historical aspects (e.g., the influence of the elements of a politic–strategic nature, the dominations of the former great empires, the communist period), socioeconomic development, and population migration after the early 1990s.

These aspects led to real-estate speculation, a key factor reducing the scope of urban green areas without specific policy interventions. Real-estate speculation is also the result of the reforms related to land ownership (generated by political changes, i.e., switching from a democratic system to a totalitarian system and back to a democratic one in less than 100 years), the dependence on certain politic–strategic orientations (e.g., belonging to the communist bloc and later to the European Union), and the lack of coherent legislation regarding property rights after 1990.

However, recent political events (e.g., opening of the European Union to Eastern European countries) that increased the level of education in the population also manifested an increased interest in improving health conditions, the development of aesthetic sense, and the promotion of nature-based solutions as vital urban elements in adaptation to climate change, all of these being pillars of the development, expansion, or conservation of green and blue urban areas.

Future research should investigate the dynamics of green/blue areas in other European metropolitan areas, to achieve a better understanding of and thus support for future management and planning.

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