

FEATURES OF VISUAL PERCEPTION OF THE HISTORICAL ENVIRONMENT OF THE DESYATYNNA CHURCH IN KYIV

   
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Abstract. Landscape, especially urban landscape, contributes to the formation of a sense of place. The identification of the perception characteristics of the historical image of Kyiv city, based on visual landscape research, was conducted with the aim of establishing visual connections and areas between sacred structures in the complex relief conditions of the Starokyivska Hill. The study applied methods for determining the quantitative indicators of spatial-visual characteristics of the studied locality based on a planned route survey. The parameters of the main selected points were determined by depth of visibility, horizontal viewing angle, presence of focal points, accents, types of perspectives, and types of space. Through visual landscape research, the dynamics of visual connections and areas between elements in the historical landscape of Kyiv were identified. The absence of changes in the spatial-visual characteristics was established at three selected points, while changes were found in others. Specifically, the changes are characterized by a decrease in the depth of visibility along the visual axis between the Desyatynna Church and the St. Andrew's Church. The need to search for ways to model the outline of the landscape in the complex relief conditions of the Starokyivska Hill is revealed for the perspective of preserving the historical image and improving spatial solutions in the urban environment.

Keywords: historical landscape, depth of visibility, horizontal viewing angle, landscape outline modeling

Introduction

The landscape plays a crucial role in the quality of urban life, as people identify with it, and landscapes contribute to a sense of place. Landscapes and people are dynamic, and over time, new elements emerge that overlay traditional landscapes, changing both the overall character of the locality and people's attitudes towards them [34]. Visual landscape studies are significant for landscape and urban planning, encompassing approaches to landscape perception, exploring its openness, and analyzing the vertical building density concerning the historic urban landscape [19].

Research strategy in landscape architecture should be based on obtaining quantitative and qualitative data to shape the formal composition that envisions the spatial possibilities of the landscape. The landscape's form is an expression of its organization and the result of its development process. Spatial design is considered a form of investigation that relates to other traditional research methods, particularly in landscape architectural design processes. Research and design mechanisms blend with imagination, creativity, and innovation. Unique spatial solutions can be achieved through specific problem characteristics, space, and time [17; 18]. Methods for describing and analyzing the built urban environment as a search for spatially optimal artificial environments should be based on the conservation-optimization hypothesis, which establishes the conceptual basis for progressive and regressive urban planning practices [11].

The description of spatial-visual landscape design includes four main categories [9]: sequence (visual perception during movement through the landscape), orientation (creating focal points to establish a sense of direction), continuity (formed through the openness of space, permeability of edges, and provision of multi-dimensionality), and complexity (perceiving complex environments through variations in texture, form, patterns, and colors). Dai, Maruthaveeran, Shahidan, Chu [4] noted a lack of information regarding landscape perception and preferences among urban dwellers in historical areas. The analysis of the historical urban space demonstrates the need to stabilize the topometric characteristics of urban planning in relation to the human scale. There should be spa-

tial and social logic in the physical and spatial characteristics of open green spaces [10; 28].

Starokyivska Hill contains numerous archaeological findings and traces. Currently, studies of such significant architectural landmarks are considered separately, without a broad historical and environmental approach. Insufficient attention is given to the interconnections with other temples and urban development in a unified complex as components of the gradually formed historical center of Kyiv [24].

The objective of this research is to establish visual connections and areas between historical elements of Kyiv in the complex terrain to identify the specifics of city image perception, locate viewing points, and reveal panoramic views of the landscape while considering modern developments and existing plantings. The inevitable dynamism of the landscape requires planning to explain emerging changes and the ability to consider them, as the contemporary landscape system should be seen as the result of past processes and a basis for future changes [7].

The tasks of this research are to identify landscape changes in the historical areas of Kyiv around Starokyivska Hill, conduct monitoring of contemporary development and existing plantings to find a balance between open spaces and sufficient green areas for the preservation of visual connections between elements of the city.

The scientific novelty of the research lies in obtaining data related to the spatial changes in the historical center of Kyiv city based on monitoring the impact of landscape changes on its openness. This includes conducting quantitative measurements and further preserving and organizing the visual spatial connections between city elements.

Materials and Methods

There are several methods of visual landscape analysis based on its transformations, each serving different purposes: 1) studying the characteristics of landscape visual perception; 2) monitoring the current state of landscape space; 3) monitoring the impact of changes in landscape openness in urban areas; 4) methods for assessing spatial changes in landscape quality in urban planning.

Visual perception physiology refers to the processes and

mechanisms of vision, light perception, and its limitations. Humans have an almost 120-degree horizontal binocular field of vision directed forward, allowing depth perception. Image recognition is concentrated in the central field of vision, covering approximately 20-60 degrees. The range of clear vision depends on the observer's position and line of sight, with the critical depth of clear vision being 1200-1400 meters [19].

Landscape modeling depends on identifying the relationships between visual focal points that form the perception of a unified historical space. Research on visual connections between landscape attributes and preferences is conducted based on the analysis of landscape images generated by processing real-world photographs to create types of visual openness, richness of compositional elements, organization regularity, and depth of view while maintaining other attributes constant [35].

To analyze changes in visual connections over different historical periods, a description and mapping of a series of spatial data layers considering landscape transformation were conducted. Historical topographic maps and orthophoto plans from various periods allow analyzing the temporal depth and stability of the landscape by defining visual areas and axes [26; 32]. For graphical construction of landscape images, profiles, and pedestrian route plans, the software package ArchiCAD 2021 by Graphisoft was used [6].

The field of view method is based on measuring view fields and mapping sightlines from the observer's position in the landscape. View zones represent areas visible from a given position [3; 19]. The measurement of landscape openness involves the following stages [34]: 1) choosing a survey route; 2) plotting topographic data and creating contour line diagrams; 3) defining visual limitations (viewing depth); 4) determining boundaries of visible space. Viewpoints along the route are characterized according to Sydorenko & Minder [27]: by the horizontal angle of view (prospective - up to 30 degrees, sector - 30-60 degrees, diorama - 60-120 degrees, panoramic - 120-240 degrees, circular - 240-360 degrees); by viewing depth (short - up to 50 meters, medium - 50-100 meters, distant - over 100 meters).

Results and Discussion

The uniqueness of Kyiv's cityscape and its panoramic perception are primarily characterized by the revelation of its unique natural landscape qualities and historical architecture. The subject of this research is the territory of Starokiyivska Hill, an area of historical significance located in the Shevchenkivskiy District of Kyiv. This plateau houses the remnants of the foundation of the Desyatynna Church, along with visual connections to surrounding sacred structures, which contribute to the identity of this locality. Currently, this area represents a hill with steep northern and moderate southern slopes, with height variations of approximately 65 meters.

Urbanization has rapidly transformed the image of Kyiv, leading to the replacement of natural environmental connections with artificial ones. During the time of Kyivan Rus, changes were relatively minor (Fig. 1). The city's topography had a rather rugged character with elevation differences reaching up to 100 meters. Sacred structures played a dominant role and were pivotal in shaping the cityscape [13].

During the analysis of the changes in visual areas and connections of the territory of the Desyatynna Church, it was found that before the beginning of the 20th century, there was a trend of increasing visual connections between these structures. At the turn of the 19th and 20th centuries, changes in the topography occurred through the filling of ravines and leveling of certain hills [1; 22]. From the second half of the

20th century, buildings were constructed in these areas that disrupted the integrity of the historical environment. Over time, the impact of urbanization increased to the point where the optimal relationships and connections between the natural landscape and architectural elements and visual connections between sacred structures have been disrupted.

Since the Desyatynna Church, St. Andrew's Church, and St. Michael's Golden-Domed Monastery are located in areas where new construction is not permitted and the height of surrounding buildings should not exceed 15 meters according to acceptable height regulations [20], most of the visual connections between them have been preserved (Fig. 1). However, there is an overlap of views in the area of visual connections due to new buildings and tree plantations.

The perception of the landscape is the result of the interaction between humans and the environment. The urban landscape is a common asset for local residents and guests [7]. The studied historical landscape should remain distinct, unique, and easily recognizable, which can be achieved through the identification, preservation, or restoration of axes and areas of visual connections.

According to data [15], the studied territories belong to monument protection zones, with the Desyatynna Church being an archaeological monument, St. Andrew's Church - a cultural heritage site, and others - historical monuments. Traditional landscapes with their ecological and cultural values are becoming highly fragmented and gradually losing their identity [2; 23]. Therefore, it is essential to study key visual concepts aimed at identifying violations, establishing consistency, considering historical context, visual scale, complexity, and naturalness [30].

According to normative documentation [25], in monument protection zones, it is necessary to preserve and restore valuable natural and landscape qualities, viewpoints, and areas that offer views of monuments and their complexes. Buildings, structures, and plantations that distort this landscape should be removed or visually neutralized.

In the process of shaping the urban environment, the historical layer becomes an integral part of the natural landscape, emphasizing cultural heritage and symbolism of the area [5; 31]. However, the conservation of the natural background remains equally important for the emotional effect [8]. Historical structures, as architectural dominants, become focal points that require consideration of the openness of spatial landmarks and the background natural environment in terms of texture, form, and color variations.

Integrated historical spaces play a significant role in urban planning as they act as reference points. They are more frequently visited and provide clear navigation [11]. The studied area is included in an excursion route, making panoramic views of the urban landscape particularly important. According to the forecast distribution of the average annual excursion flow of visitors to the Old Kyiv part of the city [21], the share of visitors from Kyiv is 20%. Therefore, this route is a crucial element of the city's tourist infrastructure and contributes to its identification.

The research on the spatial-visual qualities of the historical environment of the Desyatynna Church in Kyiv comprises four main stages according to Liu & Nijhuis [9]. The sequence of spatial perception is embedded in a survey route spanning 750 meters, starting from the central entrance, including remnants of the Desyatynna Church foundation, and offering a panoramic view of the city. Along the established route, six viewpoints have been selected (see Figure 2), with the main visual characteristics outlined in Table 1. Orientation, intended to guide movement, is represented by focal points, which

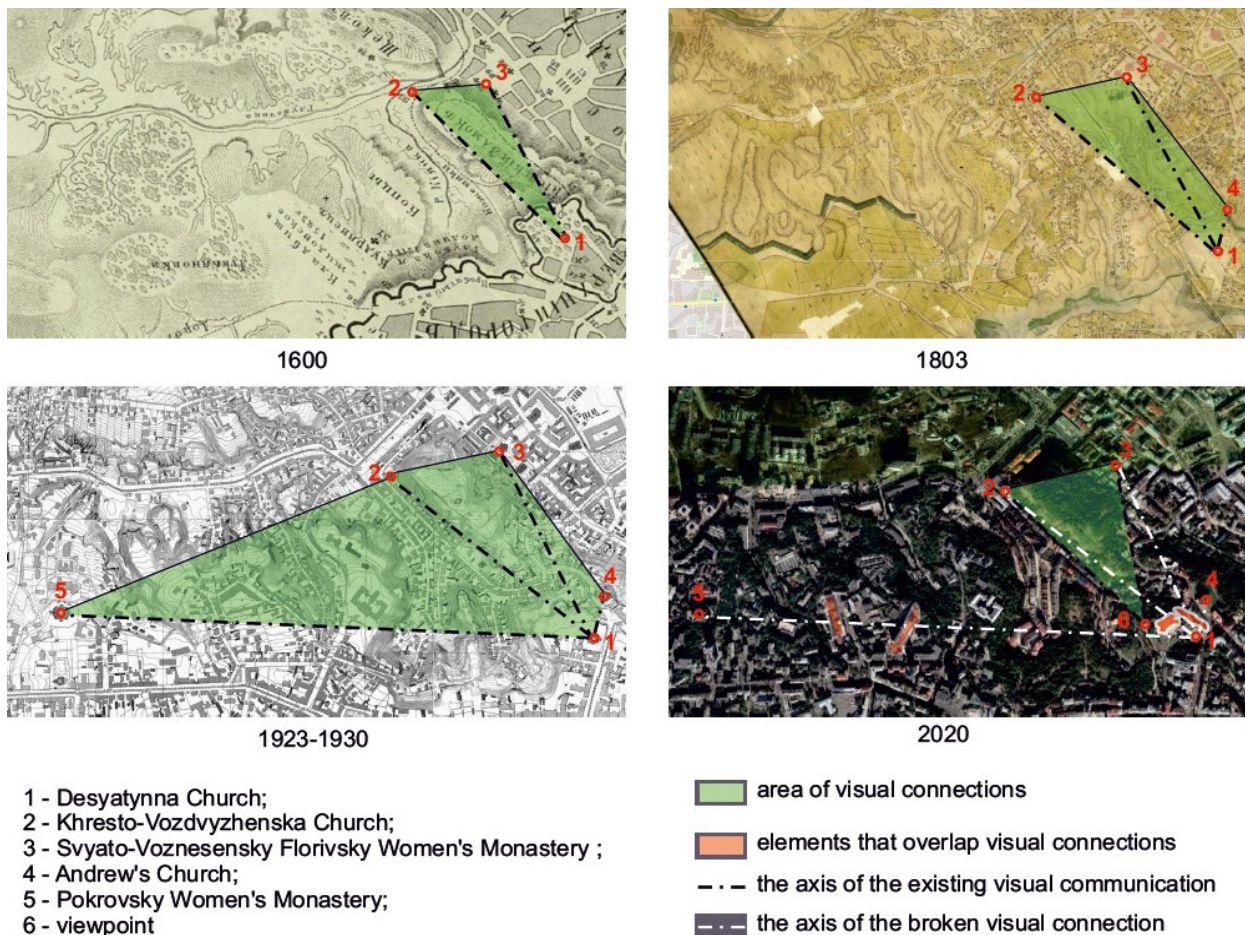


Fig. 1. Changes in visual areas and connections of the territory of the Desyatynna Church with other sacred structures (17th-21st centuries) [developed by the authors based on maps from the website <http://museum.kpi.ua/map>]

are sacred objects. The continuity of perception is based on an analysis of space types, viewing depths, horizontal viewing angles, and perspectives that characterize existing visual connections and areas (Table 1). The diversity of urban landscapes is considered based on the combination of landscape and architectural elements in the environment.

Viewpoints 1-4 represent urban perspectives directed towards the foundations of the Desyatynna Church and the elements of its approaches. Among them, viewpoint 4 stands out, where over the last 40 years, the visual connection with St. Andrew's Church has been almost completely lost. Additionally, the visual axis has reduced from 150 meters to 70 meters due to the growth of tree plantations on the northeastern slope, mainly dominated by the Norway maple (*Acer platanoides* L.) and the black locust (*Robinia pseudoacacia* L.) reaching a height of over 20 meters.

The specific locations of viewpoints 5 and 6 on elevated terrain allow for panoramic views towards the urban landscape. The most significant changes in the horizontal viewing angles are observed at viewpoints 5 and 6, situated on observation platforms of the upper and lower terraces of the Starokyivska Hill. The detected narrowing of the horizontal viewing angles (Table 1) occurred due to the growth of tree plantations on the slopes, leading to a transition from an open space to a semi-open space.

The most impressive viewpoint for observing the urban landscape along the investigated route is the panoramic observation point. The impact of changes in vegetation on the openness of the urban space on the upper terrace of the Starokyivska Hill is shown in Fig. 3.

Currently, there is a trend towards the disruption of the natu-

ral order in the urban environment due to the introduction of modern architectural elements, fragments of industrial landscapes, alteration of the natural lighting of the landscape, and changes in the ratio of natural and artificial elements [33]. A similar trend is observed at viewpoints 4, 5, and 6.

The current multi-perspective view of the landscape from the main viewpoint is illustrated in Fig. 4. Urbanized landscapes are dynamic, complex, multifunctional, and require continuous monitoring and inventory of landscape conditions [2]. The plantations on the slopes of the Starokyivska Hill are under the authority of the Communal Enterprise for Greenery Maintenance of the Podil District in Kyiv city. They cover an area of 2.74 hectares, of which 2.41 hectares (88%) are covered by tree plantations. There are 1200 trees and 1019 bushes. The dominant species among the trees are the Norway maple (78%) and the black locust (19%) with a smaller share of birch and apple trees. The condition of the plantations is mostly good. Among the bushes, decorative deciduous species account for 79%, while the rest are ornamental flowering plants.

When solving urban planning issues in areas with complex topography, there is a necessity to utilize both engineering and meliorative measures to address soil erosion problems [14]. The plantations created for this purpose on the studied hills with significant elevation differences do not disrupt visual connections in depth, enhancing the urban development situation (Fig. 5).

The overall panorama of the city should be characterized by landscapes with high openness and a well-organized balance of elements. The visual exposure significantly improves the landscape view with moderate openness [32; 35]. From view-

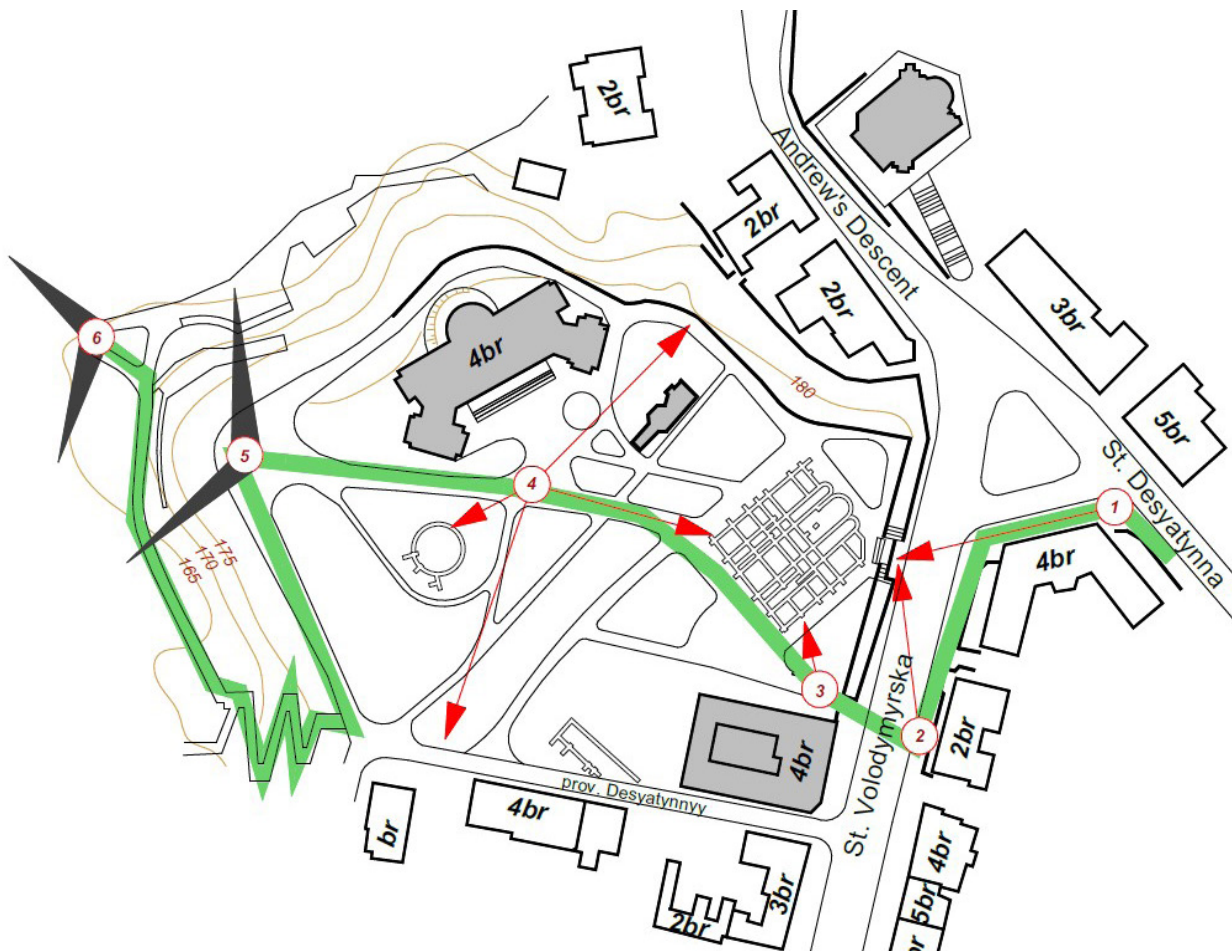


Fig. 2. Route Overview Scheme of the Desyatynna Church Territory [developed by the authors based on field surveys and topographic mapping of Kyiv city in a scale of 1:2000 (topographic maps)]

Table 1. Description of the parameters of the main viewpoints of the route

View-point Number	Depth of View, m	Horizontal Viewing Angle, degrees	Focal Points, Accents	Perspective View	Type of Space and Its Changes over the Last 40 Years
1	70 Medium	50 Sectorial	The central passage stairs to the foundations of the Desyatynna Church	Single-plane, urban interior	Open, no changes detected
2	50 Short	25 Perspective	The central passage stairs to the foundations of the Desyatynna Church	Single-plane, urban interior	Open, no changes detected
3	20 Short	90 Dioramic	The foundations of the Desyatynna Church	Single-plane, urban interior	Open, no changes detected
4	60 Medium	280 Circular	The foundations of the Desyatynna Church	Multi-plane, urban interior	Open, depth of view reduced by 80 m towards St. Andrew's Church
5	Over 700 Far	130 Panoramic	Svyato-Voznesensky Florivsky Women's Monastery, Khresto-Vozdvyzhenska Church	Multi-plane, urban interior	Semi-open, angle narrowed from 270° to 140°
6	Over 500 Far	110 Dioramic	Vozdvyzhenska outskirts	Multi-plane, urban interior	Semi-open, angle narrowed from 180° to 70°

[developed by the authors based on field surveys and topographic mapping of Kyiv city in a scale of 1:2000 (topographic maps)]

point 5, there are distant perspectives that establish visual connections with the buildings of the Svyato-Voznesensky Florivsky Women's Monastery at distances of 600 and 780 meters, as well as with the building of the Khresto-Vozdvyzhenska Church at a distance of 650 meters. However, it is noted that the current state of the green plantations on the slopes of the Starokyivska Hill hinders the exposure of a comprehensive panorama of the sacred cultural heritage structures. This issue has not been properly addressed yet, and there is a trend of further deterioration of visual connections, including those with the Pokrovsky Women's Monastery (Fig. 1), and a disruption of the balance between existing architectural and natural elements in the landscape.

At the same time, it remains essential to explore ways of developing the city that would define its architectural and compositional uniqueness in the historical part, considering the interplay of landscape and relief, including vegetation, as a three-dimensional shaping element [12]. Various methods for measuring 2D and 3D visibility of urban spaces exist to predict the visual impact of new constructions and plantations to address urban design problems, allowing the utilization of open spaces based on visibility characteristics [16]. In areas with complex topography, preserving panoramic views with distant perspectives can be achieved by modeling the outlines of the existing landscape using levelling or repetition techniques with the help of tree plantations [27]. It is important to select plants in such a way that mature plants, reaching their maximum height, do not disrupt historically valuable visual areas and connections. For example, to restore visual connection from viewpoint 4 to the Andriyivska Church on the slope with a height difference of 15 meters: in the upper

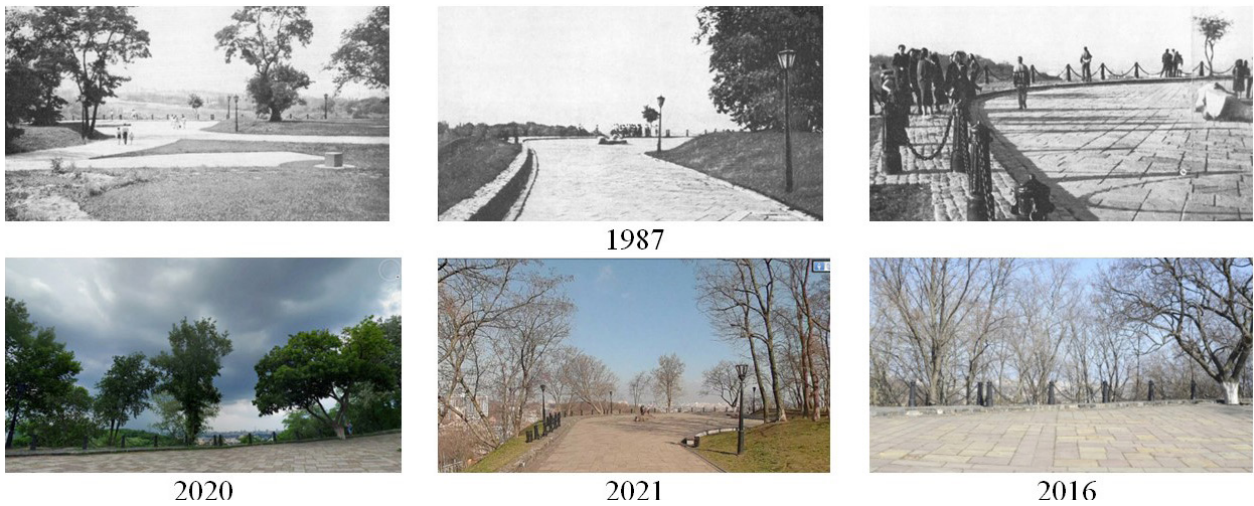


Fig. 3. Changes in the openness of the Starokyivska Hill landscape at the upper observation platform [developed by the authors based on <https://kotsiuba.com/project/renovation-of-starokyivska-mountain> and Google Earth]

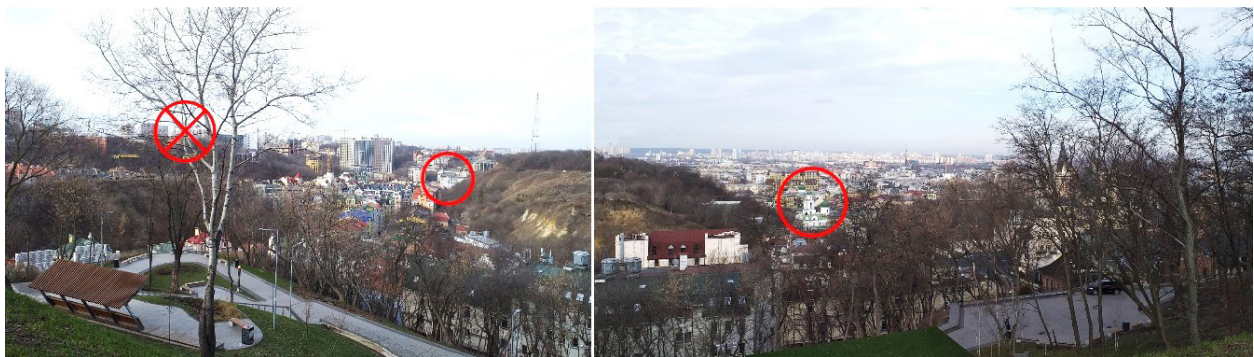


Fig. 4. Panorama of the visual exposure of the urban space from viewpoint 5 with preserved (○) and disrupted visual connections (⊗) [developed by the authors based on field surveys]

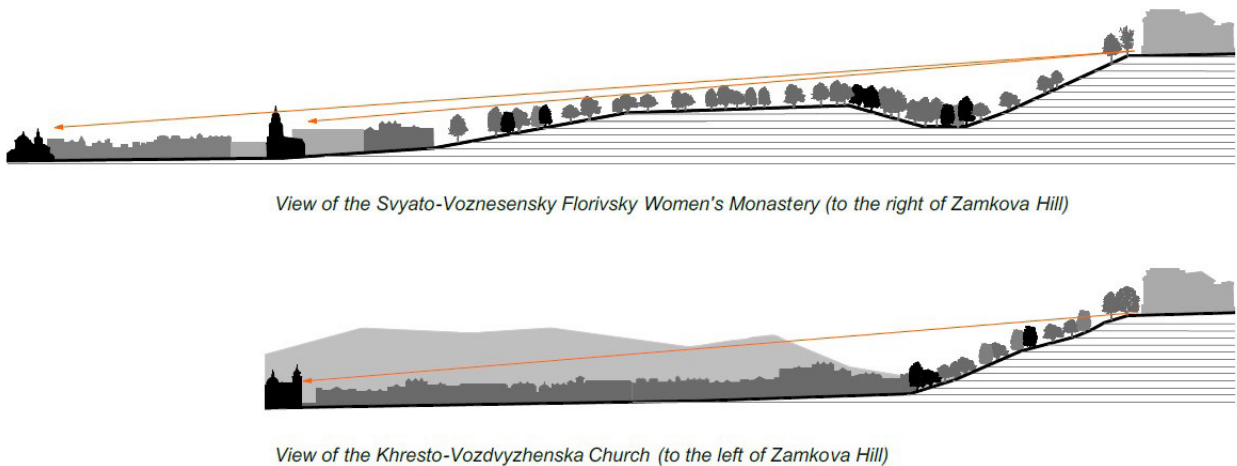


Fig. 5. Vertical profiles of viewpoint 5 (horizontal distances shown every 5 meters) [developed by the authors based on topographic mapping of Kyiv at a scale of 1:2000, Google Earth, and field surveys]

part - up to 1 meter in height, in the middle - up to 5-8 meters, and in the lower part of the slope - up to 10-15 meters. Based on this planting technique, further reconstructive measures should be taken to restore the horizontal viewing angle of distant perspectives visible from viewpoints 4 and 5.

Conclusions

As a result of the conducted research, the dynamics of visual connections and areas between sacred architectural objects in the historical landscape of Kyiv city have been analyzed, considering the complex relief conditions. The peculiarities of perceiving the territory of the Desyatynna Church in the Starokyivska Hill region as a complex urbanized area, which

serves as an identifier of the city, have been outlined.

It has been established that throughout the historical development of the territory, there have been changes in visual connections. From the 17th to the 18th centuries, there were minor landscape transformations, while at the turn of the 19th to the 20th century, landscape changes occurred due to alterations in the natural relief. Furthermore, from the second half of the 20th century, these changes were influenced by vertical development. As a result, there has been an increase in the area of visual connections between sacred structures until the beginning of the 20th century, followed by active reduction at the beginning of the 21st century. Notably, the

connection with the Andriyivska Church was disrupted by plantations, and the vertical development disrupted the connection with the Pokrovske Women's Monastery.

During the analysis, changes in the openness of the investigated landscape have been identified, expressed through the parameters of view points. Specifically, the disruption of visual connections between the Desyatynna Church and the Andriyivska Church, with a reduction of the visual axis depth from 150 m to 70 m, was observed. On the main observation platforms of this area, a narrowing of the horizontal viewing angle from 270 degrees to 130 degrees on the upper platform and from 180 degrees to 110 degrees on the lower platform was noted, which overall reduces the visual quality of the historical landscape. These changes occurred due to modern city development and the expansion of tree plantations, which transformed the open-type space into semi-open. However, it is important to emphasize the preservation of deep perspectives on the cultural heritage objects of Kyiv city, such as the Svyato-Voznesensky Florivsky Women's Monastery and the Khresto-Vozdvizhenska Church.

Highlighting the important role of the historical layer as an integral part of the urban landscape, the article emphasizes the holistic visual perception of the silhouette of ancient Kyiv, considering the influence of tree plantations in the conditions of complex relief. Recommendations for selecting plants to model the landscape outlines are provided.

The results of these studies can inform future efforts aimed at altering the existing landscape while adhering to legislation regarding the peculiarities of development in the historical part of the city. This will help avoid the obstruction of currently preserved visual connections between the city's sacred objects and restore those that have been disrupted or lost. Restoration of visual connections should be carried out considering the sequential perception of space along the route, with the identification of viewpoints from which the sacred objects are best revealed. The continuity of unveiling the historical space and ensuring the diversity of its urban landscapes is proposed to be achieved through architectural and landscape elements.

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Kopsavilkums

Ainava, īpaši pilsētas ainava, veicina vietas sajūtas veidošanos. Autori pētījumā veikuši Kijevas pilsētas vēsturiskā tēla uztveres izvērtēšanu, balstoties uz vizuālo ainavas izpēti. Izpēte veikta ar mērķi, lai pētījumā noteiktu vizuālās sakarības starp sakrālajām būvēm. Pētījumā izmantota vizuāli telpiskā pētījuma metode, lai iegūtu kvantitatīvos rādītājus. Atlasītie kritēriji pētījumā, noteica atsevišķus parametrus: redzamības dziļums, horizontālais skata leņķis, fokusa punkta klātbūtne, akcenti, perspektīvas u.c. Rezultātā pētījumā tika apzināta vizuālo telpisko savienojumu dinamika un apgabali starp elementiem Kijevas vēsturiskajā ainavā. Vēsturiskā tēla saglabāšanas un pilsētas telpisko risinājumu pilnveidošanas perspektīvai atklājas nepieciešamība meklēt veidus, kā modelēt ainavas aprises Starokyivska kalna sarežģītajos reljefa apstākļos.