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Heritage and Environment: Greenery as a Climate Change Mitigation Factor in Selected UNESCO Sites in Krakow

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Abstract: The quantity and condition of urban greenery directly affect the quality of life of residents and space users. This quality is linked to measures that reduce the negative impact of climate change. It was assumed that urban greenery should not only be protected but also should have its stock increased, which is not easy in a historical, compact structure under statutory conservation. This paper discusses the issue of green areas in the strict city centre of Krakow, a UNESCO World Heritage Site since 1978. The study area includes two medieval towns that had their town charters issued in the 13th and 14th centuries, which together formed a central town and a satellite town. Kazimierz and Stradom were subjected to a detailed investigation. A review of the literature and other sources made it possible to identify changes in the structure of green spaces in terms of chronology and quantity. Changes in the area, accessibility and the legal provisions arising from the various forms of statutory conservation and their consequences were analysed. Multi-criteria analyses of the historical urban structure and the types, forms and potential for introducing greenery into the historical area were also performed. The intention was to strengthen green infrastructure, which is a key element in climate change mitigation.

Keywords: historical city; conservation; historical greenery layouts; green infrastructure; greenery design

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1. Introduction

Natural areas in cities are a key element of their functioning and development. This means that green infrastructure assets should be treated as critical infrastructure. Due to progressing urbanisation and population growth in cities, their greenery should be protected, and its amount increased. However, this is not easy in a historical, compact structure under statutory heritage conservation. In addition to their ecological, insulating, aesthetic and cultural functions, natural areas play a social role, creating recreation and activity spaces. Thus, the amount and availability of green spaces in cities directly affects the quality of life of their inhabitants. This quality is linked to measures that reduce the negative impact of climate change.

Studies on the quantity and quality of greenery in European cities have been conducted for years. They result in various global rankings of the world's greenest cities. The European Environment Agency's (EEA) reports are valuable sources here. These reports state that green infrastructure, which includes green and blue spaces, accounts for an average of 42% of urban areas in 38 EEA member states. The city with the highest share of total green space (96%) is Cáceres in Spain, where the city centre is surrounded by natural and semi-natural areas. In contrast, the city with the lowest total green area ratio of just 7% is Trnava in Slovakia [1]. Different data are provided by the Husqvarna Urban Green Space Index (HUGSI), generated from satellite imagery and the percentage share of green space in metropolitan areas, according to which green areas account for 57% of their surface area. According to these estimates, in Krakow, approximately 37% of the city's surface area is

occupied by trees and 20% by grass. The study also showed that Krakow had more than 207 m^2 of green space per capita [2]. In comparison, Prague had 183.2 m^2, with the same 57% green space ratio in the city.

This research concerns green areas in the strict centre of a historical Old Town district and treats greenery as an important element of quality-of-life assurance and climate change mitigation. Greenery was considered as an urban structure element and an integral landscape component. The status and value of green spaces as an essential element of cultural heritage and identity has been recognised [3], and has been considered at various levels, such as historical, aesthetic, environmental, academic, intangible, utilitarian and on supra-local scales [4]. The subject of this study was Krakow, a city in Eastern Europe, the former capital of Poland and a UNESCO World Heritage Site. It consists of what were formerly two medieval towns: Krakow and Kazimierz, who had their town charters issued in 1257 and 1335, respectively. They now form a single urban organism linked by Stradom, a historical suburb of both towns. Stradom was separated on one side by Krakow's city walls, whose outline is now occupied by Planty Park, and on the other by the no-longer-existing old riverbed of the Vistula, now a green street with circulation elements.

The main aim of this study was to assess changes in the structure of the green areas of Kazimierz and Stradom and to demonstrate the potential for establishing green infrastructure in this highly significant historical area under statutory conservation, which forces specific approaches and comes with restrictions. This has become a very important issue in the process of adapting to climate change in historic cities protected as cultural heritage. This paper outlines the extent of the historical transformation of the urban structure in question and its greenery, which formed the basis for the assessment of the current green resources in the study area. The secondary objectives focused on identifying the area's stock of green spaces and comparing it with its state, as determined based on available archival materials (1980–1991), as well as showing the kinds and types of green space as divided by use, and statutory conservation forms and their effects. The results were compared with data procured and analysed earlier [5]. Other objectives were to identify problems in the study area and to develop guidelines for historic greenery and greenery in historic places that can serve as a reference for UNESCO cities. The objectives were achieved in three phases of research (Figure 1). The final results of the research confirmed the initial hypothesis that there is a significant loss of green spaces, partly due to the high investment dynamics in the study area. This study complements previous research for the areas of Kazimierz and Stradom in Krakow and other historic cities, including UNESCO World Heritage sites. Its main conclusion is that despite the many constraints that exist in these areas, climate change adaptation measures can be implemented.

The study is divided into two main parts: theoretical and empirical. The first includes a review of the literature on the core issues under consideration (UNESCO cities, urban greenery transformation, legal protection of cultural heritage, green infrastructure, climate change) and an analysis of the development of the study area in terms of urban structure and greening. The second is a qualitative and quantitative analysis of the green resources in the study area, in terms of the current structure of land use, its accessibility, the extent and forms of protection and the possibilities for implementing green infrastructure solutions.

This study focuses on Kazimierz and Stradom. They became the subject of a comparative analysis with Krakow's Old Town, which is interesting in that they did not uniformly develop. Up to the mid-19th century, Kazimierz had functioned as an island surrounded by the river Vistula, with various, interpenetrating urban structure forms, including the village of Bawół and a multicultural town where Polish and Jewish communities lived side-by-side. It was a satellite urban complex, with functions that were more diverse over their development course than those of the Old Town. The area features, among others, religious buildings belonging to various cultures, as well as hospitals, day-cares, a cemetery, industrial facilities and riverside areas. The urban fabric of Kazimierz after the Second World War was also more dilapidated and decayed, and its outskirts were not fully developed [6]. The Holocaust depopulated Kazimierz almost completely, and during

the communist years of the Polish People's Republic, it was associated with poverty and neglect [7]. The situation began to change in the 1990s, when Jewish heritage initiatives and later urban regeneration programmes emerged [8].

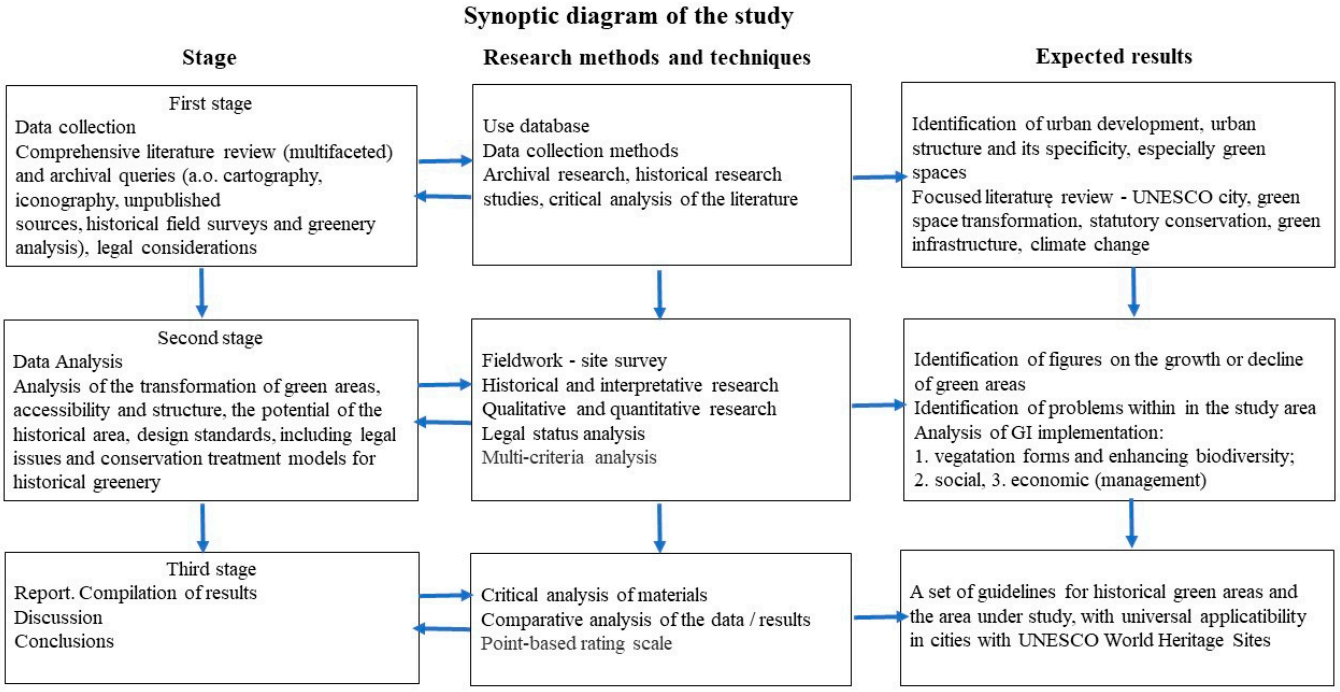


Figure 1. Synoptic diagram of the research. Source: authors.

This research concerns the morphology and the pattern of occurrence of different types of green spaces in the compact urban fabric of medieval towns of both pre- and post-town-charter origins. This fabric later became layered by a structure linked to Jewish culture, which had exerted considerable influence here, as well as later 19th-century urbanisation. These historical layouts were compared with 20th- and 21st-century shifts, including contemporary densification and development infilling, often carried out at the expense of greenery. Previously, no comprehensive research was performed to assess the condition of the greenery of Kazimierz and Stradom, the changes in its structure and area, its forms and composition, the potential for improving their accessibility and increasing its stock. This study compared the greenery structure of Krakow's Old Town with the greenery of Kazimierz and Stradom to determine the degree of development pressure exerted on them and what effect this has had on their greenery. In relation to global climate change adaptation efforts, the planned research has been extended to include the potential to create new green infrastructure assets. A model of conservation treatment for historic greenery was shown, which was extended to include the possibility of implementing green infrastructure (GI). The potential of the study area to adopt green infrastructure was assessed. The research carried out can serve as a guideline for a model for the management of green areas of historic cities under conservation protection.

2. General Overview of the Literature

The history, urban development and major transformations of Krakow, including Kazimierz and Stradom, were discussed in studies on the city's development [9,10]. Krakow's history was also presented in a political, social and economic context [11–14]. Kazimierz was analysed from a perspective of municipal landscape standards and morphology [15,16]. Krakow's qualities and characteristics were noted in international academic literature; especially, attention was paid to the combination of the grid and organic system [17], and the demolition of medieval fortifications and the establishment of Planty Park's green ring [18].

Research was also conducted on the urban structure of Krakow, morphology, detailed analyses [19,20] and in the context of the arrangement of towns in the Krakow land [21]. Archival cartography [22,23], historical depictions of the city's views [24,25] and photographs [26] and 20th-century panoramas were analysed in the context of transformations and preservation guidelines, including with regard to greenery [27]. The contemporary context of the visual linkages of Kazimierz and Stradom as a space with a listed cultural landscape is also shown [28]. The transformation of Krakow's structure is the subject of research and digital reconstructions at the Krakow Museum, as presented in its exhibitions and catalogues [29,30]. Since the 1980s, Kazimierz has been gradually recovering from post-war decay [6]. As recently as the 1990s, it mostly consisted of heavily deteriorated buildings, abandoned tenements and dilapidated public spaces [7]. However, this began to change with extensive urban regeneration programmes [8,31]. A. Gaczoł discussed protecting Krakow under different political, social and economic conditions and in the context of changing laws [32].

Unpublished studies were also used in this investigation [33]. The green areas of Kazimierz and Stradom were analysed as parts of historical, urban planning and conservation studies [34]. A general vegetation survey was carried out in 1991, and catalogue sheets were prepared for selected courtyards [35]. Cultural, historical and natural values were criteria in the analyses. High cultural value was attributed to gardens with legible composition, an identifiable style and which are located next to significant cultural sites, even if neglected. All green areas with trees, bushes (often self-seeded), vines, herbal plants, perennial plants and lawns are of environmental significance. A directional document for the development of Krakow's green spaces for 2017–2030 [36] was prepared between 2015 and 2019 in a participatory and expert format. It provides valuable material on existing conditions and management policies. It contains standards for greenery design, maintenance and care, together with general recommendations for species application [37]. Historical data, including descriptions of Krakow's gardens and parks, are contained in publications by city gardeners [38,39] and in monographs [40,41].

The protection of the study areas as a unique UNESCO World Heritage Site and recognised national heritage has a rich literature dedicated to cultural values [42,43] and landscape [44] revitalisation [45] in various aspects: social [46], urban brownfield site recycling [47], social values, biodiversity, green-blue infrastructure and climate change [48]. Specific cases were also analysed as UNESCO sites in terms of climate change, and among the cities, they included the Czech cities of Český Krumlov and Prague, in addition to Venice, Italy, and Ouadi Qadisha in Lebanon [49]. The effects of climate change on heavy rainfall occurrence in historical city centres [50] and the formation of urban heat islands were discussed [51] in the context of preparing climate change adaptation strategies. Procedures for historical gardens are regulated by the Florence Charter [52], which is a supplement to the 1964 Venice Charter. Today, the Florence Charter is called into question as anachronistic, for instance in terms of climate change, the new demands of development doctrines, as well as its approach authenticity [53].

Issues of historical garden, park and composed green area conservation in Poland were described by, among others, Bogdanowski [54]. The statutory conservation, preservation and reconstruction of gardens and their forms were also discussed in many works [55,56]. Treated as historical heritage, green spaces are also understood as semantic vehicles with aesthetic value and historical, allegorical and symbolic significance. Historical gardens should be identified and managed in the context of climate change adaptation. Analyses of the morphology of green infrastructure are carried out with this in mind [57].

An extensive literature is emerging in the context of global natural phenomena and related climate change adaptation measures. Drafting strategic green infrastructure plans at an urban scale is highlighted [58,59]. Green infrastructure issues in compact historical city centres were also discussed [60]. Attention is paid to the multifunctionality of green spaces that must meet a diverse range of needs and cope with intense recreational use [61,62]. The role of greenery in high-density areas has been described in the context of the distribution

of different types of green space [63,64]. Accessible green spaces are a major quality-of-life factor and contribute to human health and well-being [65]. The form of the city and the associated potential for biodiversity were also discussed [66,67].

Few studies are conducted in a qualitative and quantitative manner and include a matrix of multidimensional indicators that determine the impact of the cultural heritage conservation/valorisation projects they analyse on sustainable development. They present empirical evidence of the cultural landscape's contribution to improving a city's economic, social and environmental productivity so as to demonstrate that heritage conservation is an investment, not a cost [68]. The 50th anniversary of the Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) [69] gave rise to analyses of new challenges for the protection of cultural heritage, global governance and urban development, and discussions of the successes and failures of the Convention's implementation [70].

3. Methods

This research followed multiple trajectories. It was divided into three phases. The first phase consisted of a comprehensive literature review, which focused on peer-reviewed and grey literature, and archival materials. The following were reviewed, among others:

- Historical sources: cartography and iconography from the collections of the Krakow Museum [71] and the National Archives in Krakow [23].
- Unpublished studies and conservation documentation and greenery surveys, from the collection of the National Institute of Cultural Heritage [72], and the Archives of the Lesser Poland Voivodeship Conservator of Monuments [33], including records of historic gardens, simplified historical and compositional studies, which had been drawn up since the 1970s.
- Specialist publications on the history of garden design and the conservation of historical gardens, and guidelines on conservation procedures.
- Publications on the development of Krakow.
- International, national and local legislation on historical greenery.
- Data and publications on green infrastructure development, particularly in the context of historical, compact cities under statutory conservation.

In the second phase, based on the data collected, changes in the formation of green spaces, their accessibility and their structure were analysed. The historical-interpretive research method was also used. To illustrate the changes, historical and contemporary maps showing the gradual urbanisation of Kazimierz and Stradom and the changes in the development of individual plots in the 20th and 21st centuries were collated. The areas in the post-war period, at the time when the reconstruction, revitalisation and later contemporary densification of Kazimierz by real estate developers had begun, were quantitatively verified and compared with the state in early 2023. Changes in area were investigated based on greenery surveys [34,35], historical geodesic maps and orthophotographs. A general overview of greenery types was drawn up, divided by the main use, and the forms of greenery and vegetation. Applicable legislation was analysed, including local development plans [73–75], the cultural park protection plan [76] and the green space development direction document [36,37], as well as environmental impact assessments [77].

International documents on the issue of management, arising from both national conservation measures and the UNESCO listing, were also cross-referenced. Quantitative and qualitative green design standards were analysed [78], including the scope of predesign studies for a heritage site and design standards [37,41]. Spatial data aggregation was based on the analysis of vector and raster data. BDOT 500 databases and satellite images were obtained from the geodetic and cartographic repository of the City of Krakow (Miejski System Informacji Przestrzennej, MSIP) and the Marshal's Office of the Lesser Poland Voivodeship. In addition, data were updated during in situ surveys and analyses using, among other methods, direct observation.

In the third phase, the results were compared with the findings and results of previous global and national research on the subjects investigated. The valorisation and point methods were used to determine the potential of the study area for GI implementation [15,16]. When determining the types of plant forms and activities for the functioning of GI for individual types of greenery, discussions were held with specialists in the field of landscape architecture, conservation, planning, management, sociology, horticulture and dendrology. This was a key element for the formulation of the final conclusions and recommendations.

Methodological problems were generated by differences in source data. In 2023, the basis for the analyses was digital data, and in 1980–1991, it was data collected in the field and depicted on maps. The historical survey data were supplemented with satellite data analysis and transferred into GIS spatial data format. The degree of accuracy of the historical data indicates that the values provided should be regarded as estimates, with a certain margin of error.

4. Materials

Krakow is the capital of the Lesser Poland Voivodeship and is Poland's second-largest city in terms of population and area. It has been an important political and religious centre since the beginnings of Polish statehood and was the capital of Poland and the Polish-Lithuanian Commonwealth in the years 1320–1609. Krakow's significant buildings, urban layouts and landscape have been appreciated for centuries [25]. This is confirmed by famous 17th-century engravings that depict panoramas of the city [79,80]. Green spaces were an important part of Krakow's urban structure. Throughout this structure's historical development, green spaces consisted of castle gardens, extensive monastery gardens, church greens and gardens next to tenements, and since the 19th century, also public parks, green squares and streets. Riverside greenery and oxbow lakes were also important in Kazimierz and Stradom. They are all integral components of the cityscape, compositionally, aesthetically and environmentally, and together co-form the city's green infrastructure. Today, they are seen as an important component of climate change adaptation.

Krakow was the first European city to be placed on the UNESCO World Heritage List, which attests to its status on the international stage. It was among the first twelve Heritage Sites in the world, in September 1978. The entry of Krakow's Old Town, together with Wawel Hill, Kazimierz and Stradom (149.65 ha), was based on criterion IV, which states that a World Heritage Site should be an outstanding example of a type of building or architectural or technical ensemble that illustrates a significant stage in the history of mankind [70]. The justification cited the value of Krakow's historical and architectural centre, which has been shaped over almost a thousand years. The area has numerous strata that define its genius loci, and it constitutes one of Europe's most remarkable artistic and cultural complexes. For this reason, it is protected by all forms of statutory heritage conservation measures under Polish law. However, it is not a petrified area, and a range of activities are still legally permitted.

In the early 14th century, the dynamically growing Krakow (town charter issued in 1257) was becoming less and less capable of accommodating new inhabitants. Its fortified walls prevented territorial development. This led to the establishment of Florencja (Kleparz) to the north and Kazimierz to the south. Kazimierz and its suburbs developed on a flat area within the floodplain of the river Vistula [11–14]. The town of Kazimierz was founded on 27 February 1335 by King Casimir the Great, after whom it was named. The area had already been partly settled. The earliest development complex was established in the area of the limestone terrace overlooking the Vistula floodplain, known as Skałka (which means 'rock'), where religious buildings had existed. To the east, in the vicinity of present-day Szeroka Street, there was the 12th-century village of Bawół, which was founded under German law in 1276.

A łan-forest layout was created with an extensive square-like yard, of which Szeroka Street is a relic. At th end of the 15th century, the former village centre became occupied by a Jewish town [19–21]. At this time, greenery was an integral landscape element. The

settlement plots of the village were enclosed by gardens. Shoreside areas of the Vistula and the floodplains were covered with riparian vegetation. Between Kazimierz and Krakow, there was Stradom, a settlement situated low on the floodplain that never had walls and was often affected by fires and floods [81] (Figures 2 and 3).

Figure 2. A fragment of Krakow's panorama, from left to right: Wawel Royal Castle, Stradom and Kazimierz separated by the River Vistula, the *Opidum Iudeorum* (Jewish town) is also marked, and riverside roofs are visible. Drawn by Egidius van der Rye, 1603–1605 [80].

Figure 3. Reconstruction of 1650 Krakow. In the foreground, Kazimierz is surrounded by the Vistula and its defensive walls; in the background is the unfortified Stradom, and the Royal Castle and the Old Town are visible. Authors: P. Opaliński, M. Rudek and P. Turkiewicz [30].

Kazimierz, known as the New Town, had a satellite character. The privileges granted to it did not threaten Krakow. The founding resulted in a layout based on a geometric grid, with suburbs and fields. In the 14th century, a defensive wall around the town was erected, and it is still partially intact today. The town's central part consisted of a rectangular square

with plots perpendicular to it, which formed regular town blocks measuring 3 × 4 sznurs (1 sznur = 47.1 m). Its streets had widths that varied depending on use [19–21]. A historical trade route, the so-called Salt Route that led to Hungary, became Kazimierz's main street (Krakowska Street). Catholic monasteries with extensive gardens took a prominent place in the town's urban grid [81]. Outside the walls of Kazimierz, there were meadows, pastures, ponds, forests and suburbs (Figure 3).

At the end of the 15th century, by decree of King Jan Olbracht, Krakow's Jews were moved to Kazimierz. Their ghetto was an isolated, autonomous enclave. In the mid-16th century, the influx of Jewish people from Moravia, Bohemia, Spain and Italy increased the significance of this community in Kazimierz and Krakow. The centre of the Jewish town was a rectangular square (Szeroka Street). The Old Synagogue (late 15th century) and a cemetery (1535) were built next to it. The Swedish invasion of 1655–1657 marked the beginning of Kazimierz's decline. This condition was exacerbated by a fire that consumed the town in 1693 and by the Northern War of the early 18th century. A decree to abolish the Jewish town was drafted but not enacted. In the late 18th century, the Good Order Commission attempted to revive the town (1786–1791). Between 1772 and 1795, three partitions of Poland took place. After the partition, Krakow was incorporated into the Austrian crown state of Galicia and Lodomeria. In 1791, Kazimierz and Stradom became a district of Krakow, which was confirmed by the Austrian authorities in 1800 (Figure 4). During this period, demolition works began on Krakow and Kazimierz's defensive walls. In 1806, a plan was drawn up to 'beautify' the Jewish town [19,20].

Figure 4. Fragment of the Plan of the City of Krakow and the Surrounding Areas in the Era of the Four-Year Sejm, 1788–1792, published by the Polish Academy of Arts and Sciences, Krakow 1929, by T. Czort, Archiwum Narodowe w Krakowie, Zbiór kartograficzny, 29/663/0/2/160 [23].

In 1868, the law that had made it compulsory for Jews to settle in Kazimierz was repealed and they could legally settle and work throughout Krakow. At this time, a housing shortage led to the introduction of development into the open areas between Kazimierz and Stradom and between Stradom and Krakow. This melded them into a single urban organism. Contemporaneous industrial uses appeared in Kazimierz's undeveloped

areas along the Vistula at this time (Figure 5). A gasworks t plant was located there (in 1855), and a municipal power station (in 1904) was sited in Wawrzyńca Street. At the turn of the 19th century, also on Wawrzyńca Street, a tram depot was built, which was extended in 1913 to include part of the monastic gardens of the Canons Regular of the Lateran [19].

Figure 5. Kazimierz and Stradom on a plan of the Krakow Fortress. Festungs Umgebungs Plan von Krakau, Blatt 21, 1900, 1:10,000 [82].

The Second World War took a heavy toll on Kazimierz. The Nazis annihilated the Jewish population and with it severed the centuries-old continuity of Krakow's Judaic culture. Jews had been the residents and owners of many tenements in Kazimierz. The Nazis considered razing the Jewish town completely and building a new German quarter in its place or restructuring the historical area via demolition and widening its streets. These plans were not implemented, but the surviving heritage of Kazimierz had no natural heirs, which added to the post-war neglect and destruction [33]. Post-war photographs show ruined and badly neglected parts of the town [30,71] (Figure 6).

(**a**) (**b**)

Figure 6. Ruined post-war Kazimierz: (**a**) Ruins of a house, the top of the Corpus Christi Church is visible in the background, 1941, photo by E. Theuergarten, NAC 2-8286 [83]. (**b**) Destroyed granary in Kazimierz district, 1940, currently non-existent, NAC 2-83177 [83].

In the years 1945–1990, Kazimierz regressed. Communist anti-Jewish policies contributed to a Jewish emigration. In the 1950s and 1960s, parts of the historical residential buildings of the former Jewish town were demolished [6,7], including those in Kupa and Szeroka streets, Bawół Square and on the corner of Józefa Street. The Krakow authorities, elected in 1990 in the first democratic post-war election, were interested in revitalising

Kazimierz and obtained funds for this purpose from the Council of Europe and the World Bank [8,31,32]. In the years 1993–1994, an action plan for the urban regeneration of Kazimierz was developed as part of the EU ECOS programme. In the 1990s, some of the buildings were rebuilt as part of the so-called 'Krakow Retroversion', including a block of buildings on Bawół Street in Kazimierz, in the vicinity of the Old Synagogue. Retroversion (combined with Postmodernism), applied to the reconstruction of wartime damage in Poland, was defined as an attempt to restore the pre-war structure of destroyed cities using contemporary architectural means [84]. Between 2004 and 2006, the programme 'Revitalisation of the urban space of Kazimierz' was implemented. Later, plots of land on which tenement houses had been demolished in the post-war period were built on, or the development was densified.

The greenery of Kazimierz and Stradom has never been the subject of separate comprehensive projects.

5. Applications

5.1. Typology of the Green Areas under Study

This study focuses on green spaces, understood as a stock that is an integral part of the urban fabric. Accordingly, green areas in the Kazimierz and Stradom area were categorised by accessibility and type-determining use (Figure 7). This is due to the historical development, from the Middle Ages to the present day, and the current land use [54,56]. Urban transformations and changes in ownership have also affected the greenery layouts, and often at their expense.

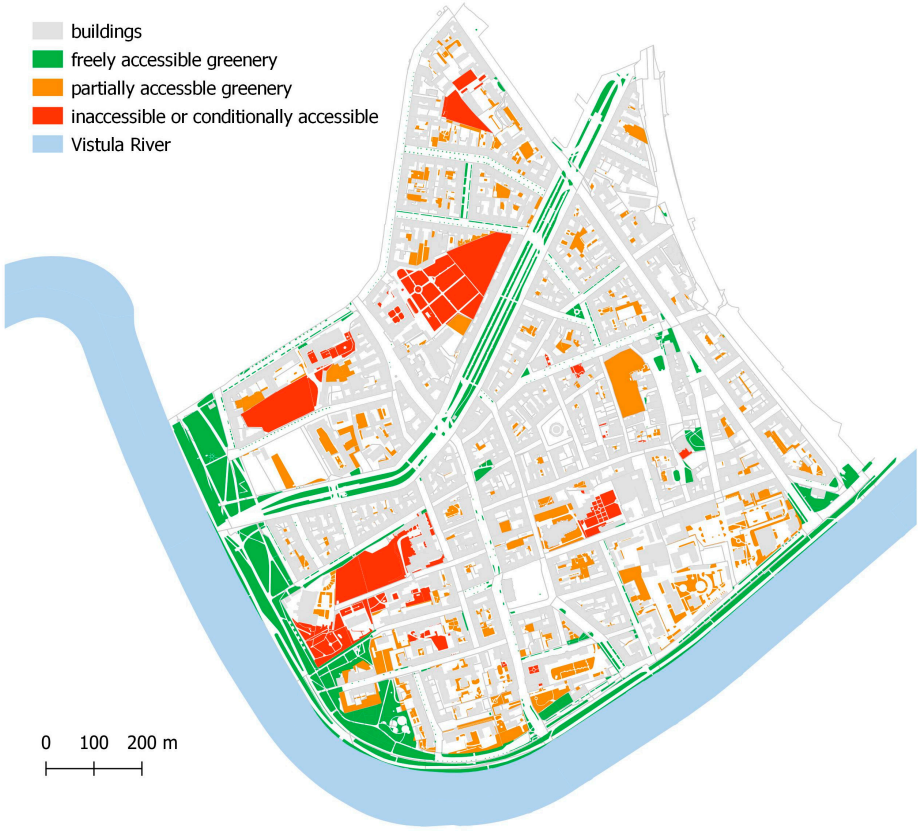


Figure 7. Spatial distribution of greenery with a different level of accessibility. Source: authors.

Three forms of accessibility were considered: (1) access time (distance) to a public green space, (2) public green space areas within reach of residents, and (3) access restriction. Research performed for the green space development direction document [36] showed that Kazimierz had areas with a deficit in terms of accessible public green areas within 300 m.

In contrast, for Kazimierz and Stradom, there is a general deficit of public green space in compact development.

The green areas of Kazimierz and Stradom were shaped over the centuries as areas that varied in terms of landscaping degree, type, size and forms present within them [40,41]. Gardens were also present outside the Jewish district. In each case, the environmental value of green areas was high, ranging from the extensive Vistula River boulevards to individual trees. At present, access to some green areas is restricted due to their use. This group included functioning monasteries, courtyard gardens, hospital gardens and sports club grounds.

Riverside and floodplain areas were undeveloped for a long time. Along the Vistula and the Old Vistula, there was riparian vegetation, dominated by oaks and alders and wetlands [20]. Today, no trace of them has survived apart from the greenery systems accompanying Dietla Street and Daszyńskiego Avenue and the greenery of the Vistula boulevards. The boulevards were created in the 20th century, with a significant portion of them built after the Second World War (Figure 8). Other publicly accessible areas, streets, squares and green squares, were planted with greenery in the 19th and 20th centuries.

(**a**) (**b**)

Figure 8. (**a**) Panorama of Kazimierz from the Vistula. The dominant silhouettes of church buildings and monasteries can be seen, from the right the Pauline Monastery on Skałka (Skałeczna Street), followed by the Church of the Brothers Hospitallers of Saint John of God (Krakowska Street), then the Augustinian Monastery (Augustiańska Street) and then that of the Canons Regular of the Lateran (Bożego Ciała Street). Underpinning all these sites is garden greenery. The banks of the Vistula in this section were not reinforced yet, postcard 1916–1939 [71], MHK-164/VIII k. (**b**) Vistula boulevards, lower terrace visible, on the upper terrace a row of black locust trees along Podgórska Street, to the right is the built-up area of the former power station. Photo by A. Zachariasz, 2023.

5.2. Overview of the Green Areas under Study

5.2.1. Freely Accessible Greenery

The Vistula boulevards form a part of the Vistula River Park (a section approximately 1960 m-long). After the disastrous flood of 1903, embankments were built on the Vistula. The river was regulated in the years 1905–1909 [41]. Monumental boulevards consisting of an upper and lower section were created. They are laid out along the following streets: Smocza, Stanisława, Rybaki and Podgórska. From the Wawel Castle, these are the Czerwieński, Kurlandzki and Inflancki Boulevards, respectively. The upper part is a public park, in some parts quite wide, with a layout of strolling paths, an outdoor gym, a playground and chess tables. On the topmost section of the boulevards, along the streets, there are trees, including a row of black locusts at Rybaki Street on Kurlandzki Boulevard and a row of maple trees along Inflancki Boulevard. The boulevards form the foregrounds of vistas and panoramas of the Vistula and towards Wawel Hill (Figures 8 and 9).

(**a**) (**b**)

Figure 9. Boulevards: (**a**) Fragment of the Vistula River Park along its Kazimierz bank, along its section from Skawińska to H. Wietora Street. (**b**) A maple row along the edge of the upper boulevard and a fragment of a park along the same section. Photos by A. Zachariasz, 2019.

Garden squares

In many cases, small green spaces have a triangular shape resulting from the growing urban structure and the merging of the more organic Jewish town with the regular grid of Kazimierz, and later with 19th- and 20th-century urbanisation (Figure 7). There are several garden squares with a triangular plan, including Bartolomeo Berecciego Garden Square at the intersection of Starowiślna and Dajwór streets, Ozjasza Thona Garden Square in front of the Tempel synagogue, the Kółeczko Garden Square adjacent to Berka Joselewicza Street and Meiselsa Garden Square. Some of the garden squares are unnamed, such as the triangular square in Wielopole Street, at the intersection of Halicka and św. Wawrzyńca streets, or the rectangular one, such as the one near Podgórska Street. Most landscaped garden squares featured trees. The square in Dajwór Street, near the Old Synagogue, was the largest. It represents a kind of relic of the past. Its site used to feature a pond near the synagogue, called the 'puddle at Dajwór'. It was filled in in 1872 [19]. The original use offers potential to locate a rain garden here, embedded in the *genius loci*.

Street greenery

There was no room for trees or any other type of greenery along narrow historical streets. The 19th-century streets, on the other hand, are wider and usually have rows of trees incorporated into their layout, either on lawns or in lawn strips (e.g., Sarego, Bogusławskiego, Św. Sebastiana, Gazowa, Mostowa, Wietora, Orzeszkowej, Kordeckiego Streets). Among the species used are maples, lindens and black locusts. In 1907, in a list of the number of trees planted as part of the greening of the streets of Krakow, city gardener B. Malecki mentioned 50 streets with 4500 trees. He writes that the following were used to plant streets and squares: common maples, field elm, lime trees, chestnut trees and ash-leaved maples (they are not used today on account of being invasive) [38]. He provides data on trees in Kazimierz and Stradom: Bernardyńska (70 specimens, currently 54), Bożego Ciała (14 specimens, currently 2), Dietla (452), Mostowa (10 specimens, currently 28), Starowiślna (124 specimens, currently 7), Stradom (38 specimens, currently 3) and Węglowa (15 specimens, currently 12). The current 'Kazimierz' local development plan provides for the replenishment and restoration of tree rows along, among others, the following streets: Miodowa, Brzozowa, Kordeckiego, Orzeszkowa, Augustiańska, Paulińska and Wietora [74].

Krakowska and Dietla Streets are significant in the urban structure and composition of Kazimierz. Krakowska Street, the main street in Kazimierz, is preceded by Stradom Street, which runs from the Royal Castle. It was refurbished in the years 2019–2020. Greenery and street furniture were introduced, and wider pavements were created and parking bays were built. Larger trees were planted along the street (11 are non-historic: 'Skyline' honey locusts, red maple and 'Rancho' Sargent's cherry), in pots set below the surface of the pavements. Low-growing beds of, among others, pruned yews and barberries were planted, and benches composed together with pots were introduced. Modern grasses were used: tufted hairgrass, Chinese fountaingrass, true sedges, moor grasses and about

600 perennials [85]. The key urban element that connects Kazimierz with Stradom is the so-called Planty Dietlowskie, or Dietla Park (Figures 5 and 7).

It was built by the municipality in 1887, on the site of the Old Vistula's former riverbed. Its landscaping was designed by city gardener Bolesław Malecki [38]. The area of Dietla Street, which originally did not extend to the Vistula, was 3.2 ha. Two avenues with a length of 1000 m were introduced. In 1891, it was reported that 'several play areas' [86] had been created there. Aleksander Gauze, city plantations director, described this 1924–1927 renovation project as follows: "At that time, landscaping and earthworks were carried out, paths were built, concrete kerbs were laid on the street sides, pavements were widened, and wrought iron fences were made to protect the square from the street and from the paths" [39]. Dietla Park was levelled in 1970 to build a tram line through its centre [19,77]. The double tram tracks significantly reduced the green space, and sections inaccessible for walking were created (Figure 10).

(**a**) (**b**)

Figure 10. Section of Dietla Street, between Krakowska and Starowiślna Streets. (**a**) Visible intersection with Krakowska and Stradom Streets, archival photograph by Natan Krieger, after 1910, MHK-7845/K [71]. (**b**) Current state, Dietla Street is dominated by transport (traffic lanes were widened, a tram line and stops were introduced), photo by A. Zachariasz, 2011.

One might consider whether a green track should be introduced on both streets, if only along their sections.

Greenery in squares

Kazimierz's charter-period market square is Wolnica Square, where the town hall is located. The square was used to hold markets. It was not decorated with greenery. By the end of the 19th century, the town hall had become a home to the municipal school, and in front of it, to the east, there was a small garden with low trees enclosed by a fence [19,26]. The trees on this square that now line a frontage appeared after the war. This layout has survived into the present. The square is framed by trees from the east, west and partly from the north, at the Three Musicians fountain. During the last renovation in 2020, parking on the square was prohibited, and it now serves as an event space. There are currently 21 trees growing there: lime trees, common maples, silver maples, Canadian poplars and weeping willows by the fountain. Bawół Square, situated in the former village of Bawół, became a part of the densely built-up Jewish town. In the 19th century, it was planned to construct buildings and a square there [19]. At present, its fragment is covered by an oval lawn lined with a hedge and a small garden square, both with a couple of trees each.

5.2.2. Partially Accessible Greenery

Gardens that accompany residential areas

They are present within town blocks, near the Puget Palace, villas and in contemporary multi-family housing. A large area is occupied by gardens next to houses and tenements. Those that accompany late 19th- and early 20th-centuriy residential buildings are the most numerous, on properties situated, for example, along: Dietla, Brzozowa, Św. Gertrudy and Starowiślna. The gardens are in an unsatisfactory state and often have haphazard greenery

layouts. A small group of gardens next to villas can also be identified in the urban layout. They are found in Stradom and date to the 19th and early 20th centuries. These are the areas next to the Puget Palace at 13/15 Starowiślna Street (Figure 11) and the villas at 6 and 8 Sebastiana Street, 6 Sarego Street and 89 Starowiślna Street (it no longer exists) [34].

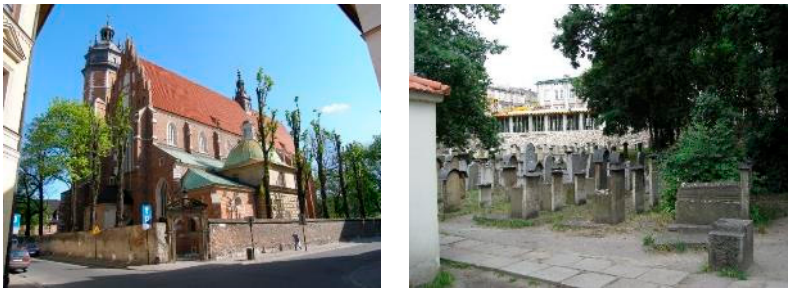
(**a**) (**b**)

Figure 11. Puget Palace with annexes and accompanying buildings and garden at 13/15 Starowiślna Street (marked with a circle), which currently features service uses, and the former garden is dominated by parking spots: (**a**) Festungs Umgebungs Plan von Krakau, Blatt 21, 1900 [82], and (**b**) current state, based on MSIP, by the authors.

New multi-family housing, built as infills and courtyard infilling in the post-industrial area occupied by the gas plant, is a separate issue. The gardens laid out alongside it have a contemporary character.

Areas near religious buildings (churches and synagogues)

Greenery also accompanies some churches, e.g., it is found around medieval, Gothic buildings. A modest green space is next to the Church of St Catherine of Alexandria. A large green area surrounds the Church of Corpus Christi: to the north it is a courtyard with an extensive lawn, the former church cemetery that had been closed in the late 18th century. The remaining boundaries are lined by rows of trees which, as the historic iconography and contemporary surveys show, have changed multiple times (Figure 12a). At the Baroque Church of St Agnes, the green areas were gradually made smaller, until almost nothing remains of them (Table 1).



(**a**) (**b**)

Figure 12. (**a**) Surroundings of the Corpus Christi Church, with the 'old' layout of tree rows along the fence, the linden and poplar trees are stunted, now replaced by hornbeams. Photo by A. Zachariasz, 2010. (**b**) Remuh cemetery, with the new development at Kupa Street in the background. Photo by A. Zachariasz, 2008.

The local religious buildings also include synagogues. Sometimes, they are accompanied by modest greenery, such as singular trees—this is the case of the Tempel Synagogue, on Miodowa Street, or the foregarden in front of the Isaac Synagogue on Kupa Street.

Remuh cemetery

Founded in 1535, it is one of the oldest in Europe [19], and the oldest in Krakow, and is an integral part of the Jewish town. It is currently a large green area with self-sown trees

(Figure 12b), and measures 0.7 ha. The oldest part of the cemetery is the garden square in the northern part of Szeroka Street.

Greenery accompanying cultural services, e.g., museums and hotels

The green spaces that accompany Kazimierz museums, hotels (Figure 13), hostels and short-term rental flats, usually designed in a contemporary fashion, are small.

(**a**) (**b**)

Figure 13. Loss of green areas in Starowiślna Street, near properties No. 89 (Stryjeński villa) and No. 91, where a hotel was built. (**a**) As encountered in 1991, and (**b**) as encountered in 2023. Greenery associated with educational services and sports grounds based on MSIP and archival maps. Source: authors.

In many cases, school gardens were turned into playing fields with an impermeable surface, with examples being the primary schools on Miodowa Street, Chmielowskiego Street or at the school run by the Ursuline Sisters on Starowiślna Street. Extensive gardens are located next to the Pauline Order's Major Seminary on Skałeczna Street. There are also sports grounds in the Stradom area. In the interwar period, the Jewish sports club Maccabi 'built a beautiful sports field at Dietla and Koletek streets right on the banks of the Vistula River' [87]. After the Second World War, the site was taken over by the 'Nadwiślan' Sports Club. The area has remained undeveloped and provides a foreground view of Wawel Castle. The sports area is large, with tennis courts and a pitch, with an impermeable surface, surrounded by ahistorical thuyas. The club, as stated in the local development plan [73], wants to invest in new buildings, though the cultural park protection plan prohibits this project [76].

Gardens at hospitals and care facilities

There are two hospitals in Kazimierz. The first was built by the Fratebenefratelli, who moved there in 1812 (a large block of the development bounded by Krakowska, Trynitarzy, Mostowa and Podgórska Streets). A second hospital has been operating in a building at 9 Skawińska Street since the 1920s [19] (Figure 14). Both featured gardens that have been transformed, partially built over and have a heavily truncated area. The monastery complex of the Fratebenefratelli and the hospital are connected. Here, the garden area was also made smaller, initially by the demarcation of Mostowa Street (the extension of the bridge over the Vistula), and later due to building a new hospital. There are also care centres in Kazimierz. At 50 Krakowska Street there is a Social Care Home with a large garden, and at the Albertine Brothers' Monastery at 6 Skawińska Street there is a Shelter for Homeless Men with a small green area.

Non-landscaped greenery

This type of greenery can be found along the railway embankment parallel to Starowiślna Street, which forms the boundary of the site under study. In 1856, the first train crossed the river Vistula here [13]. The embankment, overgrown with bushes and trees, acted as a vista termination for the streets perpendicular to Starowiślna Street. The tracks have now been routed over the viaduct and a linear park with pedestrian and cycling routes in greenery is to be built under the flyovers.

(**a**) (**b**)

Figure 14. (**a**) Jewish hospital building at 9 Skawińska Street with an extensive garden, ca. 1890, photo by N. Krieger, MHK-2177/K [71]. (**b**) Garden behind the new hospital of the Brothers Hospitallers of St John of God in Krakow with its then-fashionable carpet bedding, 1905–1910, from the archives of the Brothers Hospitallers' Monastery, photo by A. Zachariasz.

5.2.3. Inaccessible Greenery under Monastic Rule—Admittance upon Approval

Monastic gardens

There are a number of active monasteries in the area, and some have extensive gardens. In terms of the surface area, monastic gardens make up a large percentage of the overall existing green areas (Table 1). Among these, older complexes stand out. In Kazimierz, these include: the Pauline friars' Monastery at Skałka, that of the Canons Regular of the Lateran, the Augustinians, the Augustinian nuns and the Fratebenefratelli. In Stradom, it is the Bernardine monks and the Missionaries. These complexes have surviving gardens in fairly good condition. The following monasteries were established in the 20th century: the Ursuline convent in Starowiślna Street (Stradom), and the convent of the Daughters of Charity of Saint Vincent de Paul in Piekarska Street (Kazimierz) (Table 1). There are also two closed monasteries, e.g., those of the Sisters of St Bernard in Koletek Street, and that of the Order of the Holy Sepulchre in Stradom Street (today adapted into a hotel and housing) [15,19,54].

Table 1. Historic gardens of Kazimierz, table with a listing of areas as per selected sources: historical garden records [72], the register of monuments [88,89], by the authors.

Item No.	Site Name	Garden Type Monument Register Number/Year of Entry	Construction Time (Century)	Area (ha)/Record Entry Year or Its Absence	Area 1991 (ha)	Area 2023 (ha)
1	Augustinian Monastery 7/9 Augustiańska Street	monastic A-5/1973	17th/ 18th	0.9/1978	1.02	0.73
2	Augustinian Sisters' Monastery 10–12 Skałeczna Street	monastic A-984 7.XI.1994	18th–20th	0.2/none	0.43	0.1
3	Monastery of the Fatebenefratelli 48 Krakowska Street and hospital, 11 Trynitarska Street	monastic A-19/1931, A-577/1976	18th–20th	2.8/1976	0.78	0.45
4	Monastery of Canons Regular of the Lateran, 26 Bożego Ciała Street with the church grounds	monastic A-24/1931	14th–15th early 19th	1.5/1979	1.11	0.72

Table 1. *Cont.*

Item No.	Site Name	Garden Type Monument Register Number/Year of Entry	Construction Time (Century)	Area (ha)/Record Entry Year or Its Absence	Area 1991 (ha)	Area 2023 (ha)
5	Missionaries' Monastery 4 Stradom Street	monastic A-27/1931	18th	ca. 3.0/1974	2.96	2.4
6	Pauline Monastery, 15 Skałeczna Street together with the seminary garden regained in 1992	monastic A-29/1931, A-24/1968	15th–18th	0.9/1978	1.72	0.74
7	Bernardine Monastery 2 Bernardyńska Street	monastic A-18/1935, A-564/1972	17th	1.1/1994	1.47	1.3
8	Ursuline Monastery 3/5, 7, 9 Starowiślna Street	monastic A-681/1985	19th–20th	1.3/1984	0.81	0.54
9	Monastery of the Sisters of Mercy 6, 8, 10 Piekarska Street	A-870/1991 contemporary garden	19th–20th	0.3/none	0.3	0.12
10	Former monastery of the Bernardine Sisters 12 Koletek Street, former home for the elderly of the Society for Benevolence	monastic A-956/1993	18th–19th	1.5/none	0.53	0.29
11	Garrison church Św. Agnieszki Street, 30 Dietla Street	church garden A-303/1934	19th	0.5/none	0.46	0.02
12	Remuh Synagogue and cemetery, 40 Szeroka Street	cemetery A-33/1932	16th	0.75/none	0.73	0.7
13	Dietla Park	city park A-576/1976	late 19th	4.0/none	3.53	2.0
14	Puget garden 13–15 Starowiślna Street	palace A-325/1968	18th–19th	1.05/1984	0.09	0.05

Cloister garths are important features of many monasteries (Figures 15 and 16). Some of them have a four-quarter arrangement with borders, such as in the Missionary Monastery (Figure 17a) or of that of the Fratebenefratelli, and there are elements of ornamental parterres in the Bernardine Monastery (Figure 17b). Many of the monastery gardens represent the traditional Italian garden type with formal, regular gardens. The garden compartments feature orchards and vegetable plots (Figure 18). Bernardine gardens were known for offering ornamental shrubs and plant bulbs for sale, even after the war. Local horticulturists worked on interbreeding plant varieties and the acclimation of exotic plants. The monastery gardens followed garden design style changes, in the case of the Missionaries' Monastery, where, apart from a geometric utility and ornamental section, a park section appeared (within the framework of the compartment arrangement), but with solitaire-like forms, exotics and a carpet bedding, with a statue of the Virgin Mary [41,54] (Figures 15 and 16).

The layout of the quarter-based orchard no longer exists at Pauline Monastery, but the 17th-century Pond of St Stanislaus the bishop, with a figurine of the saint, a former natural water body on the Vistula floodplain, is still a prominent element of the church's courtyard [19]. The monastery garden areas are taking on new uses, such as religious use. An Altar of the Third Millennium was created in the Pauline Garden, with a paved surface. Portions of certain gardens were remodelled into car parks (the Paulines and Augustinians assigned the peripheral fragments of their gardens for parking spaces).

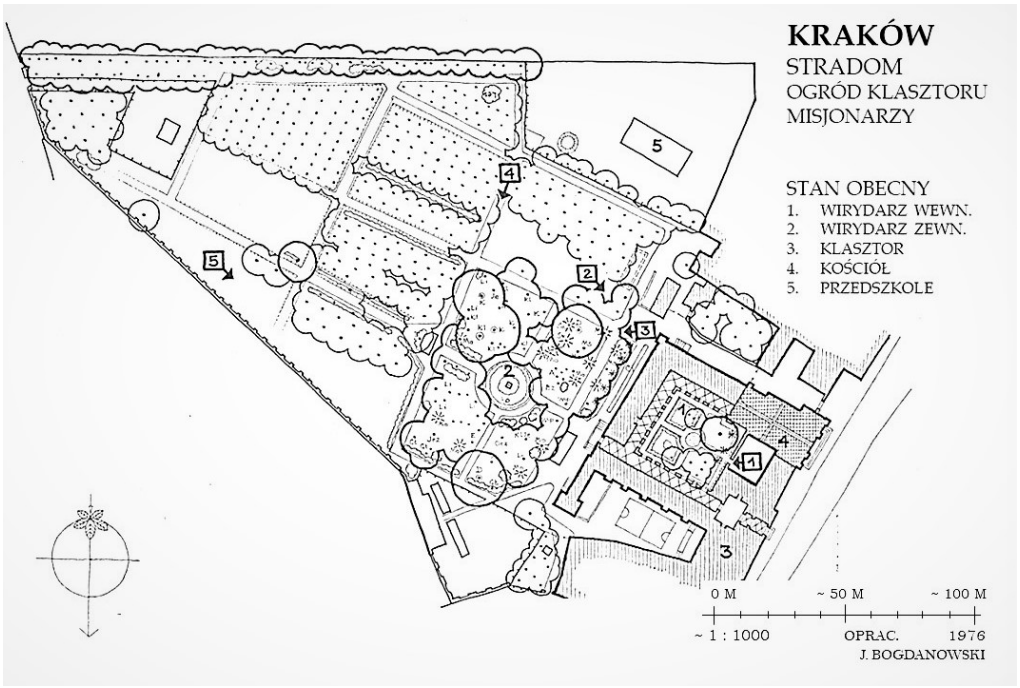


Figure 15. Survey of the garden of the Missionary Monastery by J. Bogdanowski, 1976. Garden records materials, prepared at the Faculty of Architecture, Krakow University of Technology, photo by A. Zachariasz.

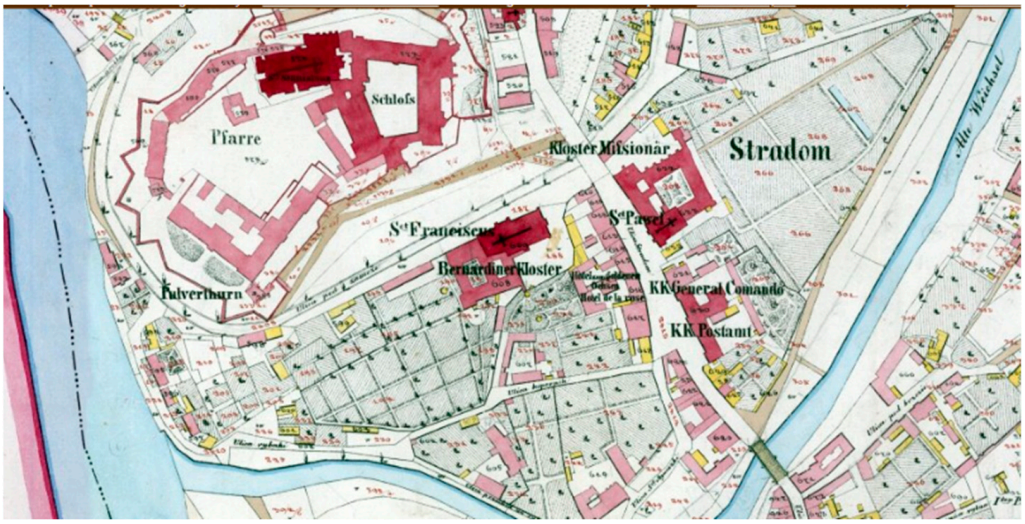


Figure 16. Stradom suburb at the foot of Wawel Castle. We can see two large monastic complexes visible, that of the Bernardines on the left, and the Congregation of the Mission on the right, both with square gardens. To the south, Stradom is surrounded by the Old Vistula and its floodplain. Cadastral map of Stadt Krakau hierzu einverbleibt Kawiory, mit den Vorstädten. . ., Stradom, Wesoła, Smolensko and Kazimierz im Galizien, 1848, 1: 2880, Archiwum Narodowe w Krakowie, Kataster galicyjski, 29/280/0/9.1/1152 [23].

(**a**) (**b**)

Figure 17. Cloister garths of Stradom monasteries: (**a**) Missionaries' Monastery, four regular quarters, framed with boxwood, with one quarter dominated by a common beech tree, in a solitaire form (monastery plans visible on the cadastral map above); (**b**) Monastery of the Bernardine monks with an ornamental parterre. Photos by A. Zachariasz, 2012.

(**a**) (**b**)

Figure 18. Formal, regular gardens of Stradom monasteries, where orchards are still an important part of the composition: (**a**) the Bernardines' on the left, and (**b**) the Missionaries' on the right (here in the background we can see development along Dietla Street and the boundary row of tall trees), photos by A. Zachariasz, 2012.

All the historically shaped green areas of Kazimierz and Stradom display stylistic diversity, resulting from the function, composition and forms used. From a garden design standpoint, monastery gardens are the most valuable. Despite their diminished size and neglect, they still represent significant cultural value [41,54]. Monastic gardens were planned in parterre layouts, sometimes framed by trees, such as fruit trees, and in many cases included orchards and vegetable gardens. None have survived in their original form. Some have been irreversibly built up. A large group of these gardens is not accessible to the public, as evidenced by the study. Surveys [34,35] and the directive document [36] show that there is a deficit of public green spaces in the study area. There is no clear structure of green areas, no green network of public areas and, in the light of the historical space, building such spaces is not an easy task. The initial regeneration plans envisaged that the area between Krakowska and Bożego Ciała Streets left over after the demolition of a tenement house would become 'Kazimierz' Park [31]. A playground for children had occupied the spot for a long time but was replaced with a hotel.

In the 19th century, Kraków's streets were planted with, among others, Italian poplars, maples and lime trees; later, smaller globular trees—maples, robinias and hawthorns—became fashionable. In the late 20th century, many street tree rows disappeared from the urban landscape, mainly due to the transport and utility infrastructure development and lane widening [41].

The vegetation of historical green areas from different periods is another matter. Initially, native species were used in them, but as garden design developed, exotic species became popular. Today, various approaches can be seen in restoration projects, namely the use of both historical plants and new species. Frequent mistakes here include the ignorant use of ahistorical, introduced species, although climate change will necessitate a verification

of species and varieties (Figure 19). The state of maintenance of green areas has improved in places in the area.

(**a**) (**b**)

Figure 19. Visual aspects, frames and obstruction. (**a**) To the left are the Bernardines' gardens with a view of a grotto with Virgin Mary, underscored by blue spruces, and deeper in the background, in a borrowed view, is the chapel of the former Bernardine Sisters' Monastery. Photo by A. Zachariasz, 2012. (**b**) To the right is Sukiennicza Street, which is a visual axis towards Wawel Castle, and the contextually ahistorical blue spruces near the grotto partially obscure this view, and to the left is a row of thuyas that surround the pitch of the 'Nadwiślan' Sports Club. Photo by A. Zachariasz, 2023.

All green spaces located within the area under study are subjected to statutory conservation as historical sites and as sites located in a historical urban layout. For this reason, every project should be approved with the conservation office. According to conservation doctrine [52,70], the scope of permissible measures includes conservation, restoration and restitution of historical gardens, of course in areas where historical gardens are documented, while for other areas, new designs embedded in tradition are permissible [42,54].

6. Results

6.1. Use Structure of Kazimierz and Stradom

Kazimierz and Stradom have a diversified use structure. Majority of the area features commercial or residential/commercial development with ground-floor services. It includes a wide range of service buildings, including religious (monasteries, churches, synagogues), cultural (museums, libraries), educational (schools, kindergartens), healthcare (hospitals, nursing homes), tourism-related and hospitality (hotels, hostels, among others) and retail and catering services.

Analysis of the area's functional structure showed that the largest share (34.8%) was taken up by public spaces, i.e., circulatory areas including garden squares and city squares (28.5%), as well as boulevards (6.3%). Due to their unique spatial character, these two categories have been separated in Table 2, but both constitute public spaces. Residential and commercial development occupied 22.6% of the study area, forming the second-largest category. Other major uses were commercial services (12.8%), religious services (12.3%) and housing (12.4%). The areas with religious service buildings, including monastery complexes with gardens, churches, synagogues and the Jewish cemetery, are of particular note.

The eight most representative use categories (Figure 20) were delineated, which form coherent morphological groups based on building and site development form specificity. Sites that represented the use either entirely or at least in 75% were considered. The most diverse use category are services, as they consist of public administration buildings, hotels, as well as sports and recreation areas. Within this category, due to spatial specificity, healthcare services, related to hospital and care facilities, were isolated. Religious service buildings were analysed under two categories: monastic complexes, churches and synagogues, as well as the historical Jewish cemetery grounds. However, some of these facilities, although they retain their original form of use, did not fully function. In Kazimierz, for example, of the seven existing synagogues, only one, Remuh, held regular services at the time of writing. Another functional category is cultural services, i.e., museums, libraries and

cultural institutions, among others. Science and education uses included school facilities of various levels. The housing category is difficult to verify due to the increasing number of dwellings for short-term rentals, which are not recorded. The proposed classification also includes green areas that accompany transport zones, i.e., streets, squares, railway embankments, etc.

Table 2. Amount of greenery in Stradom and Kazimierz in 2022, as divided by development use, by the authors.

AREA BALANCE							
Primary Use	**Total Site Area (ha)**	**Built-Up Area (ha)**	**Undeveloped Area (ha)**	**Share of Undeveloped Area (ha)**	**Biologically Active Area**	**Share of Biologically Active Area**	**Non-Permeable Area (ha)**
Commercial	17.55	6.9	10.65	61%	1.86	10.60%	8.79
Healthcare	1.97	0.72	1.25	63%	0.35	17.77%	0.9
Religion	16.9	4.14	12.76	76%	8.27	48.93%	4.49
Education	3	1.43	1.57	52%	0.61	20.33%	0.96
Culture	2.0	1.08	1.01	48%	0.07	3.35%	0.94
Mixed-use	30.89	17.61	13.28	43%	2.13	6.9%	11.15
Residential	16.92	8.5	8.42	50%	2.05	12.12%	6.37
Boulevards	8.6	n/a	8.6	100%	5.4	62.79%	3.2
Public space	39.01	n/a	39.01	100%	5.47	14.02%	33.54
TOTAL	136.93	40.38	96.55	71%	26.21	19.14%	70.34

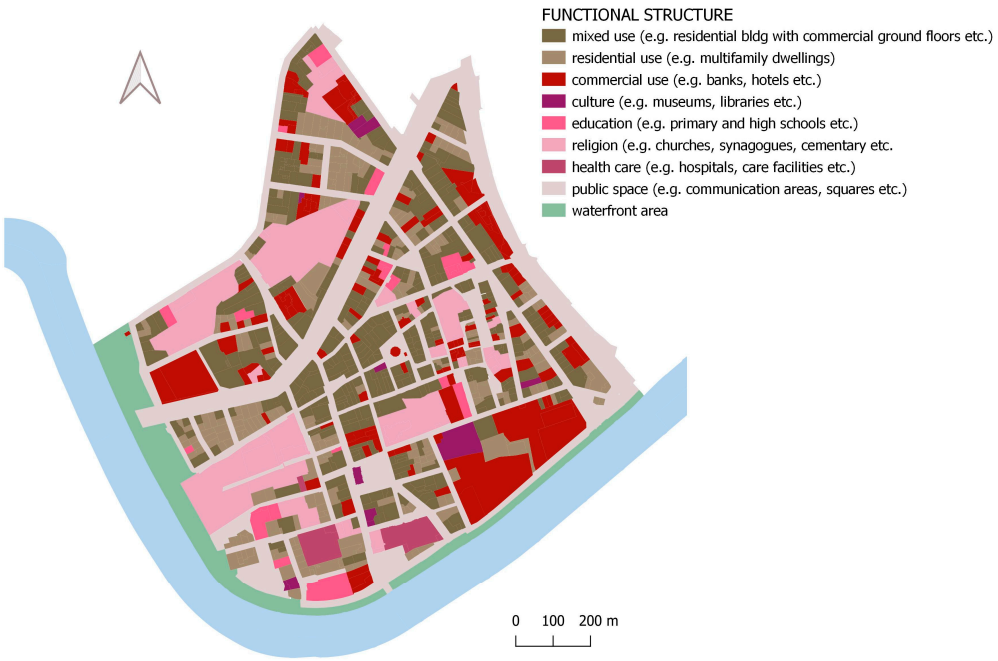


Figure 20. Land use structure of the Kazimierz and Stradom area, by the authors.

6.2. Comparison of Greenery Stock in the Study Area

Surveys of the existing greenery stock of Kazimierz and Stradom were carried out for the eight use categories listed above, to which the Vistula boulevard areas were added. This is the greenest part of the study area, which forms the linear Vistula Park that forms its southwestern boundary. With a greenery percentage of 62%, which is of a unique

spatial and use character, it was not possible to classify it under any of the other eight categories. A survey of the existing greenery stock within town blocks showed that the highest proportion of green space (48.93%) was located within properties with religious uses. This is related to the large area of monastic complexes with gardens, which also form the largest (after the boulevards) areas of greenery in terms of surface area within Kazimierz and Stradom (Table 2). The second highest biologically vital area ratio (RBVA) is in areas used as science and education services. The boulevards and the two use categories mentioned were the only examples of areas with a RBVA higher than the 19% average for the whole of Kazimierz and Stradom. In contrast, a ratio below this value was recorded for the remaining six use categories: healthcare services, services, cultural services, residential development, mixed-use housing and service development, and areas associated with transport and circulation. It should be noted that the three categories with the highest RBVA covered only 20% of the entire area under study; hence, the average value of the greenery index was significantly underestimated in relation to their respective values.

Comparative studies of green space structure were carried out on the basis of the surveyed area from materials dating from 1980, 1984 and 1991 (Table 3), satellite images (1970, 1996–2021) and field surveys performed in 2023 and MSIP data (Figure 21, Table 3). As a result of analyses of the 1991 greenery stock register, it was estimated that an area of 36.816 ha was covered by greenery, which accounted for 26.27% of the area of Kazimierz and Stradom. At the time of writing (early 2023), the area of green space was 26,222 ha, which represented 18.72% of the study area. Various urbanisation processes had led to a loss of green space by 10,594 ha, or its reduction by 28.78%, since 1991. Despite its compact structure, the area has a lot of open, undeveloped space, and in particular, the fringe areas near the river Vistula are subject to continuous densification.

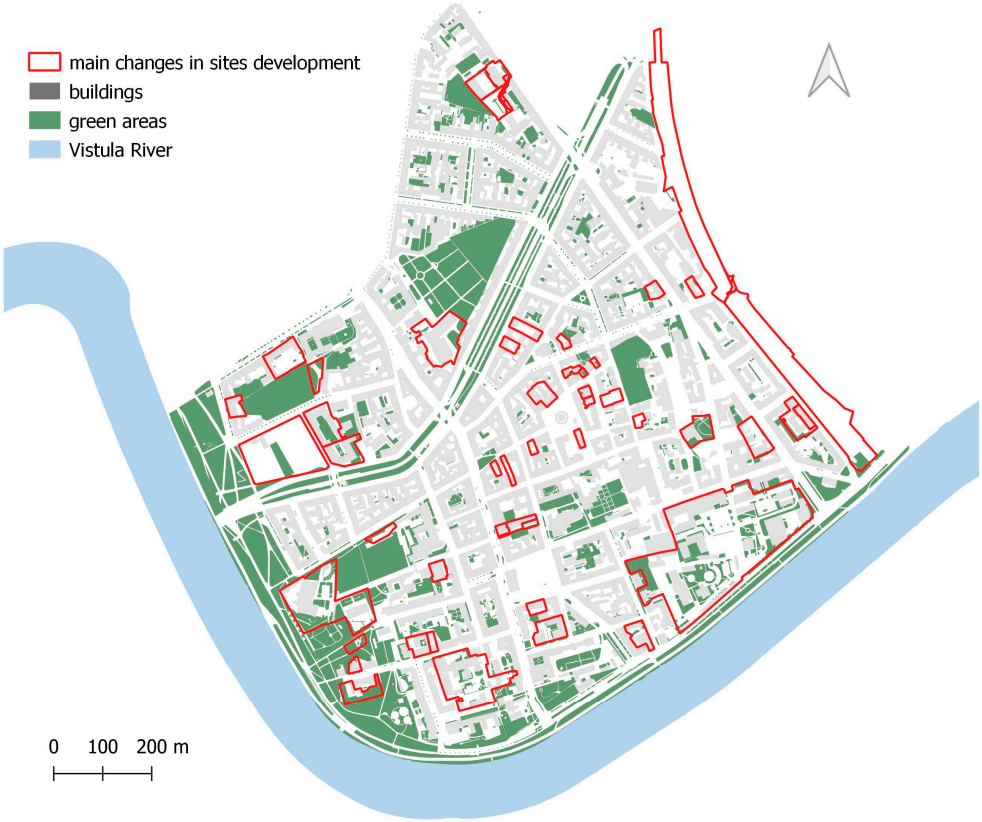


Figure 21. State of greenery of Stradom and Kazimierz in 2023, together with changes in urban structure and development, by the authors.

Table 3. Listing of downtown greenery in the Old Town, Kazimierz and Stradom.

Kazimierz and Stradom Area: 140.066 ha				**Old Town with Wawel Castle and Planty Park Area: 95.5936 ha**	
1991		**2023**		**2021 [5]**	
Area covered by greenery	Share of green areas	Area covered by greenery	Share of green areas	Area covered by greenery	Share of green areas
36.816 ha	26.27%	26.222 ha	18.72%	28.5770 ha	29.89%

Source: original work based on vegetation area surveys [35], satellite images from 1970, 1996–2021 [5] and 2023, field surveys and MSIP data.

The area under study, despite the historicity of its development and the statutory conservation of its layout, saw significant construction activity. The most important changes from recent years concern both the additions to the peripheral development and the introduction of new development within town blocks. Among changes in use, we should note infill development with hotel establishments in Krakowska Street, which is a complementation of the street's frontage, with a visual opening towards the Corpus Christi Church tower. The infilling of the development of the former Bernardine Sisters' Monastery (and later the buildings of the Society for Benevolence), with mixed-use housing and commercial premises, was a much larger project. Open spaces shrank in Stradomska Street (the former Church of the Order of the Holy Sepulchre, later a customs chamber, post office, military command post, kindergarten, and finally, housing) due to adaptive reuse of a building as a hotel from the frontage side, and the construction of housing inside the block (Figures 22 and 23).

Figure 22. Kazimierz's town blocks visible from the side the Vistula waterfronts, as seen from an observation balloon. From the left: the 'Nadwiślan' Sports Club and the former Bernardine Sisters' Monastery (before the gardens were built up), Dietla Park and Paulińska Street, further in the distance is the Pauline Monastery at Skałka, further is that of the Augustinians and further still is the monastery of the Canons Regular of the Lateran, while to the right is Kazimierz's market square and town hall. Photo by A. Zachariasz, 2010.

The new building partially filled in a plot of land that used to be a free-form garden. Other changes include infilling the frontage of Estery Street and the corner of Nowy Square's corner, as well as new modern housing development that appeared in the area of the former municipal gas plant. The railway embankment has been fully modernised, which led to the elimination of a portion of its green area. The transformation also involves adaptive reuse as a museum (Municipal Engineering Museum, Krakow Gas Plant). Urban transformation is a consequence of intensified development for commercial purposes.

Figure 23. View from Sandomierz Tower at Wawel Castle towards Stradom and Kazimierz. The following can be seen: the Bernardine Monastery garden, the sports grounds of the 'Nadwiślan' Sports Club and, to the left, the former monastery of the Bernardine Sisters and contemporary infill development in place of the monastic gardens. In the background is the panorama of Kazimierz (St Catherine of Alexandria Church on the right, Corpus Christi Church on the left) and, beyond the Vistula, Podgórze with Bednarski Park. Photo by L. Kochel, 2022.

A similar study on the structure of green spaces, historical changes and development shifts of the Old Town of Krakow in 1997–2021 found a net loss of green space by 1.669 ha [5]. However, the specific changes in green area for the Old Town were much smaller than in Kazimierz and Stradom. In these areas, a trend to make the city impermeable is more clearly observable than in the strict Old Town. Adaptive reuse change tendencies became quite widespread, and a decrease in green areas in private spaces occurred. However, in the Old Town, there was an observable increase in public green spaces. In summary, the contemporary green structure in the historical centre of Krakow (Old Town, Kazimierz and Stradom—235.659 ha) accounted for 54.799 ha, or 23.25% of its total area. More specifically, the ratio of contemporary greenery (2021) in the Old Town area was 29.89%, whereas in Kazimierz and Stradom this was 18.72% (2023) (Table 3).

6.3. Forms of Green Area Conservation in Kazmierz and Stradom

Kazimierz and Stradom are areas under many forms of statutory conservation. Including Krakow on the UNESCO World Heritage List provided an impetus to begin the regeneration of the city's historical fabric, as the condition of the monuments at the time was dire.

In Poland, statutory architectural conservation is defined in the Monument Protection and Preservation Act [90]. The forms of statutory conservation are as follows: listing in the register of monuments, monument to history status, the establishment of a cultural park and provisions in planning documents written up in accordance with the Spatial Planning and Development Act [91]. Kazimierz and Stradom are under all forms of conservation under Polish law (Table 4).

The register of monuments is the oldest form of statutory heritage conservation in Poland, established in 1928 [72]. It consists of individual and territorial listings, and both are used in Kazimierz and Stradom. In 2022, the Krakow City Council adopted a resolution on establishing the Kazimierz and Stradom Cultural Park [76]. A cultural park is established by local authorities, after consulting with relevant institutions, to protect the cultural landscape and preserve scenically distinctive areas with immovable monuments that are characteristic of the local architectural and settlement tradition.

Kazimierz and Stradom are also located within the historical architectural and urban complex of Krakow, which was proclaimed a Monument to History in 1994. This status is primarily a matter of prestige and constitutes the only exception to the principle of the

equality of monuments as stipulated in the Monument Protection and Preservation Act [92] (Figure 24).

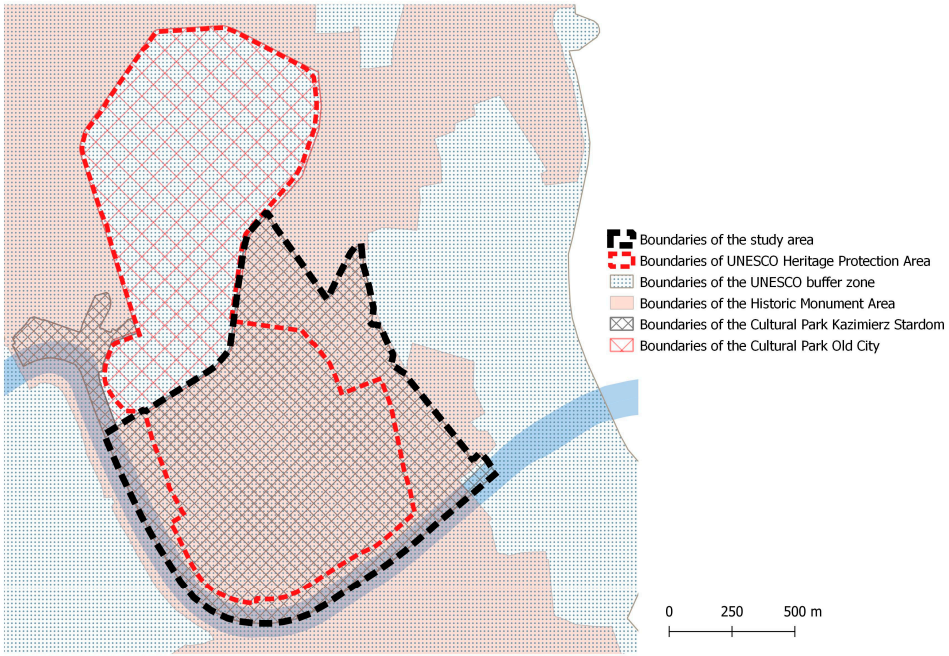


Figure 24. Areas of heritage conservation applicable to Kazimierz and Stradom, by the authors.

This act [90] defines the statutory conservation of heritage sites, but in the case of complex greenery layouts, it is the territorial extent of the listing that is crucial. The decision to list a monument in the register should include a precise definition of all its parts and elements, including greenery forms, as only this can provide a legal basis for the conservation of an entire ensemble. For example, monastery grounds can consist of a cloister garth, courtyard gardens, utilitarian and ornamental gardens and church greenery. Historical investigation is important, as is determining a site's values, its boundaries and precisely listing its area. The area around a monument, as designated in the heritage listing decision, e.g., to protect the site's visual values and the site itself from harmful external influences, is also significant. The surroundings can be protected in the provisions of the local development plan.

The study area is covered by the arrangements of three currently applicable local development plans (MPZP): 'Kazimierz', 'Stradom' and 'Bulwary Wisły'. The 'Kazimierz' local development plan [74] lists the largest green areas, such as cemetery greenery and publicly inaccessible monastic gardens. The plan also designates public greenery areas and greenery that accompanies mixed-use housing and service development. One of the objectives of the plan is to protect the existing greenery and public spaces and the interiors of the historical town blocks. Regarding the principles of shaping and arranging greenery, the plan stipulates:

- Preserving existing greenery by incorporating it into the site development design.
- Mandatory protection and preservation of indicated trees on the plan map.
- Mandatory preservation and infilling of existing tree rows and planting new tree rows in places indicated on the plan map, if not elsewhere.
- Mandatory presence of lawns or low greenery in pavements.

The extent of the minimum RBVA specified in the 'Kazimierz' MPZP varies. In mixed-use housing and commercial development and service development areas, the minimum RBVA for most town blocks is listed as 24%, with exceptions for selected properties, where the minimum ratio is 30%. Landscaped green areas and greenery accompanying buildings have a high minimum RBVA (60–90%), with the exception of historical building complexes,

where the ratio, due to the existing development, is set at a level close to the current amount of greenery [93].

The 'Stradom' MPZP [73] states the preservation of existing and providing new greenery in public spaces and town block interiors as a fundamental goal. The key provisions of the plan in terms of greenery preservation and design include:

- To the greatest extent possible, mandatory conservation of existing greenery during real estate development, especially via its preservation and incorporation into site development designs.
- Maintenance and preservation of the following greenery types: greenery accompanying buildings, monastic gardens and greenery indicated in marked town blocks that should be developed as RBVA.
- Preservation and infilling of existing tree rows, and planting new rows as indicated in the plan.
- Presence of lawns or low greenery in pavements.

In the 'Stradom' MPZP, the minimum RBVA for mixed-use housing and commercial development and service development was mostly defined as 16–20%. Landscaped green spaces and green spaces alongside buildings, as indicated in the plan, have a high minimum RBVA, which is either 70% or 80% [73].

The third MPZP in force is 'Bulwary Wisły' [75]. It is highly significant due to both preserving the historical and landscape assets of the boulevards and the boundaries, land use and development of the entire area. In terms of environmental and wildlife conservation, the plan mandates the regeneration of decayed green spaces and the preservation of existing trees. Within the boundaries of the plan, the minimum RBVA values are highly varied. In mixed-use residential and commercial development and service areas, they are within the 5–70% range, while in landscaped green spaces and green spaces accompanying buildings, the ratio is set at a minimum of either 50%, 80% or 90%. It should be noted that the minimum RBVA set out in planning documents is often inflated in relation to the existing green space. This shows that there is an intention to increase the proportion of green space in the Stradom and Kazimierz area.

The legal provisions concerning Kazimierz and Stradom and their effects were analysed (Table 4).

Table 4. Documents that determine conservation measures and development of green areas in Krakow and Stradom, by the authors.

Form of Conservation /Applicable Document	Type of Conservation Provisions in Legal Documents	Effect
International		
UNESCO World Heritage Site (1978)	Monitoring. Greenery is treated as an integral part of the historical structure. Commitment to enact national legislation that consistently and effectively guarantees proper monitoring, the possibility of interference in both protected areas and the buffer zone. Failure to comply with this obligation may result in removal from the World Heritage List.	Regeneration of the city's historical urban tissue since 1978. Institutions were established to deal with the restoration of historical monuments and to raise funds for all related activities, e.g., in 1978 the Social Committee for the Restoration of Krakow Monuments (SKOZK) was established [32]. Increased public awareness of the cultural values of Krakow, including Kazimierz and Stradom. Regular state of preservation reviews. In case of far-reaching changes, removal from the World Heritage List.

Table 4. *Cont.*

Form of Conservation /Applicable Document	Type of Conservation Provisions in Legal Documents	Effect
National		
Listing the urban layout in the register of monuments (1934) [88]	Statutory conservation covers the spatial urban layout that features building ensembles, singular buildings and forms of landscaped greenery placed in historical layouts of property and use divisions.	Conservation approval of the design or removal of greenery (felling trees and shrubs).
Register of historical monuments, applies to individual buildings and properties [88]	Statutory conservation also extends to the most valuable buildings in terms of architectural form, style, building materials and form of use.	Conservation approval of the design or removal of greenery (felling trees and shrubs).
Monument to History (1994) [72]	Continuous observation of the state of preservation and processes within the area under conservation and in its vicinity. A form of statutory conservation of immovable monuments, listed in the register of monuments and cultural parks. This rank is given to a building or site of special significance based on its value to culture (prestige).	Conservation approval of the design or removal of greenery.
Cultural park and cultural park conservation plan (2022) [76]	Regulates the manner of conservation, prohibitions and restrictions. A protection plan has been compulsorily drawn up and an institution has been set up to manage the park. A local development plan has been drawn up. The cultural park conservation plan specifies how service and commercial businesses can operate and how construction work is to be done, how catering terraces can operate, the aesthetic of building facades, the precepts for placing signs, signboards and advertisements, as well as the organisation of open-air events and street art presentations. Among other things, the conservation plan provides for the functional and compositional protection of green spaces, especially historical gardens, boulevards and garden squares, and permits the restoration of green spaces. Monitoring.	Conservation approval of the design or removal of greenery. Periodic review of the arrangements in place and, if necessary, their revision. Operational reviews conducted by a supervisory body.
Local spatial development plan provisions ('Stradom' 2018, 'Kazimierz' 2017, 'Bulwary Wisły I' 2013) [73–75]	The provisions define the intended land use and development conditions via sets of planning indicators applicable to the zone covered by the plan, such as: maximum development density or biologically vital area. The provisions stipulate, among others, the preservation of existing green and public spaces and the interiors of historical town blocks. Trees for preservation/conservation were indicated, and the infilling and introduction of tree rows along trees and in squares was stipulated. The design of selected buildings' facades as greenery on walls or vertical gardens was permitted, as were green roofs.	Conservation approval of the design or removal of greenery.
The landscape resolution (2020) [94]	Adopted based on the Spatial Planning and Development Act and is a territorial tool for the statutory conservation of the cultural and natural landscape. The landscape resolution sets out the rules on the siting of street and garden furniture, billboards and advertising devices and fences. It protects users from excessive sensory stimulation in the space of everyday activity and aims to make visual information more comprehensible. Allows fences to be shaped as hedges.	Visual and aesthetic changes. Regulating advertisements and signboards and their illumination, as well as fencing.

Table 4. *Cont.*

Form of Conservation /Applicable Document	Type of Conservation Provisions in Legal Documents	Effect
Local		
Krakow green spaces' development and management directions for 2019–2030 (2019) [36]	The scope of green space development measures that considers the needs of: increasing access to green recreational areas, improving the attractiveness of green space development and protecting the city's natural and cultural resources. The document sets out standards for the design, maintenance and care of green spaces, including general recommendations for species application.	Indications for the creation of continuous systems and networks of green spaces. Operational document.

Landscaping designs in areas under statutory conservation as stipulated in the Monument Protection and Preservation Act must include necessary data, studies and surveys to aid in issuing a conservation decision that does not infringe on the status of the applicable monument. In Poland, this includes administrative proceedings and the methodology developed by specialists [41,90,95,96] (Figure 25). The model presented below has been extended, based on the application of the green management project, with the possibilities of both GI and blue infrastructure (BI), which is an introduction to the concept and implementation projects.

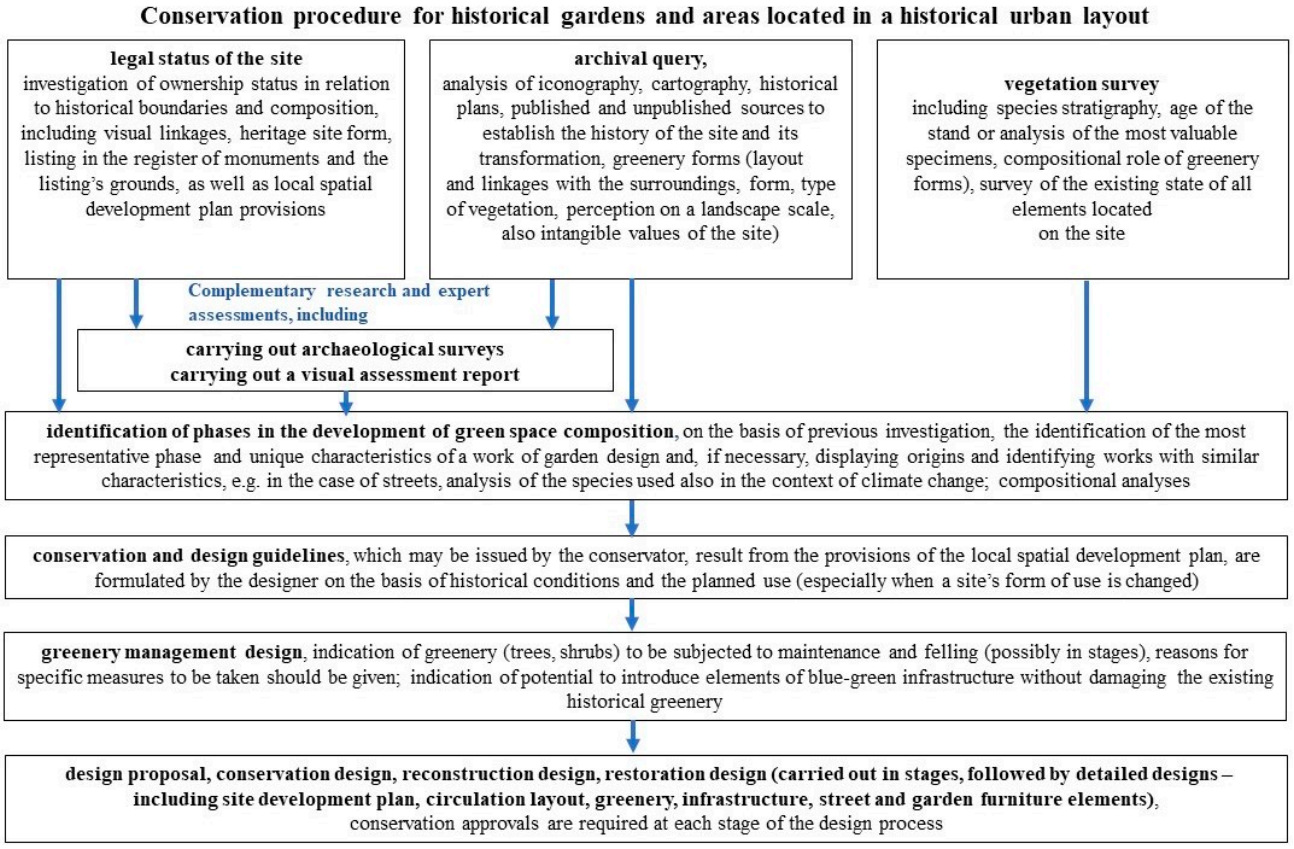


Figure 25. Conservation procedures for historical green spaces, based on [41,90,95,96], by A. Zachariasz.

6.4. Cultural Heritage Zone and Climate Change Adaptation

The strong link between cultural heritage and the environment is undeniable. The environmental context is an indispensable element for fully understanding and interpreting the value of cultural heritage, which is also the basis of everyone's cultural identity and identification. However, in the face of climate change, green spaces in cities are being

considered for their mitigating potential. Heat waves, torrential rains, floods, flash storms, water shortages and heavy winds are felt the most in urban areas. One phenomenon distinctive of cities is the urban heat island effect, where urban spaces record higher temperatures relative to less developed neighbouring areas. This is mainly caused by anthropogenic impacts. Dense development and impermeable land cover, which have a low albedo and high heat absorption, heat up much faster than green areas. The lack of trees and shrubs prevents water circulation, which cools the air, and tall and compact buildings inhibit air circulation [97]. The quality, quantity and accessibility of green spaces is also an important factor that shapes the functionality and attractiveness of urban space in its users' eyes.

In addition, green spaces provide better absorption and retention of rainwater, which contributes to mitigating the effects of driving rain and violent storms. Improved absorption performance is provided not only by larger green areas, but also by green roofs or walls. Providing such surfaces in a compact structure additionally subject to statutory conservation is a major challenge. However, despite strict guidelines for the preservation of historical greenery layouts, regulations allow for conversions that increase the amount of greenery and permeable surfaces (e.g., green car parks). Such measures are feasible while adhering to the minimum RBVA values defined in planning documents to maintain an appropriate (development density-dependent) balance of paved and permeable surfaces. The definition of biologically vital areas, as set out in legal documents [98], defines it as land with a surface arranged in such a way as to ensure natural vegetation and rainwater retention. These surfaces are crucial for climate change adaptation by lowering temperatures in areas with compact development, among other things. Additionally important is the role of greenery in shaping high-quality urban spaces, improving access to recreational areas or influencing the microclimate.

Climate analyses clearly indicate that the negative effects of climate change associated with both urban heat island impacts [99] and the risk of localised flooding will be increasingly felt in Krakow. Dense development, a high proportion of sealed areas and a low proportion of tall greenery and permeable surfaces in the form of green spaces make this area particularly sensitive to climate change. An analysis of the mean annual temperatures, as presented by Meteoblue for the Krakow region over the period 1979–2023, showed a positive trend in temperature increases. In Stradom and Kazimierz, attention should also be paid to long heat waves, droughts and heavy rains resulting in localised inundation and flooding. Average precipitation data for the Krakow region show that the amount of precipitation is increasing, as is the occurrence of sudden and heavy rains [100].

The City of Krakow Climate Change Adaptation Plan [101] indicates that areas of historical and downtown development are particularly at risk of being affected by high temperatures during heat waves, compounded by the presence of the urban heat island effect. The sealing of the land in the historical and downtown development area and low RBVAs, combined with the lack of tall greenery to provide shade for the buildings, lead to the disruption of ground–air energy exchange. The area of Kazimierz and Stradom is mostly covered by compact development, complemented by the natural areas of the river Vistula and its boulevards. This is directly related to the degree of surface impermeability and the amount of biologically vital area, which in the built-up area of Kazimierz and Stradom were determined to be in the range of 81–100% and 0–10% (Figure 26a,b), respectively.

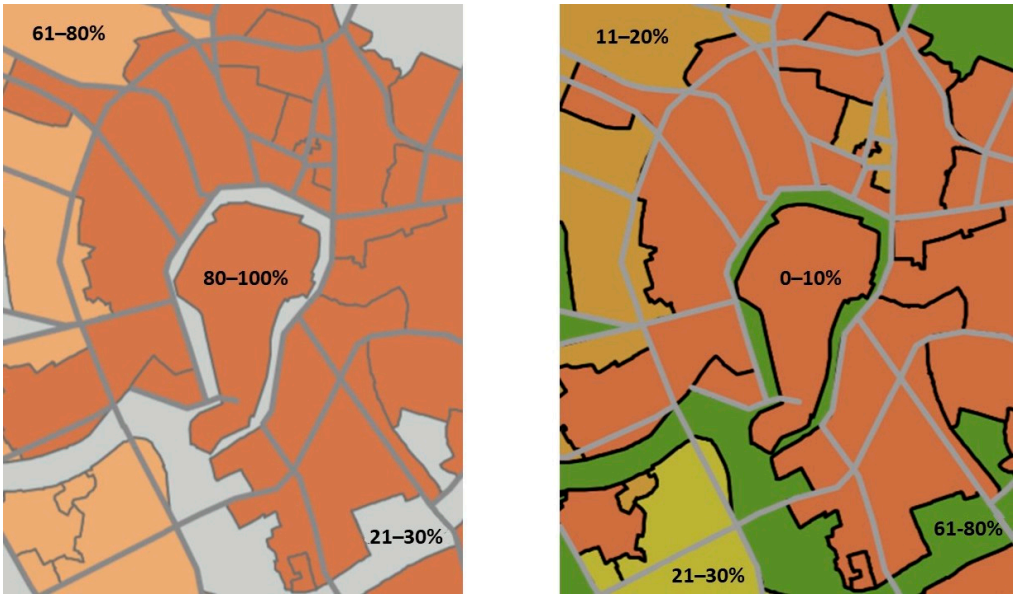


Figure 26. Overview of historical Krakow: (**a**) percentage of impervious area and (**b**) percentage of biologically vital area, based on [101], by the authors.

As mentioned above, the remedy for these problems is greenery, which lowers the air temperature and acts during torrential rains, during which surfaces with vegetation absorb and retain water. Examples of mitigation measures that could be introduced in Kazimierz and Stradom include:

- The preservation of undeveloped areas and existing green spaces, including tall greenery, which, by creating shade, moderates and balances the temperature, promotes air circulation and contributes to the elimination of the urban heat island effect. Within the study area, in addition to an extensive riverside park, there are large green spaces (monastery gardens and a cemetery) which, although inaccessible, may have a cooling effect that mitigates the urban heat island effect [97]. Therefore, it is not solely from a conservation point of view that new developments in these areas should be minimised.
- Extending green spaces, which, among other things, have the capacity to reduce and prevent flash floods by absorbing and retarding rainwater.
- Increasing the number of street trees as they provide natural shade for pavements, and planting trees in squares, garden squares and playgrounds.
- When it is not possible to plant trees, street greenery should be introduced in the form of strips of groundcover plants and climbers on frames, which has a fairly long tradition in Krakow.
- Raising standards of maintenance, establishment and care of green spaces.
- Introducing green building walls, vertical gardens and green roofs on a wider scale.
- Unsealing paved surfaces by replacing pavements with partially permeable or permeable surfaces that enable rainwater infiltration.

In order to plan a complete green infrastructure, it is important to improve existing green spaces by creating a network of continuous green connections. In this case, this should include green streets (tree rows, hedges, flowerbeds, groundcover vegetation, green tram tracks), green walls, courtyard gardens (green courtyards), green roofs, where possible, and increasing the ratio of permeable surfaces and maintaining existing green spaces. Every extra tree that provides shade counts. Water management is also key, i.e., setting up rainwater-harvesting tanks, and creating rain gardens wherever possible.

The extent of change in this area is limited due to statutory conservation. This study found a reduction in the area of green spaces in Stradom and Kazimierz, including those areas where gardens are listed in the register of monuments (e.g., courtyard gardens, monasteries) (Table 2). This indicates that changes to the blocks should be monitored and inspired by good examples of potential ways in which greenery and permeable surfaces can be extended.

The transformation of Kazimierz's green areas shows how changing and impermanent plant material is, and testifies to its susceptibility to change, both in terms of arrangement and functional transformation. In this case, the requirements of the monument and the expectations of contemporary users must always be considered, which is sometimes difficult to reconcile. The issue applies to all types of greenery, from inaccessible monastery gardens to those next to tenements and to publicly accessible areas. These expectations also include climate change mitigation, which has a positive impact on the greenery expansion potential.

The historical city's green areas have different modification capacities. A post-medieval structure has a limited absorption capacity, e.g., for historical reasons, and the conservator's decision-making role here is crucial. The contemporary development of historical gardens and gardens in historical layouts inspires discussions among local residents—the users of the space—which, in the light of gentrification, over-tourism and the depopulation of city centres, is gaining in significance. They also remain debatable in cultural and historical matters, for instance when faced with public pressure lifting restrictions on access to monastic gardens and how this clashes with monasticism.

Undoubtedly, environmental assets are a factor that contributes to the social behaviour and attachment of users to a place, especially in residential areas. A historical compact city such as the centre of Krakow faces the urban heat island effect and the availability of green spaces for recreation and sport. These facts are recognised by residents, who demand greenery for various reasons, these included. This can be seen with the example of civic budget drafts. In the 2022 civic budget edition, a proposal for introducing trees into the area of Krakow's Main Market Square was adopted [102]. This year's edition of the budget features the greening of Krakow's remaining squares, including Wolnica Square and the square on Szeroka Street (now a car park). The proposal states "we want to green the other squares in the city too! Using trees and greenery, we fight with the concrete sickness that plagues them and which forms urban heat islands that prevent a happy life" [103].

In the research of the green areas of Kazimierz and Stradom, their accessibility for users and the type of greenery were determined. Then, the possible application types of GI natural (10 types) and social and economic (2 types) were assigned to the individual types of green areas (Table 5). Valorisation and a point scale were used to determine the implementation potential, which showed that the study area has a high potential for GI implementation. The types of green space were collectively assessed, but each requires an individual design and implementation approach. For example, types such as trees (1) or hedges (2) (formal or informal) can be introduced in any type of green area, as can educating residents and supporting bottom-up activities (11). There are also types, e.g., green tram tracks (10), which can only be found on certain communication routes (Table 5). However, the large implementation potential and systematic activities directed to enhance the greenery area indicators are promising for the natural environment of the study area.

Table 5. Green areas in Kazimierz and Stradom divided by accessibility, type, green infrastructure (GI) and implementation measures. Source: authors.

Accessibility (Restrictions on Entering the Green Space and Greenery Type)	Type of GI and Implementation Measures (A)	GI Implementation Potential (B)
Freely accessible greenery		
Parks bigger than 2 ha, Vistula boulevards	1, 2, 3, 4, 5, 9, 11	***
Greens and garden squares, Smaller than 2 ha	1, 2, 3, 4, 5, 11	***
Street greenery	1, 2, 4, 6, 9, 10, 11	***
Greenery on squares (Kazimierski Market Square, Bawół Square, Nowy Square)	1, 2, 4, 9, 11	**
Partially accessible greenery		
Gardens and courtyards near housing	1, 2, 3, 4, 7, 8, 9 11, 12	***
Areas near religious buildings (churches and synagogues)	1, 2, 9, 11	**
Remuh cemetery	1, 2, 11	*
Greenery accompanying cultural services, e.g., museums, hotels	1, 2, 3, 4, 7, 9, 11	***
Greenery accompanying educational services and sports grounds	1, 2, 3, 4, 5, 7, 8, 9, 11	***
Gardens near hospitals and welfare facilities	1, 2, 3, 4, 7, 9, 11	***
Greenery near industrial/service areas/municipal gas plants	1, 2, 3, 4, 7, 9, 11	***
Non-landscaped greenery/other, e.g., railway embankments	1, 2, 3, 6, 11	**
Inaccessible, monastic greenery/conditionally accessible upon approval		
Monastic gardens	1, 2, 3, 4, 5, 7, 9, 11, 12	***

(A) In terms of vegetation and enhancing biodiversity: (1) trees, (2) hedges, (3) flowery meadows, wild vegetation strips, (4) flowerbeds, climbers, e.g., on poles, (5) rain gardens, (6) retention ditches near streets, (7) green walls, (8) green roofs, (9) introducing pervious surfaces, (10) green tram tracks [57–60]. Social and economic: (11) resident education: supporting local communities with a strong sense of place, working towards preserving and establishing green areas, (12) municipal financial incentivization scheme: tax exemptions. (B) Rating scale: high (***), medium (**), low (*).

7. Discussion

Studies on the state of city greenery most often focus on entire spatial and functional structures [104]. There is a lack of thorough analyses and surveys of the areas, most deficient in terms of green space. These include historical Old Towns. In these areas, due to little undeveloped space and the various forms of statutory conservation, there is limited potential to increase the amount of green space. Any and all design measures in such areas must be approved by the relevant conservation services. In light of the dangers that accompany historical towns, i.e., the flight of residents from city centres, the issue requires urgent interventions and comprehensive solutions. The touristification and over-commercialisation of public spaces, the progressively worsening impacts of the urban heat island effect, noise, air pollution and rising property prices, lower the populations of historical centres. This makes them increasingly commercialised, historical open-air museums [105–108], which was particularly evident in 2020–2021 because of the pandemic. It is the quality of urban life and climate change that provide the rationale for discussion, research and analysis of the role of green spaces in cities.

It should also be emphasised that the gap in the research of historical cities, both in Poland and abroad, in terms of a precise analysis of the resources of green areas in their territory is due to the lack in the past of IT tools that would allow this task to be carried out for larger areas. It is only within the last years, with the help of spatial and satellite data and GIS software, that it is much easier to accurately estimate the area of greenery in cities, to identify areas with deficits and areas potentially suitable for permeable surfaces.

A direct reference for the present study is the results of an earlier study conducted by the authors in 2021 for the Old Town area of Krakow. There is a close relationship between this area and the area of Kazimierz and Stradom, which is the subject of this study. It consists, among other things, of the spatial–functional relationship of these directly neighbouring areas and the same forms of conservation protection occurring in them. Despite the similarities, there are also apparent differences related, among other things, to their different morphological structure, functional layout and the social and economic conditions of the respective areas. The previously developed research method for the Old Town (Figure 1) allowed for the analysis of the Kazimierz and Stradom areas, outlining the need to introduce changes to it, related to, for example, the method of examining the accessibility of individual green sites and improvements in the analysis of the obtained spatial data. This can lead to the conclusion that to develop a research method that would have a more universal character, it is necessary to carry out additional comparative studies, both in terms of morphological systems of cities with different historical provenance, locations and from other climatic zones, as well as different legal, social and economic conditions. Nevertheless, the presented research model is a good starting point for research.

Types of GI and their implementation in the area of cultural heritage covered by various forms of conservation protection primarily depends on the historical value of the object—green area (often transformed many times)—and its importance for the UNESCO area, but also on the function (Figure 20) and the absorptive capacity of the place without losing the quality of the protected landscape (Table 4). In addition, in order to estimate the potential for increasing the share of green areas, it is necessary to conduct an inventory, not only of the existing green resources but also of the paved area of undeveloped space, the potential of walls and walls that can be transformed into permeable/semi-permeable surfaces or vertical gardens (Table 2).

This study analysed originally medieval urban layouts and the presence of greenery in these layouts. They were under all possible forms of statutory conservation currently possible in Poland at the time of writing. They were shown as living structures that are subject to change that is detrimental from the standpoint of greenery design, namely a reduction in the biologically vital area, which has three main causes:

- Densification of development, namely developing both undeveloped and previously developed plots (whose buildings were demolished either during or after the Second World War), the introduction of development (housing, multi-level car parks) into post-industrial areas (power plant, tram depot, gas plant) and densification due to a site's attractiveness as real estate, and this is allowed under law.
- The second results from the development of infrastructure and transport (widening of road lanes, tramway network extension), but also from the continuous development of underground utilities infrastructure on which vegetation, especially tall vegetation, cannot be planted (e.g., in 2023, the adopted civic budget project to plant trees along Wawrzyńca Street was not implemented, due to the impossibility of relocating utilities based on cost).
- The third issue is the need for new parking spaces, which results in the paving of courtyards, the removal of street lawns and the 'trimming' of garden edges.

Another issue was also discussed: how to adapt, with the help of greenery, this historical space to climate change and how to improve the GI network. This is unavoidable, as climate change can contribute to the destruction of historical green structures [109] (e.g., temperature rises, droughts and torrential rains, but also the invasion of alien insect species that destroy plants (including chestnut, boxwood)).

Kazimierz and Stradom form a unique area, which used to be a former multicultural town on an island, with a layered urban structure, traces of which are still legible in the layout. It is an area frequented by tourists and from which a radical exodus of permanent residents has been observed [5,110,111]. Noise, the city's nightlife and the desire for profit all have a detrimental effect on the quality of life. This is compounded by the depletion of green spaces, which is ongoing despite statutory conservation measures. This study showed that the loss of greenery over thirty-two years in the Stradom and Kazimierz area was 10.594 ha. Improving this depends on a number of factors, but the importance of green space for residents, for health, for leisure opportunities and for lowering temperatures in compact development, should also be highlighted.

The issue requires comprehensive solutions, as the area is a living monument due to its varied vegetation, both native and introduced, and requires constant care and often, depending on the type of plants and plant forms used, their replacement, and constant monitoring. Climate change is driving the need to adapt these facilities to new conditions [109]. The final issue concerns conservation measures, which come with additional pre-design phases and numerous administrative approvals. Historical green spaces, as highly specific sites, often with restricted uses, require an appropriate species composition and forms of vegetation. They require the highest standards of arrangement, maintenance and care—depending on needs, preferences and specifics (e.g., monastery gardens, public parks in specific styles, landscaped street greenery).

A comprehensive analysis of the literature showed that the area under study had never had such a distinct layout of green areas as the Old Town in Krakow with its Planty Park—an encircling ring park. The areas associated with the rivers Vistula and the Old Vistula have become the basis for planning the district's public green space system. In the early days, Dietla Park (Dietla Street), with an area of over 4 ha, acted as a park space. It had a formal space dedicated to strolling, with ornamental parterres and tall trees, included park alleys and sites for children to play. It had the potential to become part of the unbuilt Second Ring of Krakow, residually present as Dietla Street and Trzech Wieszczów Avenue. After a tram was routed through the middle of Dietla Street, the park's recreational value significantly decreased.

The greenery of the Vistula boulevards continues to play a major role in the local green space system. The area between Wawel and Skałka was landscaped quite late, as up to the Second World War it had not had any flood prevention infrastructure, and now plays an important environmental and recreational role, as well as that of a vista foreground. It does not, however, have, like Planty Park, a distinctive composition that would include open areas, which are paramount here due to passive and active exposition. None of Kazimierz and Stradom's green areas acted as parks. Garden squares, apart from the green area at the Old Synagogue and Dajwór Street, and on Szeroka Street, which is a religious area (a fragment of the Remuh cemetery), are small and unconnected.

Green streets, especially 19th-century ones, as well as squares, can be integrative. Monastic gardens are crucial to both districts. They are large and highly biodiverse, and have retained forms typical of such gardens, while cloister garths, parterre layouts and parterres themselves, as well as orchards, are currently mostly ornamental. They also lower the temperature.

In an expert study, using the scoring method [15,16,68], the potential for GI adoption was indicated for Kazimierz and Stradom. Implementation possibilities were assessed taking into account the type of vegetation used and the possibility of increasing biodiversity [57–59] (Table 5). In this respect, function and availability/property were important. In the adopted point scale, after discussion, it was assumed that all the studied areas could introduce GI. The activities can be on a different scale and there are areas that, for example, due to the extent and mixed-use, can take more forms. The types of areas were collectively assessed. However, each case will be considered individually due to conservation protection, and therefore the need to prepare proposals of plants and forms as well as standards for carrying out implementation and maintenance works.

This study showed that there is great potential for specific GI measures to be introduced in the types of green areas in Kazimierz and Stradom identified (Table 5). Therefore, in the light of the assessment presented, the following measures are proposed:

- Retaining biologically vital areas and aiming to extend them (e.g., by replacing paving in squares, enlarging lawn spaces with so-called 'tree windows' and converting them into street lawns, while in courtyards, if there are impermeable car parks, introducing green parking spaces or permeable surfaces).
- Comprehensive vegetation surveys, including comparative analyses based on historical materials, examination of changes in species use and identification of historical species at risk in the area, especially in gardens of unique value—monasteries—and the surveying of tall greenery, and identification of areas and paths where it may obstruct views.
- Developing a directional document on shaping Kazimierz and Stradom's green areas (which would be interdisciplinary, with a public participation process, involving officials and experts).
- Specialists and the conservation office should draft a catalogue that would include plants, species and varieties, as well as forms of vegetation that can be applied in historical spaces, divided into public and private spaces. It would also recommend species, varieties and forms in directional documents and through promotional campaigns related to planting in harmony with a place's identity. Special standards may include species and varieties of trees and shrubs, indications for the use of perennials and annual plants, historically based, preferred due to form, habitat or resistance to pollution (for different types of public spaces, traffic spaces or specific recommendations, e.g., playgrounds). Additionally of relevance are the proposed heights of 'green partitions' (threat of obscuring views), the degree of compactness or quality standards and the work specification standards for construction and maintenance. It is also worth listing prohibited species and varieties in the catalogue, e.g., culturally alien native species (e.g., bog pine, common juniper) or forms (e.g., prohibition of stem-grafted forms).
- Planting of trees where possible, subject to conservation approval, and subsequent monitoring of their condition.
- Once a survey has been conducted, an identification of building walls that can be greened (local development plans allow this).
- Conducting a broad educational campaign, drawing the attention of residents and managers of heritage areas to the problem of the urban heat island effect and driving rain, together with a set of simple design solutions to help offset the negative effects of these phenomena. Solutions should also gain the approval or opinion of conservation services.
- Educating and supporting local communities with a strong sense of place, working towards the preservation and establishment of green spaces, creating a municipal system of financial incentives to support such projects, e.g., partial tax exemption.

8. Conclusions

The Florence Charter states that the protection of historical gardens depends on their investigation and identification [52]. This is also what this work aimed to do. The discussion presented here applies to most of the unique, attractive and therefore protected historical towns of medieval origin, which are compact and subject to a greenery deficit. The resulting problems and potential solutions that can be used in other settings were shown here. Only close supervision and constant monitoring provide a chance for the greenery to last, co-creating a unique cultural landscape, and with a systematic policy of direction, measures to increase its area are implemented.

The key finding of this research is that various urbanisation processes, including development pressure, have led to the loss of green areas in the study area of Krakow. Comparative studies of changes in the structure of green areas in the Kazimierz and

Stradom areas showed a loss of 10,594 ha, or 28.78%, over 32 years (Table 3). However, despite the significant decrease in biologically active areas, it was shown that the study area has the potential to mitigate climate change through the implementation of various types of green infrastructure (Table 5).

At this stage of analysis, the present study should be considered exploratory. It will be further developed in terms of the content, research procedure, types of data used and in terms of consideration of research through design [112], which is essential in light of climate change. In further stages, the study will be developed based on analyses of selected detailed areas, at a scale that will allow GI design solutions to be presented in terms of their natural (vegetation and biodiversity enhancement), social and economic values (Table 5). The detailed analyses will also allow an accurate assessment of the potential for using vertical surfaces (walls and facades) and roofs to increase green and bioactive areas.

For a broader interpretation of the research results and the possibility of adapting the presented research method to similar sites, the model can be implemented in terms of structure (Figure 1). Limitations may arise from the availability of historical and contemporary data sources (their existence) and the existing legal systems for planning and protection of cultural heritage in Poland; therefore, there is no direct translation for foreign historical areas. Further planned analyses of selected case studies, both local (Poland) and international, will allow for a more general conclusion and improve the method of analysis in terms of its universality.

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References

1. European Environment Agency. *Who Benefits from Nature in Cities? Social Inequalities in Access to Urban Green and Blue Spaces across Europe*; EEA Briefing no. 15/2021; European Environment Agency: Copenhagen, Denmark, 2022. [CrossRef]
2. How Greens Are the Cities. Available online: https://www.hugsi.green/city/?Krakow (accessed on 30 May 2023).
3. Bazrafshan, M.; Tabrizi, A.M.; Bauer, N.; Kienast, F. Place attachment through interaction with urban parks: A cross-cultural study. *Urban For. Urban Green.* **2021**, *61*, 127103. [CrossRef]
4. Witwicki, M.T. Kryteria oceny wartości zabytkowej obiektów architektury jako podstawa wpisu do rejestru zabytków. *Ochr. Zabyt.* **2007**, *1*, 77–98.
5. Zachariasz, A.; Jopek, D.; Kochel, L. Structure of areas of greenery within Cracow's city blocks: Historical transitions and contemporary development in the context of adaptation to climate change. *J. Herit. Conserv.* **2021**, *68S*, 137–148. [CrossRef]
6. Murzyn-Kupisz, M. *Kazimierz: The Central European Experience of Urban Regeneration*; International Cultural Centre: Kraków, Poland, 2006.
7. Kwiatek, A. Wątki żydowskie w fotografii ze zbiorów Muzeum Historycznego Miasta Krakowa. Część 3. Fotografie z okresu po II wojnie światowej. *Krzysztofory Zesz. Nauk. MHK* **2017**, *35*, 385–404. [CrossRef]
8. Zuziak, Z.K. Rewitalizacja miast i teoria urbanistyki. *Czas. Tech.* **2012**, *12*, 1–12.
9. Dąbrowski, J. (Ed.) *Kraków Studia nad Rozwojem Miasta*; Wydawnictwo Literackie: Kraków, Poland, 1957.
10. Wyrozumski, J. (Ed.) *Kraków: Nowe Studia nad Rozwojem Miasta*; Towarzystwo Miłośników Historii i Zabytków Krakowa: Kraków, Poland, 2007.

11. Wyrozumski, J. *Dzieje Krakowa I. Kraków do Schyłku Wieków Średnich*; Wydawnictwo Literackie: Kraków, Poland, 1992.
12. Bieniarzówna, J.; Małecki, J.M. *Dzieje Krakowa. T.II. Kraków w Wiekach XVI-XVIII*; Wydawnictwo Literackie: Kraków, Poland, 1984.
13. Bieniarzówna, J.; Małecki, J.M. *Dzieje Krakowa. T.III. Kraków w Latach 1796–1918*; Wydawnictwo Literackie: Kraków, Poland, 1979.
14. Bieniarzówna, J.; Małecki, J.M.; Mitkowski, J.; Wyrozumski, J. (Eds.) *Dzieje Krakowa: Kraków w Latach 1918–1939*; Wydawnictwo Literackie: Kraków, Poland, 1997.
15. Bogdanowski, J. Miejskie standardy krajobrazowe krakowskiego Kazimierza. *Teki Krak.* **1995**, *II*, 3–30.
16. Bogdanowski, J. *Problemy Metodologiczne Rewaloryzacji Urbanistyczno-Krajobrazowej Miasta Zabytkowego na Przykładzie Krakowskiego Kazimierza*; Wydawnictwo PKZ: Warszawa, Poland, 1985.
17. Kostof, S. *The City Shaped: Urban Patterns and Meanings Through History*, 2nd ed.; Thames & Hudson: London, UK, 1999.
18. Carter, F.W. *Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795*; Cambridge University Press: Cambridge, UK, 1994.
19. Krasnowolski, B. *Ulice i Place Krakowskiego Kazimierza*; TAiWPN Universitas: Kraków, Poland, 1992.
20. Krasnowolski, B. *Krakowski Kazimierz: Historia i Kultura*; Księgarnia Akademicka: Kraków, Poland, 2022.
21. Krasnowolski, B. *Lokacyjne Układy Urbanistyczne na Obszarze Ziemi Krakowskiej w XIII i XIV Wieku*; Akademia Pedagogiczna w Krakowie: Kraków, Poland, 2004; Volume 1–2.
22. Odlanicki-Poczobutt, M. (Ed.) *Catalogue of Old Large-Scale Maps of Cracow 16th–19th Centuries*; PWN: Warszawa, Poland; Kraków, Poland, 1981.
23. Zbiory Archiwum Narodowego w Krakowie. Available online: https://ank.gov.pl/o-archiwum/ (accessed on 10 January 2023).
24. Banach, J. *Kraków Malowniczy*; Wydawnictwo Literackie: Kraków, Poland, 1980.
25. Banach, J. *Dawne Widoki Krakowa*; Wydawnictwo Literackie: Kraków, Poland, 1983.
26. *Album Fotografii Dawnego Krakowa z Atelier Ignacego Kriegera*; Krajowa Agencja Wydawnicza: Kraków, Poland, 1989.
27. Dąbrowska-Budziło, K. *Wśród Panoram Krakowa. O Przemianach Widoków i o Tym, Jak Je Ocalić*; Wydawnictwo Literackie: Kraków, Poland, 1990.
28. Forczek-Brataniec, U. Assessment of Visual Values as a Tool Supporting the Design Decisions of the Cultural Park Protection Plan: The Case of Kazimierz and Stradom in Kraków. *Sustainability* **2021**, *13*, 6990. [CrossRef]
29. Marek, M. *Cracovia 3D. Digital Reconstructions of the Historical Built-Up Areas of Kraków*; Muzeum Historyczne Miasta Krakowa: Kraków, Poland, 2011.
30. Muzeum Krakowa. *Cracovia Iudaeorum 3D*; Muzeum Historyczne Miasta Krakowa: Kraków, Poland, 2013.
31. Zuziak, Z.K. *Strategie Rewitalizacji Przestrzeni Śródmiejskiej*; Wyd. Politechniki Krakowskiej: Kraków, Poland, 1998.
32. Gaczoł, A. *Kraków. Ochrona Zabytkowego Miasta. Rzeczywistość czy Fikcja*; Wydawnictwo WAM: Kraków, Poland, 2009.
33. Catalogues and Documentation Inventories in Archive Collection, Archiwum Wojewódzkiego Małopolskiego Konserwatora Zabytków, Archives of the Malopolska Province Conservator of Monuments, Kraków, Kanonicza St. Available online: https://www.wuoz.malopolska.pl/archiwum/ (accessed on 16 March 2023).
34. Krasnowolski, B.; Kraków, K.M. Kazimierz ze Stradomiem i Łąką Św. Sebastiana. Studium Historyczno-Urbanistyczne i Urbanistyczno-Konserwatorskie. Kraków, Poland, 1984, Archives of the Malopolska Province Conservator of Monuments, Kraków. *unpublished*.
35. Uruska-Suszek, D.; Fabijanowska, K.; Zachariasz, A. *Katalog Zabytkowych Założeń Zielonych Miasta Krakowa*; Archives of the Malopolska Province Conservator of Monuments, Kraków; Ogrody Śródblokowe Kazimierza i Stradomia: Kraków, Poland, 1991.
36. Kierunki Rozwoju i Zarządzania Terenami Zieleni w Krakowie na Lata 2017–2030, UMK Kraków 2019. Available online: https://www.bip.krakow.pl/?dok_id=115410 (accessed on 15 December 2022).
37. Muras, P. *Standardy Zakładania i Pielęgnacji Podstawowych Rodzajów Terenów Zieleni w Krakowie na Lata 2017–2030*; Annex III, to the Document [36]; UMK: Kraków, Poland, 2016. Available online: https://zzm.krakow.pl/images/pliki/KRiZTZ/12_E_251069_0_zal5_aneks_III_standardy_zakladania_pielegnacji_zieleni.pdf (accessed on 20 December 2022).
38. Malecki, B. *Plantacje, Ogrody i Urządzenia Ogrodowe Miejskie w Krakowie*; Gmina Miasta Krakowa: Kraków, Poland, 1907.
39. Gauze, A. Kraków w zieleni. *Ogrodnictwo* **1931**, *6*, 166–181.
40. Stępniewska, B. *Ogrody Krakowa*; Wydawnictwo Literackie: Kraków, Poland, 1977.
41. Zachariasz, A. *Zielony Kraków: Dla Przyjemności i Pożytku Szanownej Publiczności*; Wyd. Politechniki Krakowskiej: Kraków, Poland, 2019.
42. Martínez Pino, J. The New Holistic Paradigm and the Sustainability of Historic Cities in Spain: An Approach Based on the World Heritage Cities. *Sustainability* **2018**, *10*, 2301. [CrossRef]
43. Hosseini, F.; Sajadzadeh, H.; Aram, F.; Mosavi, A. The Impact of Local Green Spaces of Historically and Culturally Valuable Residential Areas on Place Attachment. *Land* **2021**, *10*, 351. [CrossRef]
44. Azpeitia Santander, A.; Azkarate Garai-Olaun, A.; De la Fuente Arana, A. Historic Urban Landscapes: A Review on Trends and Methodologies in the Urban Context of the 21st Century. *Sustainability* **2018**, *10*, 2603. [CrossRef]
45. Lam, E.W.M.; Zhang, F.; Ho, J.K.C. Effectiveness and Advancements of Heritage Revitalizations on Community Planning: Case Studies in Hong Kong. *Buildings* **2022**, *12*, 1065. [CrossRef]
46. Smagacz, M. *The Revitalization of Urban Space: Social Changes in Krakow's Kazimierz and the Ticinese District in Milan*; Plus-Pisa University Press: Pisa, Italy, 2008.
47. Konior, A.; Pokojska, W. Management of Postindustrial Heritage in Urban Revitalization Processes. *Sustainability* **2020**, *12*, 5034. [CrossRef]

48. Colette, A.; Cassar, M.; World Heritage Committee. *Climate Change and World Heritage Report on Predicting and Managing the Impacts of Climate Change on World Heritage and Strategy to Assist States Parties to Implement Appropriate Management Responses*; World Heritage Reports 22; UNESCO World Heritage Centre: Paris, France, 2007.
49. Case Studies on Climate Change and World Heritage. 2007. Available online: https://whc.unesco.org/enpino/activities/473/ (accessed on 30 January 2023).
50. Fior, M. Adaptive Urban Design to Cope with Heavy Rainfall in the Historic Centre: A Masterplan for Ferrara (Italy). *J. Urban. Int. Res. Placemaking Urban Sustain.* 2022. Available online: https://www.tandfonline.com/doi/full/10.1080/17549175.2022.2108113 (accessed on 15 March 2023).
51. Sangiorgio, V.; Bruno, S.; Fiorito, F. Comparative Analysis and Mitigation Strategy for the Urban Heat Island Intensity in Bari (Italy) and in Other Six European Cities. *Climate* **2022**, *10*, 177. [CrossRef]
52. ICOMOS-IFLA. Historic Gardens—The Florence Charter. 1981. Available online: https://www.icomos.org/images/DOCUMENTS/Charters/gardens_e.pdf (accessed on 11 April 2023).
53. Jagiełło, M. Do We Need a New Florence Charter? The Importance of Authenticity for the Maintenance of Historic Gardens and Other Historic Greenery Layouts in the Context of Source Research (Past) and Taking into Account the Implementation of the Sustainable Development Idea (Future). *Sustainability* **2021**, *13*, 4900. [CrossRef]
54. Bogdanowski, J. *Polskie Ogrody Ozdobne. Historia i Problemy Rewaloryzacji*; Arkady: Warszawa, Poland, 2000.
55. Majdecki, L.; Majdecka-Strzeżek, A. *Ochrona i Konserwacja Zabytkowych Założeń Ogrodowych*; PWN: Warszawa, Poland, 2019.
56. Mosser, M.; Teyssot, G. (Eds.) *The Architecture of Western Gardens: A Design History from the Renaissance to the Present Day*; The MIT Press: Cambridge, MA, USA, 1991.
57. Báthoryné, R.I.N.; Valánszki, I. Green Infrastructure as Heritage, Planning with Landscape: Green Infrastructure to Build Climate-Adapted Cities Chapter: 10 Publisher: Springer Nature Switzerland, Landscape Series Book Series (LAEC, 2023, vol. 35). Available online: https://link.springer.com/chapter/10.1007/978-3-031-18332-4_10 (accessed on 12 May 2023).
58. Liquete, C.; Kleeschulte, S.; Dige, G.; Maes, J.; Grizzetti, B.; Olah, B.; Zulian, G. Mapping green infrastructure based on ecosystem services and ecological networks: A Pan-European case study. *Environ. Sci. Policy* **2015**, *54*, 268–280. [CrossRef]
59. Madureira, H.; Andresen, T. Planning for multifunctional urban green infrastructures: Promises and challenges. *Urban Des.* **2013**, *19*, 38–49. [CrossRef]
60. Kristianova, K.; Stepankova, R. Green Infrastructure of Historic City Cores—Case Studies from Slovakia. In Proceedings of the 15th International Multidisciplinary Scientific Geoconference SGEM 2015, Albena, Bulgaria, 18–24 June 2015; pp. 437–444.
61. Hansen, R.; Olafsson, A.S.; van der Jagt, A.P.N.; Rall, E.L.; Pauleit, S. Planning multifunctional green infrastructure for compact cities: What is the state of practice? *Ecol. Indic.* **2019**, *96*, 99–110. [CrossRef]
62. Hansen, R.; Pauleit, S. Planning Multifunctional Urban Green Infrastructure for Compact Cities in Europe. In *Making Green Cities Concepts, Challenges and Practice*; Breuste, J., Artmann, M., Ioja, C., Qureshi, S., Eds.; Springer International Publishing: Cham, Switzerland, 2023; Cities and Nature (CITIES). [CrossRef]
63. Lin, B.; Meyers, J.; Barnett, G. Understanding the potential loss and inequities of green space distribution with urban densification. *Urban For. Urban Green.* **2015**, *14*, 952–958. [CrossRef]
64. Wong, N.-H.; Chen, Y. The Role of Urban Gnarodreenery in High-Density cities. In *Designing High-Density Cities for Social and Environmental Sustainability*; Earthscan: Sterling, VA, USA; London, UK, 2010.
65. Giannico, V.; Spano, G.; Elia, M.; D'Este, M.; Sanesi, G.; Lafortezza, R. Green spaces, quality of life, and citizen perception in European cities. *Environ. Res.* **2021**, *196*, 110922. [CrossRef]
66. Tratalos, J.; Fuller, R.A.; Warren, P.H.; Davies, R.G.; Gaston, K.J. Urban form, biodiversity potential and ecosystem services. *Landsc. Urban Plan.* **2007**, *83*, 308–317. [CrossRef]
67. Coombes, M.A.; Viles, H.A. Integrating nature-based solutions and the conservation of urban built heritage: Challenges, opportunities, and prospects. *Urban For. Urban Green.* **2021**, *63*, 127192. [CrossRef]
68. Nocca, F. The Role of Cultural Heritage in Sustainable Development: Multidimensional Indicators as Decision-Making Tool. *Sustainability* **2017**, *9*, 1882. [CrossRef]
69. Albert, M.-A.; Bernecker, R.; Cave, C.; Prodan, A.C.; Ripp, M. 50 Years World Heritage Convention: Shared Responsibility—Conflict & Reconsiliation, Heritage Studies (HEST). 2022. Available online: https://link.springer.com/book/10.1007/978-3-031-05660-4 (accessed on 23 February 2023).
70. UNESCO. Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris. 16.12.1972. Available online: http://portal.unesco.org/en/ev.php-URL_ID=13055&URL_DO=DO_TOPIC&URL_SECTION=201.html (accessed on 3 June 2023).
71. Zbiory Muzeum Krakowa. Available online: https://muzeumkrakowa.pl/zbiory (accessed on 24 March 2023).
72. Narodowy Instytut Dziedzictwa; There Is also a Collection of Records of Historic Gardens. Available online: https://mapy.zabytek.gov.pl/nid/ (accessed on 23 January 2023).
73. Miejscowy Plan Zagospodarowania Przestrzennego Obszaru "Stradom". Uchwała nr XCIII/2443/18 Rady Miasta Krakowa (24.01.2018). Available online: https://www.bip.krakow.pl/?dok_id=95056 (accessed on 30 January 2023).
74. Miejscowy Plan Zagospodarowania Przestrzennego "Obszaru Kazimierz". Uchwała nr LXXXVIII/2145/17 Rady Miasta Krakowa (8.11.2017). Available online: https://www.bip.krakow.pl/?dok_id=92971 (accessed on 30 January 2023).
75. Miejscowy Plan Zagospodarowania Przestrzennego Obszaru "Bulwary Wisły". Uchwała nr LXXXI/1240/13 Rady Miasta Krakowa (11.09.2013). Available online: https://www.bip.krakow.pl/?dok_id=58413 (accessed on 30 January 2023).

76. Plan Ochrony Parku Kulturowego Kazimierz ze Stradomiem, Uchwała nr LXXXIII/2369/22 Rady Miasta Krakowa (27.04.2022). Available online: http://edziennik.malopolska.uw.gov.pl/legalact/2022/3267/ (accessed on 30 January 2023).
77. Prognoza Oddziaływania na Środowisko. Document Prepared for Miejscowy Plan Zagospodarowania Przestrzennego Obszaru "Kazimierz". Biuro Planowania Przestrzennego Kraków. 2017. Available online: https://www.bip.krakow.pl/?dok_id=92971 (accessed on 30 January 2023).
78. Rubaszek, J.; Gubański, J.; Podolska, A. Do We Need Public Green Spaces Accessibility Standards for the Sustainable Development of Urban Settlements? The Evidence from Wrocław, Poland. *Int. J. Environ. Res. Public Health* **2023**, *20*, 3067. [CrossRef]
79. Braun, G.; Hogenberg, F. Civitates Orbis Terrarum, Theatri Praecipuarum Totus Mundi Urbium; volume 6, plate 46, Köln 1617. Available online: https://commons.wikimedia.org/wiki/File:Cracovia-lobzovia.jpg (accessed on 30 May 2023).
80. D'Avity, P.; Gottfied, J.L. *Neuwe Archontologia Cosmica. . .*; Wolffgang Hoffmans: Frankfurt, Germany, 1638.
81. Rejduch-Samkowa, I.; Samek, J. (Eds.) *Katalog Zabytków Sztuki. Kazimierz i Stradom, Kościoły i Klasztory. 1. T. IV Miasto Kraków*; Polska Akademia Nauk. Instytut Sztuki: Warszawa, Poland, 1987.
82. Festungs Umgebungs Plan von Krakau. Available online: http://maps.mapywig.org/m/K.u.K._maps/series/010K_Festungs-Umgebungsplan_von_KRAKAU/FESTUNGS-UMGEBUNGS-PLAN_VON_KRAKAU_10K_BL_21_KRAKAU_1900_LoC_G6524.K7A1_s10_.A9.jpg (accessed on 12 May 2023).
83. Narodowe Archiwum Cyfrowe. Available online: https://www.nac.gov.pl/ (accessed on 20 November 2022).
84. Lubocka-Hoffmann, M. Retrowersja—Konserwatorska Metoda Odbudowy Miasta Historycznego. In *Problemy Zarządzania Dziedzictwem Kulturowym*; Gutowska, K., Ed.; Res Publica: Warszawa, Poland, 2000; pp. 192–209.
85. Modernizacja Torowisk Tramwajowych Wraz z Infrastrukturą Towarzyszącą, Projekt UE 2014-2020. Available online: https://zdmk.krakow.pl/dzialania/program-modernizacji-torowisk/program-modernizacji-torowisk-przebudowa-ul-krakowskiej/ (accessed on 12 April 2022).
86. Rostafiński, J. (Ed.) *Przewodnik po Krakowie i Okolicy*; Drukarnia UJ: Kraków, Poland, 1891; p. 170.
87. Rympel, M. Słowo o Żydach Krakowskich w Okresie Międzywojennym (1918–1939). In *Kopiec Wspomnień*; Wydawnictwo Literackie: Kraków, Poland, 1964; p. 583.
88. Rejestr Zabytków. The Register of Monuments. Available online: https://www.wuoz.malopolska.pl/ (accessed on 10 March 2023).
89. Michałowski, A.; Sulimierska, A.; Wendlandt, J.; Zwiech, T.; Kamińska, K. (Eds.) *Parki i Ogrody Zabytkowe w Polsce—Stan 1991 Rok*; KOBIDZ: Warszawa, Poland, 1992.
90. Ustawa o Ochronie Zabytków i Opiece Nad Zabytkami (23.07.2003). Dz.U. 2022 poz. 840. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu20031621568 (accessed on 15 December 2022).
91. Ustawa o Planowaniu i Zagospodarowaniu Przestrzennym (27.03.2003). Dz.U. 2003 Nr 80 poz. 717. Available online: https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20030800717/U/D20030717Lj.pdf (accessed on 18 May 2023).
92. Molski, P. Waloryzacja dziedzictwa architektonicznego w systemie ochrony zabytków. In *Systemy Ochrony Zabytków w Polsce—Analiza, Diagnoza, Propozycje*; Szmygin, B., Ed.; Polski Komitet Narodowy ICOMOS: Warszawa/Lublin, Poland, 2011; p. 56.
93. Łasocha, M. Protection of Cultural Values in Local Spatial Plans Based on The Example of Kazimierz in Krakow. *Teka Kom. Urban. I Archit. Oddział PAN W Krakowie* **2021**, *XLIX*, 32–46. [CrossRef]
94. Uchwała Krajobrazowa—Zasady i Warunki Sytuowania Obiektów Małej Architektury, Tablic Reklamowych i Urządzeń Reklamowych Oraz Ogrodzeń, Uchwala nr XXXVI/908/20 Rady Miasta Krakowa (26.02.2020). Available online: https://www.bip.krakow.pl/?dok_id=128261 (accessed on 30 May 2023).
95. Mitkowska, A.; Fabijanowska, K.; Uruska-Suszek, D.; Zachariasz, A.; Tor, K. Model postępowania konserwatorskiego dla zdewastowanych założeń ogrodowych przejmowanych przez Agencję Rynku Rolnego Skarbu Państwa. *Stud. Mater. Ogrody* **1994**, *2*, 1–56.
96. Stachańczyk, R. Problematyka standardów w postępowaniu i dokumentacji konserwatorskiej na potrze-by rewaloryzacji zabytkowych parków i ogrodów. *Kur. Konserw.* **2010**, *7*, 7–50.
97. Liao, W.; Guldman, J.-M.; Hu, L.; Li, X. Linking urban park cool island effects to the landscape patterns inside and outside the park: A simultaneous equation modeling approach. *Landsc. Urban Plan.* **2023**, *232*, 104681. [CrossRef]
98. Rozporządzenie Ministra Infrastruktury w Sprawie Warunków Technicznych, Jakim Powinny Odpowiadać Budynki i Ich Usytuowanie. Dz.U. 2022 poz. 1225. Available online: https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20190001065/O/D20191065.pdf (accessed on 24 April 2023).
99. Bokwa, A. *Wieloletnie Zmiany Struktury Mezoklimatu Miasta na Przykładzie Krakowa*; Inst. Geografii I Gospodarki Przestrzennej UJ: Kraków, Poland, 2010. Available online: https://ruj.uj.edu.pl/xmlui/bitstream/handle/item/85976/bokwa_wieloletnie_zmiany_struktury_mezoklimatu_2010.pdf?sequence=1&isAllowed=y (accessed on 30 May 2023).
100. Meteoblue, Kraków. Available online: https://www.meteoblue.com/pl/pogoda/prognoza/meteogramweb/krak%c3%b3w_polska_3094802 (accessed on 23 April 2023).
101. Plan Adaptacji Miasta Krakowa do Zmian Klimatu do Roku 2030 (MPA), UM Kraków. Available online: https://www.bip.krakow.pl/?dok_id=114317 (accessed on 20 March 2023).
102. Edycja Budżet Obywatelski. Posadźmy Drzewa na Rynku Głównym. 2022. Available online: https://budzet.krakow.pl/projekty2022/4410-posadzmy_drzewa_na_rynku_glownym_.html (accessed on 30 April 2023).
103. Edycja Budżet Obywatelski. Drzewa na Place. 2023. Available online: https://budzet.krakow.pl/projekty2023/5400-drzewa_na_place_.html (accessed on 30 April 2023).

104. Russo, A.; Cirella, G.T. Modern Compact Cities: How Much Greenery Do We Need? *Int. J. Environ. Res. Public Health* **2018**, *15*, 2180. [CrossRef]
105. Almeida-García, F.; Cortés-Macías, R.; Parzych, K. Tourism Impacts, Tourism-Phobia and Gentrification in Historic Centers: The Cases of Málaga (Spain) and Gdansk (Poland). *Sustainability* **2021**, *13*, 408. [CrossRef]
106. Kruczek, Z. Turyści vs. mieszkańcy. Wpływ nadmiernej frekwencji turystów na proces gentryfikacji miast historycznych na przykładzie Krakowa (Tourists vs. residents. Influence of excessive tourist flow in the process of historical cities gentrification: The case of Krakow). *Tur. Kult.* **2018**, *3*, 29–39.
107. Tracz, M.; Semczuk, M. Wpływ turystyki na zmianę funkcji przestrzeni miejskiej na przykładzie Krakowa. *Biul. PAN KPZK* **2018**, *272*, 272–284.
108. García-Hernández, M.; De la Calle-Vaquero, M.; Yubero, C. Cultural Heritage and Urban Tourism: Historic City Centres under Pressure. *Sustainability* **2017**, *9*, 1346. [CrossRef]
109. Menezes-Silva, P.E.; Loram-Lourenço, L.; Alves, R.D.F.B.; Sousa, L.F.; Almeida, S.E.D.S.; Farnese, F.S. Different ways to die in a changing world: Consequences of climate change for tree species performance and through an ecophysiological perspective. *Ecol. Evol.* **2019**, *9*, 11979–11999. [CrossRef]
110. Kazimierz się Wyludnia? Zobaczcie jak Zapuszczona Była Kiedyś ta Dzielnica (Film). Available online: https://lifeinkrakow.pl/w-miescie/6053,kazimierz-sie-wyludnia-zobaczcie-jak-zapuszczona-byla-kiedys-ta-dzielnica-film (accessed on 23 April 2023).
111. Gazeta Krakowska. Available online: https://gazetakrakowska.pl/krakow-wygonil-nas-stamtad-halas-urzednicy-i-radni-glowia-sie-jak-przywrocic-wyludniajacy-sie-kazimierz-mieszkancom/ar/c1-17290879 (accessed on 23 April 2023).
112. Lenzholzer, S.; Duchhart, I.; Koh, J. Research through designing' in landscape architecture. *Landsc. Urban Plan.* **2013**, *113*, 120–127. [CrossRef]