



## Article

# Increasing the Livability of Open Public Spaces during Nighttime: The Importance of Lighting in Waterfront Areas

Ivana Rakonjac <sup>1,\*</sup> , Ana Zorić <sup>1</sup> , Ivan Rakonjac <sup>2</sup>, Jelena Milošević <sup>1</sup> , Jelena Marić <sup>1</sup> and Danilo Furundžić <sup>1</sup>

<sup>1</sup> Faculty of Architecture, University of Belgrade, Bulevar Kralja Aleksandra 73/II, 11120 Belgrade, Serbia; ana.zoric@arh.bg.ac.rs (A.Z.); jelena@arh.bg.ac.rs (J.M.); jelena.marić@arh.bg.ac.rs (J.M.); danilo.furundzic@arh.bg.ac.rs (D.F.)

<sup>2</sup> Faculty of Security Studies, University of Belgrade, Gospodara Vučića 50, 11000 Belgrade, Serbia; ivan.rakonjac@fb.bg.ac.rs

\* Correspondence: i.rakonjac@arh.bg.ac.rs; Tel.: +381-653-217-996

**Abstract:** The contemporary way of life influences the forms and time framework of outdoor activities in open public spaces, shifting their focus to nighttime usage. The aim of this study is to demonstrate the limits of existing outdoor lighting design standards and recommendations in terms of livability. As an exploratory case study, the Sava waterfront in New Belgrade, Serbia was chosen. The methodology consisted of theoretical research and specific analysis, which included: (1) mapping the spatial distribution of users during several periods of the day; (2) criteria and indicator network analysis of outdoor lighting quality, and (3) a survey with a questionnaire conducted among the users of the waterfront area. The results showed that lighting design can influence overall open public space usage during nighttime through its parameters. It can affect the spatial distribution of users and their sense of safety and comfort, as well as the duration, frequency, and manner of usage. This study could improve planning and design practices regarding outdoor lighting, enabling more active and inclusive usage of open public spaces, thus increasing the overall livability of spaces and their social sustainability.

**Keywords:** urban outdoor lighting; artificial lighting quality; open public space usage; contemporary lifestyle; livability; nighttime outdoor activities; users' perception; New Belgrade; Serbia



**Citation:** Rakonjac, I.; Zorić, A.; Rakonjac, I.; Milošević, J.; Marić, J.; Furundžić, D. Increasing the Livability of Open Public Spaces during Nighttime: The Importance of Lighting in Waterfront Areas. *Sustainability* **2022**, *14*, 6058. <https://doi.org/10.3390/su14106058>

Academic Editors: Edwin H.W. Chan, Zheng Tan and Anqi Wang

Received: 20 March 2022

Accepted: 7 May 2022

Published: 17 May 2022

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



**Copyright:** © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

In the modern era, there is a high stress level to everyday life, and spending time in open spaces includes experiencing natural elements, such as greenery, fresh air, and natural sounds, which can benefit the overall physical and mental health of people in urban areas [1]. Open public spaces, as an indispensable factor of socialization, recreation, and public life, represent an important aspect of urban contexts from the viewpoint of social sustainability. As such, they have always been open to transformation in order to follow the changing nature of people's outdoor behavior. Contemporary lifestyle patterns have changed the meaning and scope of activities in open public spaces, shifting their focus from daytime to nighttime. In these circumstances, the vitality and livability of these spaces depends on their ability to adapt and support the flexibility of these changes, despite their physical limitations. Existing open spaces often remain unsuitable for their original purposes, and in the present, they are spontaneously supplemented with objects and structures, expanding their boundaries and following the rhythm of urban development [2–4].

In this paper, we analyze the outdoor lighting and usage of a specific type of open public space during nighttime. This study aims to demonstrate the limits of existing outdoor lighting design standards and recommendations in terms of livability. The homogeneity of globally accepted standards and regulations establishes uniformity in lighting design practices, focusing on urban safety and shifting attention away from specific urban contexts and space usage [5]. Additionally, we address the spatial distribution of users in open

public spaces; more precisely, the specific position of users in these spaces, and how the position and movement of users could depend on the design and quality of artificial lighting. Due to urban safety issues, artificial lighting can play a significant role in the spatial distribution of users and their behavior, as well as leisure and recreational outdoor activities at night [6].

By recognizing inadequate lighting as a key cause of the decrease in outdoor activities at night, this research was focused on the relative relationship between lighting quality and the dynamics of leisure and recreational activities in open public spaces. A starting point of the study correlates to several research questions: (1) does the shift from day to night influence the change in the way people use and perceive open public spaces; (2) does the quality and design of artificial lighting influence outdoor leisure and recreational activities, and (3) can artificial lighting influence the user's overall satisfaction and comfort in open public spaces.

The topic of nighttime open public space usage in contemporary urban contexts promotes social and cultural sustainability by establishing a conceptual framework for the reassessment of urban design practices and the existing standards and recommendations for lighting design. The benefits of outdoor activities are recognizable in the promotion of physical health through leisure and recreational activities [7–9] and mobility, as well as emotional and behavioral well-being [10]. The use of open public spaces stimulates social interaction [11] and helps the population to connect with their cultural heritage and nurture identity [8,12,13]. The previous period of the COVID-19 pandemic emphasized the importance of open public spaces for safe socialization [14,15] and maintaining physical and mental health during the pandemic [16]. Outdoor recreational and leisure activities increase social sustainability simply through social interaction [10]. Although social behavior requires inevitable support and control through design [17], the development and design support for nighttime open public space usage still does not follow the rate of urban growth, leading to declining quality of everyday life [18]. Existing studies consider nighttime leisure activities mainly from the aspect of social sustainability, economic contribution [19], development of sociability and socialization [20], public safety [21–25], and health [26,27]. Furthermore, nighttime leisure activities in open public spaces have a broad impact on economic growth [28], urban competitiveness [29], urban vitality [30], and social equality [31,32]. Thus, the affirmation of nighttime recreational activities in open public spaces is becoming an urban trend [33] and affects the prevention of crime in open public spaces by encouraging an increase in the number of users during night hours [34]. Cultural and ecological sustainability are addressed through encounters with cultural heritage and learning about the environment [33,35,36], controlled energy consumption, cost-saving, and the preservation of existing resources [37,38]. The technical and economic aspects of lighting and the sustainable aspects of energy efficiency and savings, as well as carbon dioxide emissions, were not considered in detail in this paper, keeping in mind that LED technology in lighting has already been extensively researched [23,37–44]. The recent scientific research further expands into the field of economic efficiency and energy security through the concept of smart cities [23,25,41,44–46]. In addition, outdoor lighting has been researched and studied in terms of safety and security while driving. The topic of artificial lighting in scientific research has been focused mainly on technical characteristics and street lighting, while the relationship between space usage and artificial lighting quality in open public spaces has been focused on urban safety and crime prevention [21–25].

The research results presented here provide insight into the contemporary dynamics of outdoor activities and the impact of lighting quality on the livability of open public spaces, especially during nighttime. The research results show how homogenizing tendencies in lighting design practices are socially unsustainable and require quality reassessment.

The contribution of this paper is to deepen knowledge in the field of specific usage of open public spaces during nighttime, in relation to the quality of artificial lighting that brings cohesion to the landscape both during the day and at night. This research could serve as motivation for the reassessment of existing standards and recommendations, as

well as the knowledge base for developing urban design guidelines for artificial lighting of open public spaces, in order to enable more active and inclusive usage of open public spaces throughout the whole day, thus increasing the overall livability of spaces.

As the research area, the waterfront zone was chosen as a traditional type of open public space in New Belgrade, Serbia, and one of the most frequently used types at night.

## 2. Background Research

The transformations of contemporary life are reflected not only in the way we use open public spaces but also in the time we use them—nighttime activities are becoming more frequent. High daytime temperatures in certain periods of the year, during the summer and other seasons, discourage the development of outdoor activities in open public spaces during daytime [47]. The urban heat island impact of pollution has significantly reduced the quality of living conditions in cities for daily outdoor activities [48,49]. On the other hand, the hectic contemporary lifestyle in an urban context creates a lack of free time during the day [50], because leisure is compatible with working hours, where the focus on working during the day reduces the possibility of free time [51]. These restrictions have changed the patterns of human behavior in urban environments, shifting the focus of free time to nighttime [33]. The livability of open public spaces in an urban context is determined by usage and the frequency, duration, and activities of users [52]. People's activities in public spaces, according to Jan Gehl [53], can be divided into three types: necessary, optional, and social behaviors. According to him, the physical environment and spatial features of the area play an important role when engaging in outdoor activities, except for the necessary behaviors (including going to school, going to work, shopping, etc.). The optional activities, however, depend to a significant degree on what a place has to offer and how it makes people behave and feel about it [53].

In this study, we analyzed the specific factors that influence nighttime usage (optional and social activities), such as artificial lighting quality and the overall significance of outdoor lighting.

### 2.1. Usage and Perception of Contemporary Open Public Spaces

The importance of open public spaces in everyday life is manifested in the form of social benefits. According to UN-Habitat, they are a "vital ingredient of successful cities", and places that create a sense of community, culture, and social capital [54] from the aspect of ecological urbanism [49,55]. They are key places to create a sense of community, and thus civic identity and urban culture [56]. The identity of a place is a matter of socio-environmental values [57].

The relevance of this research topic reflects the need to improve the design of open public spaces in order to enable their usage for leisure and recreational activities [8–10,36,58]. The focus of previous research in the domain of nighttime usage of open public areas is mainly focused on urban safety, not on leisure and recreational activities [21,24,59,60]. Therefore, the contribution of this paper is in examining the frequency, duration, and type of outdoor activities in open public spaces during nighttime.

The relationship between people and spaces is a rather complex one, and has been deeply researched using theories such as environmental psychology, and by many researchers from Lefebvre [61] and Kevin Lynch [62] to more contemporary ones [62,63]. The theory of cognitive maps, in Lynch's view, explains users' perception of urban form based on five types of spatial elements: paths, edges, districts, nodes, and landmarks.

The users' spatial impressions are based on their experience and their image of the space [56]. On the other hand, the potential for preserving open public areas for a certain activity is determined by the layers of visual identifications [64–66], which emphasizes the importance of the way space is perceived. In addition to the existence of three inseparable dimensions of space—mental, physical, and social, Lefebvre also notices the existence of the fourth dimension that includes time, i.e., movement [64,67]. In this paper, the comprehension of open public space is defined both by the movement of users and by the

relationship between users and the urban environment—their spatial distribution [68,69]. The scope (limits/boundaries) of a certain space is conditioned by specific features like edges, whereas the flow or movement (the paths) is the most important characteristic in the perception of the environment [62,63,70,71].

The characteristics of pedestrian movement (the slower motion) influence the perception of spatial characteristics [72]. In pedestrian areas, movement speed enables the comprehensive sensory experience of spatial characteristics and a more articulated interpretation of the environment. The kinetic experience of the environment is defined by the dynamics of outdoor recreational activities [6].

The lighting in a space influences our perception and our urban experience [73], as well as the usage, activities, and spatial distribution of users in space [74].

## *2.2. Nighttime Usage, Safety, and Quality of Artificial Lighting in Open Public Spaces*

The most obvious transformation of space in terms of visibility occurs in a shift between daytime and nighttime, when replacing daylight with artificial lighting affects perception and the possibility of performing outdoor activities. Nighttime is the part of the day when visibility deteriorates and perceiving environmental characteristics is possible only under the effect of artificial lighting. In that sense, lighting could represent a useful design tool for shaping both urban spaces and user behavior [6,73,75,76].

Daytime usage of open public space is determined rather equally by several environmental, social, cultural, and spatial factors [77], while during nighttime one of the main factors that influence usage is the personal sense of safety [60]. In her famous work, “The life and death of the great American cities”, Jane Jacobs argues that the constant flow of people makes a place more livable, and how active usage of open public space throughout the whole day is one of the main factors of livability [34]. Further, Jacobs stated that the safety aspect is an important part of a livable urban environment. According to Marcus and Francis [78], safety refers to the personal security of open public space users, and it can be perceived as an objective and subjective measure. In this paper, we deal with the perceived feeling of personal safety as opposed to objective safety, which includes actual incidents or crime [33]. Increasing urban safety and security is one of the major principles addressed by UN-Habitat in their sustainable development goal number 11. Therefore, to create an inclusive public space, it is important that different categories of users can freely participate in society [60]. Design elements that improve safety and reduce general fear include lighting, surveillance, improved sightlines and visibility, clearer access points, and pedestrian routes through spaces and services, including ablutions and sanitation [21,59,60]. In several crime-prevention studies street lighting was recognized as an important part of the physical features that help in feeling safe in public spaces and influence overall crime reduction [79,80], while according to Rezvani and Sadra, lighting and visual accessibility of public places leads to strengthening the sense of feeling safe in neighborhoods, because they allow the person to detect possible threats [24,59]. In addition, there may exist an intuitive or learned association between lighting and safety [81]. The quality of visual information is of great significance for memorizing the environment and artificial night light makes the urban environment more comfortable for users and visitors [73,75,82,83].

This paper presents an extension of wider research regarding the lighting quality of different types of open public pedestrian areas [6,72,75,76,84]. The research is based on previous studies [6,75] which include the analysis of existing outdoor lightning standards in two types of open public spaces in residential areas. These two areas represent city districts, the examples used are residential neighborhoods designed under the socialist paradigm in Belgrade, Serbia in the mid-20th century. The results of the case study of the Danube waterfront within the open-formed residential blocks of Dorćol showed the influence of standard lighting design practices for residential areas on the overall lighting quality and creation of dark, unsafe areas in the open public spaces of the neighborhood [75]. The dominant usage of the pedestrian area (a plateau elevated from the approach street and bordered on two sides by residential buildings) is as access paths to housing, framed by relaxation

areas of greenery. In this paper, the lighting quality transformation under the influence of the environment is presented through the comparative analysis of in-field measured illuminance level and designed values in accordance with standards and recommendations in the open public pedestrian area. The case study of the Eastern City Gate of Belgrade housing complex showed the relationship between outdoor leisure activities and artificial lighting quality in open public spaces based on the kinetic experience of users [6]. The complex, spatially defined by an elevated, circular, car-free forecourt surrounded by an access road, is designed as an open-formed modernist block with open public space for outdoor recreational activities and three identical skyscrapers placed radially from the center of a main-access pedestrian path. This study showed that the contemporary context, along with new forms of time consumption, transforms the dynamics of open public space usage, and the in-field analysis showed that the decrease in the level of activities at nighttime is a consequence of the lighting quality. The presented methodology in this paper offers tools for the analysis of recreational usage of open public spaces in relationship to lighting quality parameters.

Furthermore, several previous research studies dealt with questions regarding how people experience lighting and ambience as they move through an urban context [73], as well as lighting and perception of safety during nighttime [21]. The study from 2021 dealt with the issue of perceived safety, exploring how the presence of different design interventions impacts the perceptions of safety in public spaces. The study was focused on women's experiences in particular [85]. The results of this study suggested the overall importance of evidence-based design in open public spaces and the need to integrate a gender perspective. In a study from 2012, nighttime open public space usage was researched by gender and age group (seniors above 60 years old, adults from 20 to 59 years old, teenagers from 13 to 19 years old, and children), as well as the location of outdoor leisure activity and type of activity (sedentary, moderate, and vigorous) [33]. In this study, the authors showed that, in every age group except the seniors, the male population used open public spaces more frequently during nighttime. This study also showed that the most prevalent type of outdoor activity was moderate (social gathering), while sedentary (electronic device usage) and vigorous (sports) were equally performed. Additionally, the most-used area of open public space at night was a grassy area. Moreover, this research questioned the issue of uniform lighting design by considering how designers translate lighting codes in the design and planning process [5]. This research argues that lighting design should include the specificity of local culture or geographical context and an individual approach in the lighting process.

Lighting design for open public spaces relies on the standards and recommendations defined by the Illuminating Engineering Society (IESNA) [86], the International Commission on Illumination (CIE) standard [87], and the British Standards Institution (BS EN) standard [88]. Regarding open public pedestrian areas, outdoor urban lighting design is based on the fulfillment of functional lighting features as the top priority to achieve adequate visibility according to the users' needs, as well as to meet all the safety and security requirements in an open public space. The IESNA standards categorize adequate illumination according to the space usage at nighttime as very active (commercial zone), moderately active (intermediate zone), and less active space (residential zone) [86]. The CIE standards categorize the influence of the luminosity of the surroundings, the boundary area (edges of open public space), in three categories—high, moderate, and low [87], while the BS EN standards categorize the level of urbanity as rural, urban, and city center [88]. For the various types of open public spaces (streets, parking places, pedestrian areas) the types of lighting situations are defined by the lighting technical class [87,88] and the specific sets of parameters, based on the category of the existing type of traffic in space, users' motion speed, and the roughly denoted dominant space usage. In the Serbian context, the Lighting Committee makes decisions based only on the CIE standard. The lighting design practice in the country is based on a rather formal and rigid approach and interpretation of lighting policies and regulations. Therefore, this paper explores all mentioned standards and regu-

lations in order to determine differences between the planned design of lighting in open public spaces and real everyday situations. In addition to previous research, the added value of this paper is the users' perspective on the nighttime dynamic of space through the relationship between qualitative and quantitative results of overall lighting quality.

In the next section, the specific methodology used for the research is explained, and the research is based on the aforementioned theoretical framework.

### 3. Materials and Methods

The paper methodology consisted of both qualitative and quantitative methods, including (1) content analysis and (2) an exploratory case study, followed by several methods and techniques described in this section.

1. Content analysis focused on the domain of open public space usage during nighttime and the quality of artificial lighting. These topics were analyzed in the broader sense and within several topics, such as outdoor recreational and leisure activities, user behavior and perception of open public space, environmental psychology, urban safety, and social sustainability. The focus of the research was on the quality of artificial lighting in pedestrian areas, including a literature review of quality standards and recommendations. The technical and economic aspects of lighting—energy efficiency and consumption, as well as carbon dioxide emissions, were excluded from deeper content analysis and were not directly connected to the aims of the research. The theoretical research, presented in the previous section, served as a framework and a baseline for creating an outline for the exploratory case study, the development of criteria and indicators, and overall interpretation of the results. The second part of the research included the exploratory case study [89].
2. Exploratory case study research was developed through the analysis of a specific type of open public space—the Sava waterfront in New Belgrade. The case study area was chosen based on several criteria. The waterfront area is one of the most frequently used pedestrian areas for leisure and recreational activities during nighttime, thus having a high influence on the livability of the space. The waterfront area represents one of the traditional types of open public spaces, with the different spatial elements of open public spaces such as urban furniture and lighting, pedestrian and cycling paths, greenery, and water. These spaces are equally accessible for users during daytime and nighttime. The case study analysis was performed using two main methods: (a) expert observation and (b) field survey with a questionnaire. Expert observation provided objective data and detailed insight into the spatial characteristics and usage of the waterfront area, as well as the quality of artificial lighting, while the field survey included actual users of the waterfront area who provided their subjective perspectives.
  - (a) Expert observation was focused both on the spatial characteristics of the site as well as on user behavior. The main techniques here were mapping and measuring. To explore the dynamics of nighttime activities and usage of the waterfront area and the lighting quality, the specific analysis included methods such as (I) expert observation of spatial characteristics and spatial distribution of users (by mapping their specific position and movement), and (II) analysis of artificial lighting quality and design using a predefined C&I (criteria and indicators) network.
    - (I) The spatial analysis of the waterfront area was performed according to the presented theoretical context based on Lynch's approach to the image of the urban context, [62] in order to define the specific character of the waterfront district. The spatial distribution, position, movement, and activities of users in the waterfront area were observed at different periods of the day (in the morning, midday, afternoon, evening, and nighttime) and for different user categories considering age and gen-

der. This provided insight into the frequency of user categories, space occupation, and the dynamics of outdoor activities.

- (II) Analysis of artificial lighting quality and design was based on previous studies and all established standards and parameters (IEASNA, CIE, and BS EN). Based on outdoor urban lighting design recommendations, the analysis of the existing nighttime lighting situation was conducted following the relevant artificial lighting quality parameters for open public pedestrian zones: (a) selection of the light source, light type, optical features, and the physical arrangement (influence on light distribution); (b) illuminance level and overall uniformity (the overall illuminance distribution); (c) the users' feeling of safe and secure space (the quality parameter based on basic orientation in space, perceiving obstacles and face recognition). The illuminance level in the selected segment of the open public space was measured using the lux/chroma meter Konica Minolta CL-200A, which provided illuminance measurement in a very wide range of 0.1–99,990 lx. The ground level was taken as the referent surface for recording the levels of horizontal illuminance on the evaluation points at 1 m intervals on the dominant pedestrian routes and 2 m intervals in other areas. The evaluation points were set as nodes of a square network [90]. In this paper, we argue the need to challenge the current lighting design parameters for pedestrian areas and introduce the users' perspective as an important aspect in evaluating overall lighting quality. In this study, the user perspective was established through a field survey.
- (b) The field survey with a questionnaire was conducted among users ( $n = 231$ ) of the waterfront area, in a period of 2 months during summertime (May and June), when open spaces are most frequently used. The aim of the survey was to analyze subjective user perception regarding the usage of specific open public spaces in the New Belgrade waterfront area.

The questionnaire was developed with pre-coded questions, with multiple-choice options, where participants chose one option for answering each question (Figure S1). At the beginning of the questionnaire, basic information about age and gender was gathered. Four age groups were used (18–25; 25–40; 40–55; 55+). The questionnaire was divided into two parts, with a total of 8 different questions. In the first part (PART A) the participants answered two questions—questions 1 and 2 (Question 1 (Q1): Do you use open public space in the waterfront area; Question 2 (Q2): When do you use these spaces the most) regarding the general usage of open public space (Q1) and the time of day they use these spaces the most—morning, afternoon, or nighttime (Q2).

The second part (PART B) consisted of 6 questions (questions 3 to 8) focused on nighttime open space usage. (Question 3 (Q3): How often do you visit these spaces during nighttime; Question 4 (Q4): How much time do you usually spend in these places during nighttime; Question 5 (Q5): What type of activities do you engage in these spaces during nighttime; Question 6 (Q6): When spending time in open space during nighttime what is the most important spatial feature that influences the position and means of usage; Question 7 (Q7): Are you satisfied with the location and overall quality of artificial lighting in these spaces and Question 8 (Q8): Do you feel comfortable and safe in these spaces during nighttime). In part B three main categories of nighttime usage were analyzed: frequency (Q3), duration (Q4), and activity (Q5). Additionally, the participants were asked about specific spatial features of open public spaces that influenced their nighttime usage the most (Q6). They chose between (1) urban furniture and pedestrian/bicycle paths; (2) greenery and water proximity, and (3) lighting. Furthermore, the satisfaction of the users with artificial lighting, as well as the user perception of comfort and safety, were analyzed (Q8). The 5-point Likert scale was used to establish the level of satisfaction regarding safety and comfort, a type of psychometric response scale in which responders specify their level

of agreement to a statement typically in five points from the lowest level of satisfaction (grade or point 1) to the highest (grade or point 5): (1) very dissatisfied; (2) dissatisfied; (3) neutral (4) satisfied; (5) very satisfied. The results of the questionnaire and statistical analysis were performed in Excel. By combining several responses and averaging those responses, we obtained the results presented in the next section.

In addition, the results which present the design and quality analysis of outdoor lighting are compared to similar previous studies which include different types of open public space, users, and activity.

#### 4. Case Study/Results

##### 4.1. Case Study Area: The Character of the New Belgrade Waterfront Area

New Belgrade, whose construction began in the middle of the 20th century [91,92] modeled on the modernist concept of a healthy city, abounds in tall buildings and large open areas intended for recreation. The residential settlement was built under the influence of the socialist paradigm and promoted the idea of modern life through the transformation of social norms and the formation of a new lifestyle through the medium of architecture. New Belgrade was known as the “Belgrade dormitory”, the largest residential area in socialist Yugoslavia, with several administrative and industrial complexes [52,93]. However, at the beginning of the 1990s, this area underwent a post-socialist transition and transformation, with added activities and functions [94]. This spatial transformation further influenced the blossoming of upscale residential, leisure, and recreational activities [95].

The waterfront area of New Belgrade experienced rapid development in the above-mentioned period, followed by a period of stagnation, and then by an intensive degradation of open public spaces along the banks of Belgrade’s rivers. Today, the context of the Belgrade waterfront can be interpreted in terms of the post-socialist transition that began at the end of the last century, and it may also be observed as a part of the process of creating space within global urban society in the contemporary moment [96]. The Sava waterfront area in New Belgrade was designed under a modernist concept strengthened by the socialist paradigm, encouraging the idea of unity and socialization through open public spaces. The present space usage reflects the influence of the West in shaping the waterfront area according to the contemporary way of life.

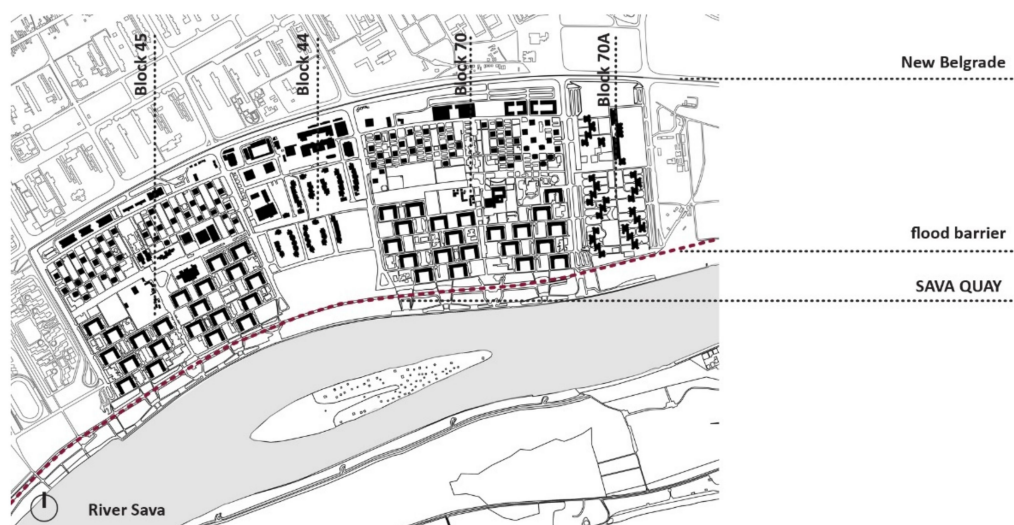
The Sava waterfront area stretches along the left bank of the Sava River in the southwestern part of New Belgrade. Its promenade connects several of New Belgrade’s characteristic super-blocks (70a, 70, 44, and 45) lying opposite the islands of Ada Ciganlija and Ada Medjica (Figure 1). A detailed urban plan for the construction of Block 70, based on the ideas of I. Tepes and V. Gredelj, were adopted in 1966, whereas the block, designed by architects Popovic, Sekerinski, Canko, and Aleksic, was built in the period from 1973 to 1975 [96]. To this day, this space has not experienced any transformation regarding its physical structure.

This open public space (district) is defined by an embankment and developed vegetation and green landscape on one side, and by the promenade, which is in contact with the river through the vertical bank protection (edges). This area is characterized by the possible intertwining of activities within the boundary areas—entertainment, relaxation, sports, and recreational activities, both on the mainland and on the water—hospitality and water sports (Figure 2). Pedestrian interactions are emphasized by paved pedestrian routes (paths).

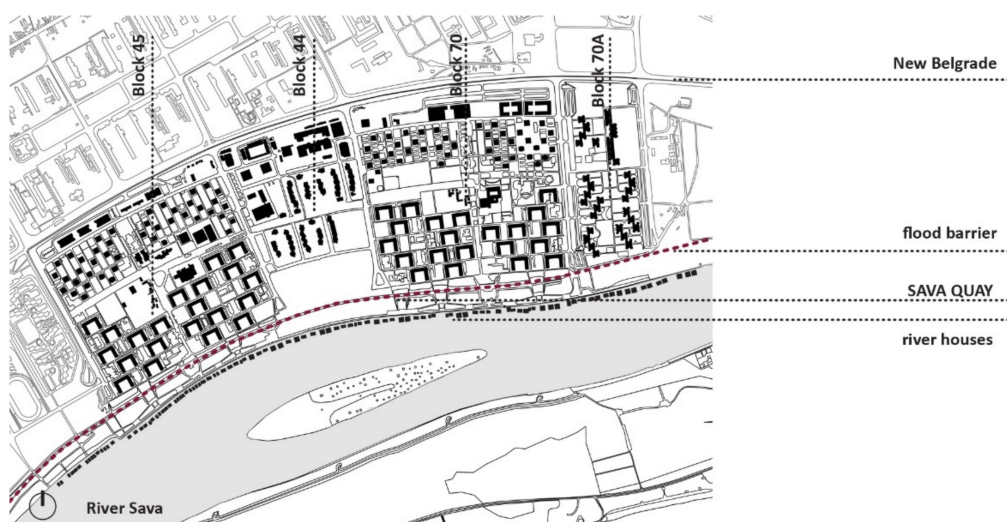
##### 4.2. Waterfront Area Usage

The mapping of outdoor activities and frequency of users gave insight into open public space usage, defining the character of the New Belgrade waterfront district. The syntax for the collection of data was based on the kinetic experience in open public space by mapping the spatial distribution of users during several periods of the day. The measurements included the position and movement of users, dominant age and gender categories, and dynamics of outdoor activities.





**Figure 1.** The urban context: Sava waterfront—initial architectural design. Source: the authors.



**Figure 2.** Context: Sava waterfront—physical structure and natural elements. Source: the authors.

The diagram of spatial elements of the open public area presents the main routes of user movement (paths); defined spatial fragments for different free time outdoor activities (green areas); relaxation areas (seating areas/benches); contact zone of open public space and water surface (riverside); and the Sava River (water) (Figure 3).

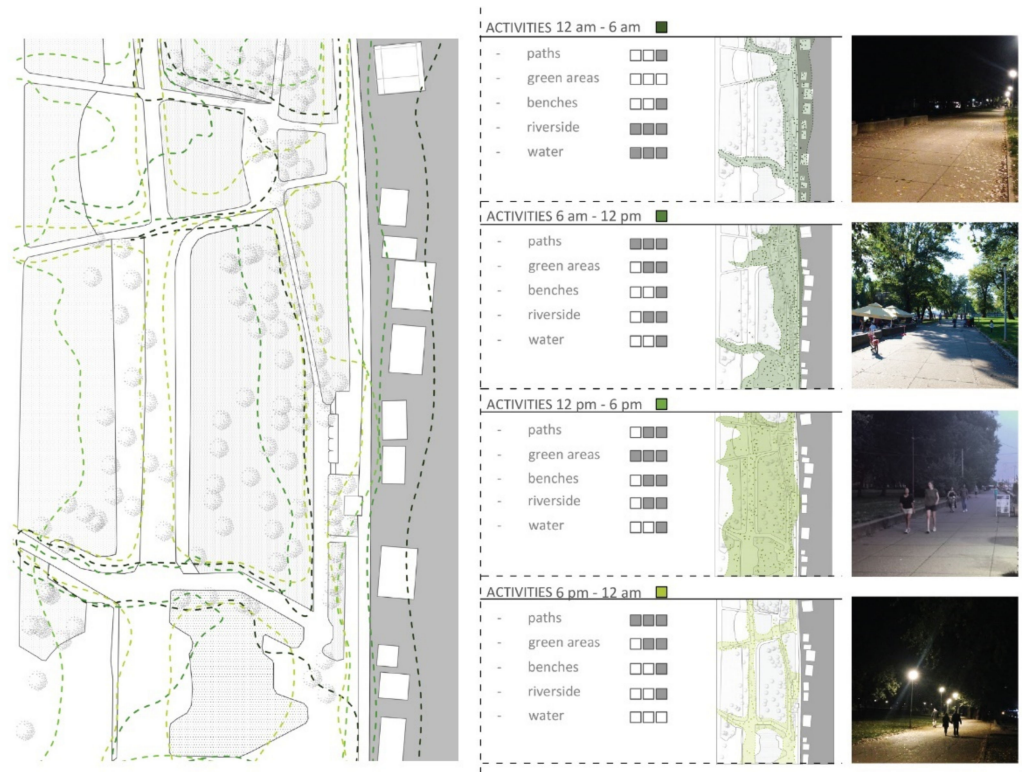
These parameters provide an insight into the concept of open public space usage. Spatial orientation is defined by paved paths supported by unilaterally positioned lights. Green areas represent zones of landscaped vegetation intended for leisure activities without additional urban furniture and lighting features. Seating areas are extensions of specified paths and are equipped with benches and fencing that separate this space from green areas. The riverside zone defines a leveled path that enables closer contact between the user and the river. The water surface is not accessible to users, and no swimming area is foreseen. Currently, the growing need for contact with the water has led to the development of river houses on the water, which are becoming more and more popular as a part of nighttime user activities [97].



**Figure 3.** Sava waterfront—original architectural design and spatial elements. Source: the authors.

The analysis of open public space usage is presented in relation to the dynamics of outdoor leisure and recreational activities and the manner in which space is used in accordance with contemporary habits. These days, Belgrade is the city that never sleeps [97,98].

Expert observation and mapping of the spatial distribution of users in different time frames provided insight into the frequency of users, space occupation, and dynamics of outdoor activities. Through graphical representation—framing the field and outlining the active area—the edges of the waterfront district are presented through the fluid character of open public space boundaries (Figure 4).



**Figure 4.** The space usage rhythm—the dynamic of outdoor activities. Source: the authors.

The movement of users and users' frequency was observed for 2 months during the summertime. The analysis dynamics for outdoor activities is shown for four different usage

periods of the day, concerning dominant types of activities and different groups of users (Table 1). The observed users' activity in the open public waterfront area was divided into age groups: children (infants up to 12 years old, with adult supervision), teenagers (13 to 19 years old), adults (40–55 years old), and elderly users (55 years old and above).

**Table 1.** Observed dynamics of space usage and users. Source: the authors.

Time/Period of the Day	Activity	Dominant Group of Users	Dominant Gender of Users
12 a.m. to 6 a.m.	youth gatherings after midnight, recreational activities in the early morning hours	adults and teenagers	equally male and female
6 a.m. to 12 p.m.	walking, running, cycling, exercise, sports, outdoor play, board games, reading, sitting	all groups of users	female
12 p.m. to 6 p.m.	walking, cycling, exercise, sports, outdoor play, reading, sitting	all groups of users	female
6 p.m. to 12 a.m.	walking, running, cycling, exercise, sports, outdoor play, board games, reading, sitting, social gatherings	adults and teenagers	female

The space usage by various activities in the diagram (Figure 4) presents the frequency of users—the main paths of users following the dynamic of outdoor activities. By framing the space occupation, the usage of areas of open public space is presented depending on a time frame—the period of the day.

Edges of space usage define the active and inactive areas and fluid character of open public space boundaries caused by users' spatial distribution. Further analysis showed that the frequency of open public space usage was significantly reduced during nighttime, and that inadequate lighting in different areas may be a limitation for developing outdoor activities.

#### 4.3. Nighttime Usage: Characteristics of the Existing Lighting Situation in Open Public Spaces

The New Belgrade waterfront area is a car-free area characterized by a very low speed of motion, low pedestrian traffic density, absence of parked vehicles, and low surrounding luminosity; thus, it qualifies as the lighting technical class P6 [87,99]. It is also located within an urban context [88], but the influence of the surroundings, i.e., the impact of the lighting from the neighboring areas is low [99]. Based on visual performance, an open public space area is defined as “typically not work-related, but related to dark sedentary social situations, sense of safety, and casual circulation based on landscape, hardscape, architecture, and people as visual task” [86].

Characteristics of the existing lighting situation within the open public space were analyzed through the aforementioned artificial light quality parameters: (a) selection of the light source, light type, optical features, and their physical arrangement; (b) illuminance level and overall uniformity; and (c) the users' feeling of a safe and secure space. The quantitative part of the analysis was based on the field measurements of horizontal illuminance and analysis of optical features of the light. The qualitative analysis covered the survey of lighting quality influence on users' feeling of a safe and secure space, based on users' experience of ambiance, expert analysis, and the questionnaire conducted among the users of the waterfront area.

Selection of light sources, light types, optical features, and their physical arrangement:

The lighting of the pedestrian lane—the path—was enabled by the one-sided arrangement of lights at varying intervals from 12 to 25 m (the path geometry defined the

arrangement of lights and discrepancies in distance ranges). The light arrangement emphasized the main pedestrian path along the riverside, while the other zones intended for outdoor activities were not supported with additional lighting installations. The light source is metal halide, with a nominal power of 100 W, and a warm white average temperature of approximately 2700 K (Figures 5 and 6). The illumination of the pedestrian path is provided by the installed lights. There are no additional effects of colored lighting, while the warm white light source creates an agreeable ambiance.

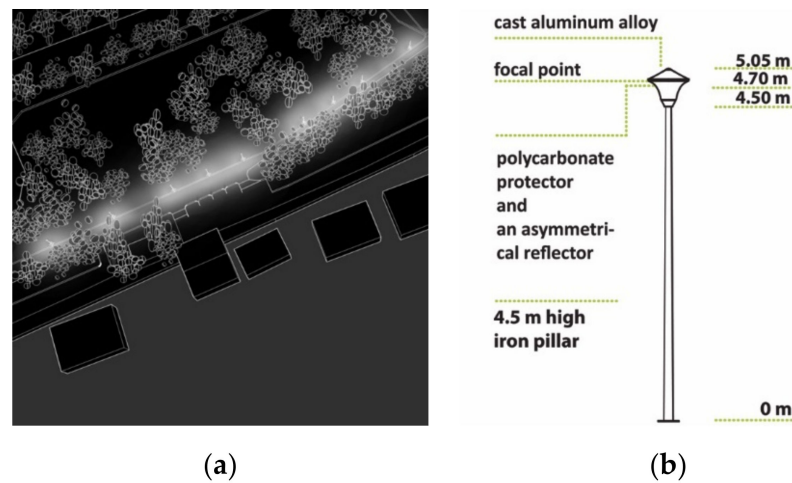


Figure 5. (a) Light arrangement and (b) installed light. Source: the authors.

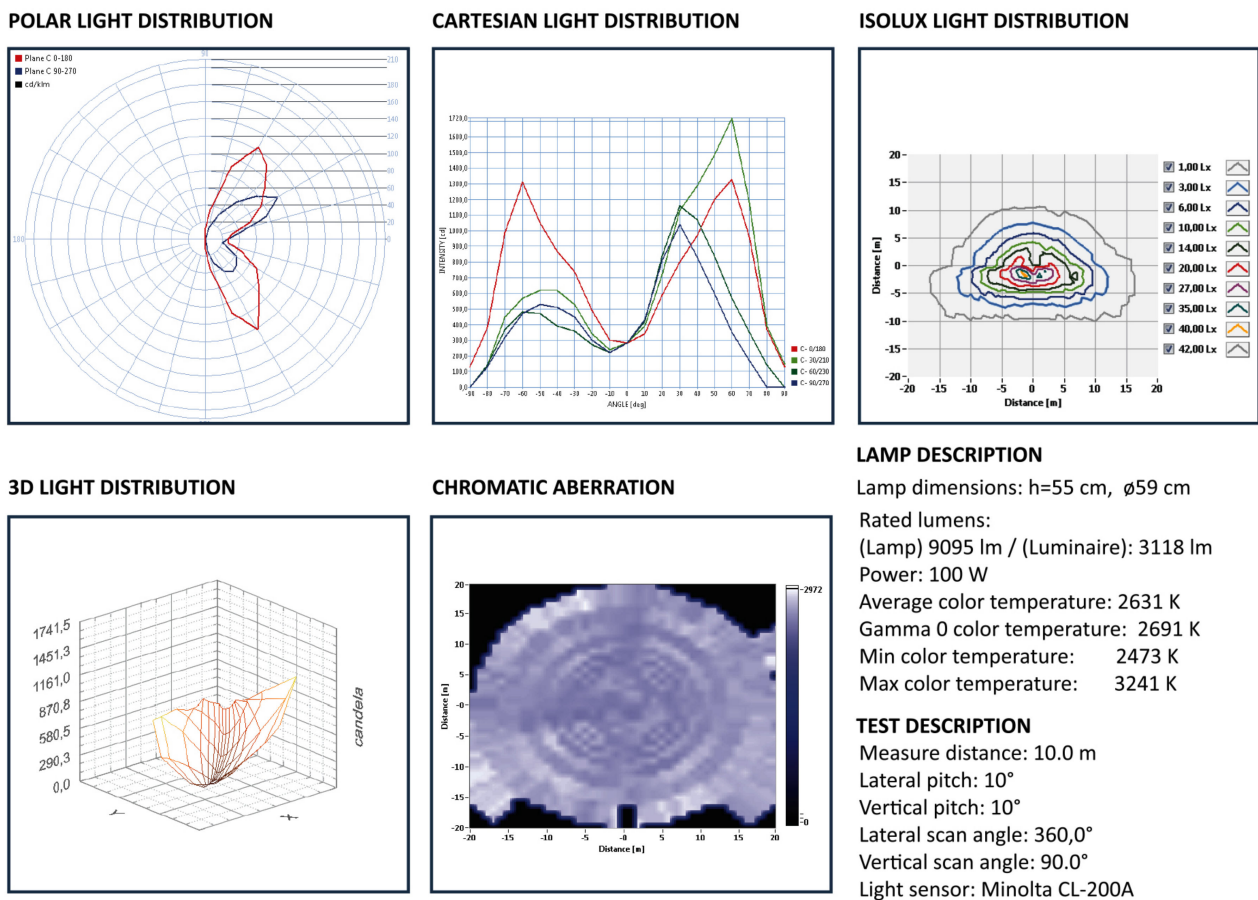
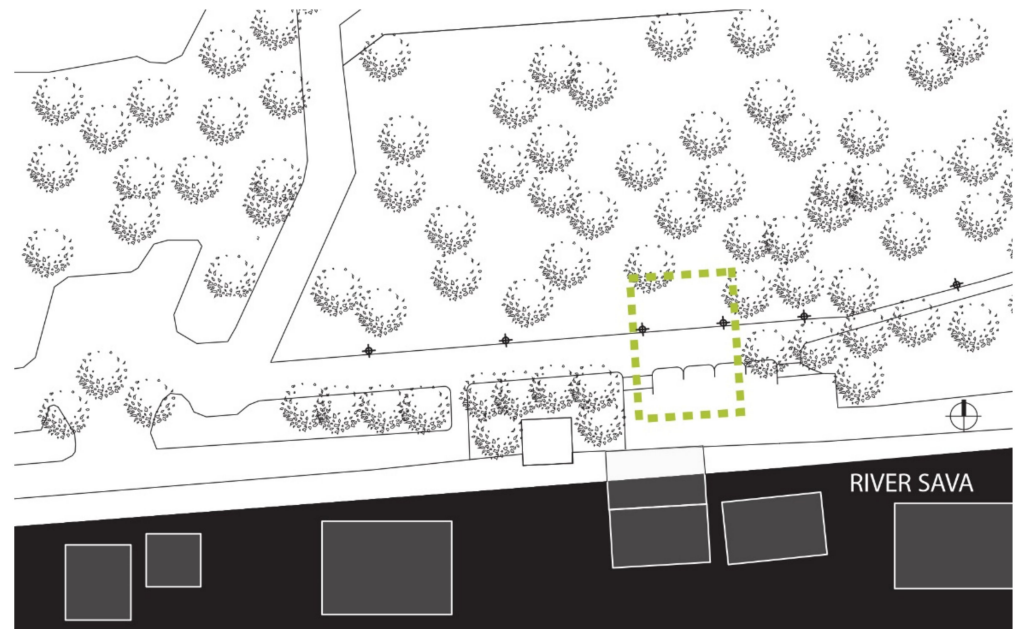


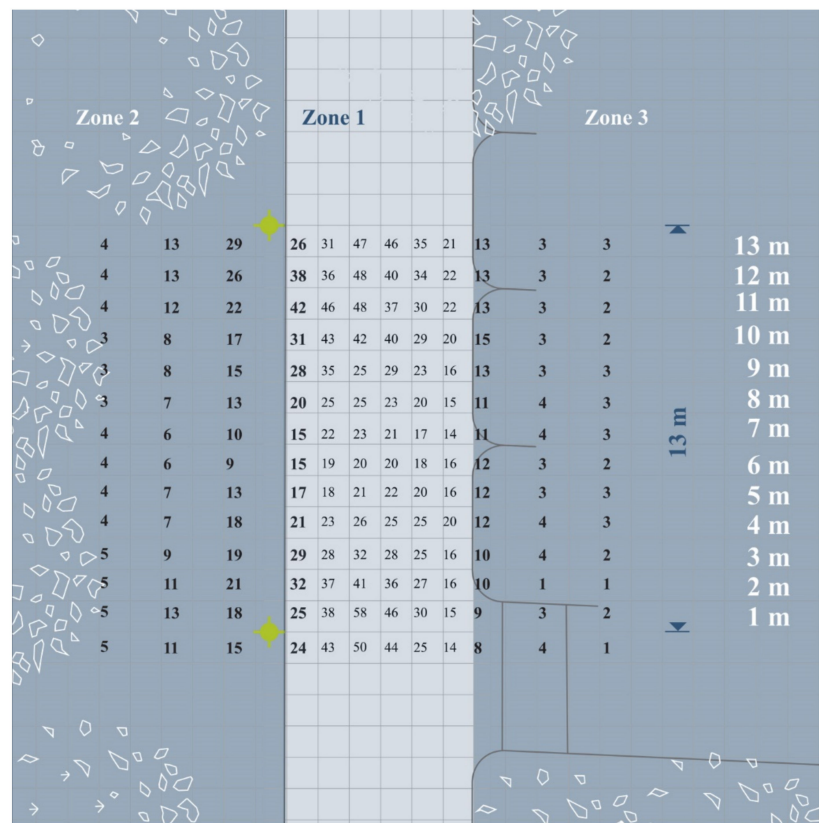
Figure 6. Light sources: test measurement report. Source: the authors.

**Illuminance level and overall uniformity:**

The measurement of the illuminance level within the open public space was carried out on a segment on the main pedestrian path, where an overlapping green area and access to the riverside with a seating area define the edges of the illuminated field (Figures 7 and 8).



**Figure 7.** Light arrangement: representative sample. Source: the authors.



**Figure 8.** Illuminance distribution measured at the site. Source: the authors.

Zone 1—defined by the main pedestrian path, lit on one side. The measured values of the minimal horizontal illuminance of this zone were in accordance with the recommended values (Table 2).

**Table 2.** Recommended and measured values of horizontal illuminance: review.

Result Type	Min. Horizontal Illuminance	Average Horizontal Illuminance	Max. Horizontal Illuminance	Uniformity Minimum/Average
IESNA <sup>1</sup> [86]	Not defined	1–8 lx	Not defined	Not defined
CIE <sup>2</sup> 115-2010 [87]	0.4 lx	2 lx	Not defined	Not defined
BS <sup>3</sup> EN 13201-2:2015 [88]	0.4 lx	2 lx	Not defined	Not defined
Measured values: Zone 1	14 lx	28 lx	50 lx	1:2
Measured values: Zone 2	3 lx	14 lx	42 lx	1:5
Measured values: Zone 3	1 lx	6 lx	15 lx	1:6

<sup>1</sup> IESNA: Illuminating Engineering Society. <sup>2</sup> CIE: International Commission on Illumination. <sup>3</sup> BS EN: British Standards Institution.

Zone 2—the green areas, which are covered not only by low greenery but also plenty of tall trees. The illuminance level in this zone also conformed to the recommended values for minimum and average horizontal illuminance (Table 2). In the daytime, this zone bustled with outdoor activities, but by night all activities were reduced as an effect of the dark, unlit area.

Zone 3—the access to the river and seating area, completely without lighting installation, left an impression of an unsafe space. The main path lighting provided the illuminance for this area and fulfilled the recommended values for minimum and average horizontal illuminance (Table 2).

Users' perception/feeling of safe and secure space:

The users' sense of safety was partly disturbed. The level of illuminance complied with standards (Table 2) and provided basic orientation in space. The overall uniformity of the area of the main pedestrian path enabled perception of obstacles and face recognition. However, due to the lack of lighting features in other areas (green areas, seating areas/benches, and riverside), an impression of unsafe ambiance is created in zone 2 (Figure 9).



**Figure 9.** Position of the lighting and people's behavior in the Sava waterfront: representative sample. Source: the authors.

Questionnaire results showed direct insights into user perception of the main points analyzed in this study. Regarding the general information about the participants in a typical characteristic/demographic sample, the sample that we used in this survey consisted of 39.83% male and 60.17% female respondents, with most participants in the age group between 25 and 40 (35.50%). A more elaborate demographic structure of the sample is presented in Table 3.

**Table 3.** Gender and age of the participants presented in percentages.

Age	Participant %	Male %	Female %
18–25	30.30	44.28	55.71
25–40	35.50	39.02	60.98
40–45	28.14	38.46	61.34
55+	6.06	28.57	71.43
Total	100%	39.83	60.17

Part A: In regard to the nighttime usage of open public spaces on the waterfront, 40.69% of all participants stated they use these spaces during nighttime, and 59.31% of users tended to avoid these spaces when there was no natural sunlight. The majority of the participants stated they used these spaces the most in the morning (27.71%) or during the afternoon (31.60%). However, there was a group of users (24.24%) that stated they used the waterfront the most during the evening or night. Outdoor activity frequency and duration during daytime and nighttime are presented in Table 4. The daytime usage considers the waterfront area users in the morning and in the afternoon, and users that visit the space in the morning and the evening. The nighttime usage considers the evening/nighttime and groups of users visiting the waterfront area in the morning and the evening.

**Table 4.** Activity frequency during daytime/nighttime presented in percentages.

Activity	Daytime %	Nighttime %
leisure and socialization—hanging out with friends	45.14	34.04
recreation—walking, running, cycling, exercise	17.14	28.72
relaxing by myself	14.29	10.64
just passing through	19.43	21.28
other: walking the dog	4.00	5.32
Duration	Daytime %	Nighttime %
more than 1 h	38.86	43.62
around 30 min	34.29	34.04
10–15 min	17.71	13.83
a couple of minutes	9.14	8.51

Part B: Regarding the specific usage of open public spaces, the waterfront during nighttime was analyzed from three aspects: the frequency (Table 5), duration (Table 6), and activity of users (Table 7). The majority of participants used it rarely and almost never (55.84%), but 15.58% stated they used it every day. Around 77.66% of participants used the space during nighttime for more than one hour (43.62%) or 30 min (34.04%), while 8.51% only spent a couple of minutes. They were using the open space mostly to engage in leisure activities and socialization (44.68%), recreation (28.72%), and other activities—mostly walking the dog (5.32%); still, some users were just passing through this area (21.28%).

When spending time in open spaces during nighttime, the most important spatial feature that influenced the position and means of usage for users (Table 8) was greenery and water proximity (24.47%), then urban furniture and pedestrian paths (13.83%), while some of the participants stated it was the proximity of restaurants on the water (12.77%) or monuments of public art (8.51%). What is especially important for the study is that 40.43% of participants who used the waterfront area during the nighttime thought that lighting had the most influence on their movement, behavior, and usage.

**Table 5.** Frequency of usage of the waterfront area during nighttime presented in percentages.

Frequency	All Participants %	Participants Using the Space during Nighttime %
very often—every day	15.58	14.89
often—once or twice per week	28.57	30.85
rarely—once or twice per month	38.53	43.62
almost never	17.32	10.64

**Table 6.** Duration of usage of the waterfront area at nighttime presented in percentages.

Average duration	All Participants %	Participants Using the Space during Nighttime %
more than 1 h	39.83	43.62
around 30 min	33.77	34.04
10–15 min	18.18	13.83
a couple of minutes	8.23	8.51

**Table 7.** Activities during usage of the waterfront area at nighttime presented in percentages.

Activity	All Participants %	Participants Using the Space during Nighttime %
leisure and socialization—hanging out with friends	41.13	34.04
recreation—walking, running, cycling, exercise	21.21	28.72
relaxing by myself	15.15	10.64
just passing through	18.18	21.28
other: walking the dog	4.33	5.32

**Table 8.** Nighttime open public space usage and the most important spatial feature that influenced the position and means of usage, presented in percentages.

Spatial Feature	All Participants %	Participants Using the Space during Nighttime %
urban furniture and pedestrian/bicycle paths	12.55	13.83
greenery and water proximity	29.44	24.47
lighting	33.77	40.43
other: monuments	12.12	8.51
other: river restaurants	12.12	12.77

Additionally, participants expressed their overall satisfaction with the position and quality of artificial lighting in the waterfront area. The average grade was 2.62 (of 5), while the majority of users gave a grade of 3 (37.66%), although 17.32% gave a grade of 1. When asked about their perceived feeling of satisfaction and safety, it is important that the majority of all participants (69.26%) and participants visiting the area at nighttime (74.47%) still did not feel comfortable nor safe in this area during nighttime.



Furthermore, the results were analyzed by combining several questions in order to gather specific conclusions (Table 9). Most of the population that stated they use open public spaces mostly during nighttime (40.69%) were aged between 25–55 (72.34%), while users aged 55+ rarely used these places at night (4.26%).

**Table 9.** Relationship between type of outdoor activities and the area usage regime (daytime/nighttime) by age group, presented in percentages.

Age	Leisure and Socialization—Hanging Out with Friends Daytime/Nighttime	Recreation—Walking, Running, Cycling, Exercise Daytime/Nighttime	Relaxing Alone Daytime/Nighttime	Just Passing Through Daytime/Nighttime	Other: Walking the Dog Daytime/Nighttime
18–25	49.12/31.82	21.05/45.45	17.54/9.09	12.28/9.09	0.00/4.55
25–40	49.18/23.53	11.48/29.41	13.11/14.71	19.67/20.59	6.56/11.76
40–55	34.78/50.00	19.57/14.71	10.87/5.88	28.26/29.41	6.52/0.00
55+	45.45/0.00	18.18/50.00	18.18/25.00	18.18/25.00	0.00/0.00

The participants who visited public spaces often during nighttime (14.89%) were in the 40–55 age group (35.71%), and the ones who spent more than 1 h or 30 min in open public spaces during nighttime (77.66%) were in the 25–40 age group (39.73%). The majority of participants who spent more than 1 h in open public spaces during nighttime (43.62%) were the ones who engaged mostly in leisure activities and socialization (34.15%), while other activities such as walking the dog were less frequently present (4.88%).

Participants who stated that lighting was the spatial feature that influenced their usage of open public spaces the most were the ones between the age of 40–55 (34.62%), and mostly engaged in leisure activities and socialization (48.15%), using this space more than 1 h (40.74%). The participants who emphasized artificial lighting as the most important spatial feature for feeling safe and secure in spaces used the area for more than 1 h (42.11%), while the rest of the visitors used the area for around 30 min (39.47%), 10–15 min (13.16%), and a couple of minutes (5.26%).

Around one-third (30.74%) of all participants stated they felt comfortable and safe (they chose grades 4 and 5 on the satisfactory Likert scale), while more than half of those participants (54.93%) were women. Out of all the female population (60.17%) in this study, 28.08% stated that they felt comfortable and safe during the nighttime.

The space usage during nighttime and users' feeling comfortable and safe are presented in relation to dominant activity—leisure and socialization (Table 10). Feeling comfortable and safe decreased in the waterfront area during nighttime for all participants, except for the female population in the 25–40 age group. It is interesting that, for nighttime users, the female population stated that they felt more comfortable and safer than men.

**Table 10.** Activity duration in the waterfront area of participants who emphasized artificial lighting as the most important spatial feature for feeling comfortable and safe, presented in percentages.

Age	Space Usage during Nighttime %	Users Engaged in Leisure Activities and Socialization in These Spaces during Nighttime %	Users' Feeling Comfortable and Safe %	Users' Feeling Comfortable and Safe Male/Female %	Nighttime Users' Feeling Comfortable and Safe Male/Female %
18–25	31.43	31.82	24.28	32.26/17.95	10.00/25.00
25–40	41.46	23.53	37.80	34.38/40.00	30.77/33.33
40–55	52.31	50.00	29.23	36.00/25.00	21.43/25.00
55+	28.57	0	28.57	50.00/20.00	100.00/0.00

In this section, all of the results are presented, including the results of the observational study and the questionnaire results. In the next section, the discussion and interpretation of the results are presented.

## 5. Discussion

The results of expert observation and site analysis answered the aforementioned research questions. They showed how the change of lighting type—the shift from natural daylight (sun) to artificial lighting during nighttime—affects space usage, frequency of users, and their spatial distribution in open public spaces, as well as perceived feelings of safety and comfort in the waterfront area. The perception of space changed under the influence of lighting. Mapping outdoor activities and users' dynamics showed that the users' position and movement were defined by lighting distribution. Analysis has shown that the decrease in space livability at night is determined by space usage (differences in frequency, duration, and types of outdoor activities), thus emphasizing the fluid character of waterfront area usage, under the influence of lighting change. The absence of daylight limits the area for outdoor activities dependent on visibility. Expert observation (Table 1) and mapping of the users in different time periods during the day (Figure 4) showed how the frequency and overall dynamics of activity in the observed waterfront area declined significantly during nighttime (Table 5). This is in line with the questionnaire results, where more than half of the participants (59.31%) stated they used these spaces the most during the daytime (Table 4). However, the survey showed that almost a third of all participants (24.24%) preferred spending time on the waterfront during the nighttime. On the other hand, the duration of open space usage during nighttime, in the category of long visits (for more than 1 h) was increasing, as a consequence of the contemporary way of life in an urban context (Table 4).

The quality of the lighting situation during nighttime in the waterfront area was examined by quantitative and qualitative analysis of artificial lighting parameters. By measuring illuminance level, the analysis showed that minimum values were following the standards for lighting design of open public pedestrian spaces such as waterfront areas (Table 2). Regardless, the frequency of users decreased during nighttime (Figure 4 and Table 5). The quality artificial lighting was reduced only to the main pedestrian route—a paved path and seating area, while most of the greenery, as the place for the majority of leisure activities during the daytime, was in the dark zones (Figure 7). The results of the analysis suggest that the users' feeling of safety and security, especially in the greenery, was significantly reduced during nighttime.

The qualitative results of the questionnaire are in relation to the quantitative results—measured illuminance levels in the waterfront area give insight into the safety of open urban public space during nighttime. The observation and questionnaire results showed the trend of increasing recreational activities (walking, running, cycling, and exercise) and dog walking during nighttime (Table 4), as part of the contemporary lifestyle. This could be the result of adequate illuminance level of the main pedestrian path—the measured average level is 28 lx, which provides adequate illuminance level for the abovementioned outdoor activities (Table 2). The nighttime users mostly spent time in leisure and socialization (hanging out with friends) and recreational activities (Table 4). The majority of nighttime users who engaged in leisure activities and socialization in these spaces during nighttime were in the 40–50 year-old and 18–25 year-old age groups (Table 9). These types of activities require users to spend time outdoors, which is reflected in the questionnaire in the rise of nighttime visitors spending more than 1 h in the area compared to daytime visitors (Table 4). Socialization activities took place in the main pedestrian path and the area of access to the river and seating area, and according to the questionnaire, during nighttime most of the users (77.68%) were spending from 30 min to more than 1 h there (Tables 6 and 7 and Figure 4). When spending time in open spaces during nighttime, the most important spatial feature that influenced the position and means of usage for users was greenery and water proximity (Table 8). The measured average illuminance level of the seating

area was 6 lx, which is adequate lighting for these collective activities and a feeling of safety (people in the group feel safer) (Tables 2 and 7). Even though the measured average illuminance level of the green area of the open public space was 14 lx, the overall uniformity was 1:5, and the presence of tall greenery created an impression of an unsafe space with the appearance of shadows (Table 2, Figure 9). Nevertheless, the majority (74.47%) of all nighttime users still did not feel comfortable nor safe in this area. Hence, around one third (28.08%) of all participants in the survey stated they felt comfortable and safe, while more than half of those participants (54.93%) were female. The study, both expert observation (Table 1) and the survey (Table 3), showed that the majority of all waterfront area users were female (60.17% of all survey participants). Furthermore, the survey results showed that female users in almost all age groups felt more comfortable and safer than the male users during nighttime (Table 10). In general, these results are not in accordance with the previous recent studies. The study from 2021 showed that the female population were less-frequent open public space users compared to the male population, in almost every age category, because of concern for their personal safety during nighttime [85]. However, it is important to mention that even though it turns out that female participants felt safer than male participants during nighttime (Table 10), when we consider the overall usage of the waterfront area (daytime and nighttime), male users, in general, felt safer than women (Table 10), suggesting that a significant percentage of female users who stated they do not feel safe or comfortable in the waterfront at night simply choose not to use these spaces at all during nighttime.

Regarding the general topic and aim of this research, it is significant to emphasize that 40.43% of participants who used the waterfront area during the nighttime stated that lighting had the most influence on their movement, behavior, and usage (Table 8). The participants who used this area for more than one hour actually chose artificial lighting as the most important spatial feature. The overall satisfaction of users with the position and quality of artificial lighting in the waterfront area was graded as dissatisfactory, with an average grade of 2.62 (out of 5). The problem of unlit greenery and the area near the water presented dark, unsafe zones, and as such, they could be the reason that the elderly population (users aged 55+) avoided these areas during nighttime.

The results of the in-field analysis of outdoor lighting quality parameters were compared to the previous studies [6,74] which also included the illuminance level measured in open public pedestrian areas, as well as the lighting quality reflection on space usage. The three open public spaces which are compared are in residential neighborhoods (city districts) designed under the socialist paradigm in Belgrade, Serbia in the mid-20th century. All three existing lighting design solutions were based on the selection of the same urban lighting fixture that represents specific heritage features typically applied in open public spaces designed and built by the socialist paradigm in the former Yugoslavia. The light source is metal halide, with a nominal power of 100 W, and a warm white average temperature of approximately 2700 K. There are no additional lighting features in the open public space areas. The comparison (Table 11) is based on overlapping parameters analyzed in all three studies: lighting quality (physical arrangement of lights; horizontal illuminance level and overall uniformity; the users' feeling of being in a safe and secure space during nighttime), morphological characteristics (urban context and special characteristics, and geometry of open public areas) and space usage (dominant daytime and nighttime outdoor activities).

The comparative analysis shows that all three open public areas are designed for recreational and leisure (daytime) outdoor activities for residents in these districts. Although all three areas are in the open-formed modernist block, the geometry of public spaces is different, defined by dominant pedestrian paths. The lighting features following the main users' paths are the primary source of artificial lighting in the nighttime, and green areas are unlit. The spatial arrangement of lights depends on the geometry of space, even though the urban lighting fixture is the same, except for the lights' focal point height, which varies by 50 cm (when the distance of the light is smaller, the focal point is higher). The illuminance level in all three places conforms to the recommended values for average

horizontal illuminance, while the minimum level of horizontal illuminance is slightly under recommended values only in the case of the Dorćol district. The overall uniformity of lighting is a critical parameter of lighting quality regarding the users' perception of a safe and secure space. Albeit the IESNA, CIE, and BS EN standards do not consider this parameter as significant for pedestrian areas in residential zones (Table 2), in all three areas, the ratio of the minimum and the average level of horizontal illuminance is very high, which creates unevenness and significant deviation from the 1:10 ratio recommended for the horizontal illuminance uniformity ratio [100]. Therefore, unlit dark areas of greenery and the appearance of shadows have an impact on the decrease of outdoor activities during nighttime.

**Table 11.** Comparative analysis of three open public spaces in residential neighborhoods in Belgrade, Serbia.

Quality Parameters	Sava Waterfront Area, New Belgrade	Open-Formed Residential Blocks of the Dorćol District, Danube Waterfront Area	Residential Settlement: Eastern City Gate of Belgrade	
Lighting quality parameters	Physical arrangement of lights	Light focal point height: 4.7 m Light distance: 12–25 m	Light focal point height: 4.2 m Light distance: 16–18 m	Light focal point height: 4.2 m Light distance: 19–25 m
	Horizontal illuminance level and overall uniformity	Min: 1 lx Average: 16 lx Max: 50 lx Overall uniformity: 1:16	Min: 0.3 lx Average: 5.8 lx Max: 41 lx Overall uniformity: 1:19	Min: 1 lx Average: 16.5 lx Max: 70 lx Overall uniformity: 1:17
	The users' feeling of a safe and secure space during nighttime	Disturbed: unlit dark area (greenery)	Disturbed: unlit dark area (greenery)	Disturbed: unlit dark area (greenery and surrounding area)
Morphological characteristics	Urban context and special characteristics	Waterfront area in open-formed modernist block, open public space along neighborhood urban area	Open-formed modernist block, open public space in neighborhood urban area	Waterfront area, open-formed modernist block, open public space in neighborhood urban area
	Geometry of open public area	linear	rectangular	circular
Space usage	Daytime outdoor activities	Recreation and leisure activities, pedestrian paths to the restaurants' entrances	Pedestrian paths to the residential buildings' entrances, recreation and leisure activities	Pedestrian paths to the residential buildings' entrances, recreation and leisure activities
	Nighttime outdoor activities	Recreational outdoor activities decrease, leisure activities, pedestrian paths to the restaurants' entrances	Pedestrian paths to the residential buildings' entrances	Pedestrian paths to the residential buildings' entrances

## 6. Conclusions

The frequency of nighttime usage of open public spaces has increased in the last few decades. This paper focuses on the specific usage and spatial distribution of users in open public spaces, more particularly on artificial lighting and its impact on the overall dynamic of outdoor activities during different periods of the day. The paper reflects on the results from a case study of a traditional type of open public space, the waterfront of the Sava River in New Belgrade, Serbia. The main strengths of this study are that the topic of urban outdoor lighting is analyzed from different aspects that include, on the one hand, the objective viewpoint from expert observation and, on the other hand, a more subjective one, regarding user perception analyzed through a field survey.

The results showed that the shift from daytime to nighttime changes the way people use and perceive open public spaces. Furthermore, the quality of artificial lighting influences outdoor leisure and recreational activity, as well as the users' satisfaction and perception of safety and comfort. However, even though the quality of lighting is in line with all standards and recommendations, the users still felt unsafe and uncomfortable. The results of this research, which present the design and quality analysis of outdoor lighting, were compared to the similar previous studies, which included different types of open public space but very similar lighting quality situations. The compared results of the three studies showed that users' feeling of safety and of a secure space was related to the overall uniformity of lighting. The minimal and average illuminance level ratio in open public pedestrian areas should be considered in the process of lighting design, and the standards and recommendations regarding lighting quality should vary according to specific urban context and usage of space. Regarding the specific gender categories, there are certain inconsistencies between this study and previous research, in the domain of safety and comfort in the nighttime usage of open public spaces. This confirms the need to challenge uniform standards and recommendations for urban design of open public spaces, especially regarding artificial lighting parameters. Therefore, this study could contribute to future policymakers' taking into consideration local characteristics, such as cultural and geographical context, as well as the characteristics of user and usage, age, gender, and overall lifestyle.

The purpose of this research is to deepen knowledge about the nighttime usage of open public spaces, focusing on the aspect of lighting, as well as to intensify the research of academics and scholars regarding these topics. However, there are certain limitations observed in this study, such as the overall reliability and validity of the results gathered through the questionnaire, since it relies on the user's opinion, which can be subjective. In addition, the research was conducted on a specific type of open public space, a waterfront area, which could make the results limited to these types of open public spaces, with a specific urban context.

Possible future research could serve as a knowledge base for developing guidelines for sustainable urban design solutions regarding lighting design that may result in the improvement of social sustainability and overall livability at the city level and beyond. Considering the current unstable situation and the pandemic, the significance of livability and the active usage of open public spaces has proven to be even more important, due to their beneficial effects on social interaction, as well as physical activity and public health.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su14106058/s1>, Figure S1: The questionnaires.

**Author Contributions:** Conceptualization, I.R. (Ivana Rakonjac), A.Z., I.R. (Ivan Rakonjac), J.M. (Jelena Milošević), J.M. (Jelena Marić) and D.F.; methodology, I.R. (Ivana Rakonjac), A.Z. and J.M. (Jelena Marić); software, I.R. (Ivana Rakonjac), I.R. (Ivan Rakonjac) and J.M. (Jelena Milošević); formal analysis, I.R. (Ivana Rakonjac), A.Z., I.R. (Ivan Rakonjac), J.M. (Jelena Milošević) and J.M. (Jelena Marić); investigation I.R. (Ivana Rakonjac), A.Z., I.R. (Ivan Rakonjac) and J.M. (Jelena Marić); data curation, I.R. (Ivana Rakonjac), A.Z., J.M. (Jelena Marić) and D.F.; writing—original draft preparation, I.R. (Ivana Rakonjac), I.R. (Ivan Rakonjac), A.Z. and J.M. (Jelena Marić); visualization, I.R. (Ivana Rakonjac) and A.Z. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number 451-03-68/2020-14/200090.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Not applicable.

**Acknowledgments:** Technical support given by Meteor Ltd.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## References

- Đukić, A. *Design of Public Urban Space*; University of Belgrade, Faculty of Architecture: Belgrade, Serbia, 2021; ISBN 978-86-7924-251-8.
- Kalyukin, A.; Borén, T.; Byerley, A. The second generation of post-socialist change: Gorky Park and public space in Moscow. *Urban Geogr.* **2015**, *36*, 674–695. [[CrossRef](#)]
- Kristiánová, K. Post-Socialist Transformations of Green Open Spaces in Large Scale Socialist Housing Estates in Slovakia. *Procedia Eng.* **2016**, *161*, 1863–1867. [[CrossRef](#)]
- Hirt, S.; Stanilov, K. *Twenty Years of Transition: The Evolution of Urban Planning in Eastern Europe and the Former Soviet Union, 1989–2009*; United Nations Habitat: Nairobi, Kenya, 2009; ISBN 9789211321142.
- Ebbensgaard, C.L. Standardised difference: Challenging uniform lighting through standards and regulation. *Urban Stud.* **2020**, *57*, 1957–1976. [[CrossRef](#)]
- Rakonjac, I.; Rakonjac, I.; Zorić, A.; Djokić, V.; Milojević, M.P.; Rajić, M. Light as a Medium for Supporting Leisure Activities in Open Public Spaces. *Teh. Vjesn. Tech. Gaz.* **2022**, *29*, 157–171. [[CrossRef](#)]
- Winter, P.L.; Crano, W.D.; Basañez, T.; Lamb, C.S. Equity in access to outdoor recreation—informing a sustainable future. *Sustainability* **2020**, *12*, 124. [[CrossRef](#)]
- Frumkin, H.; Bratman, G.N.; Breslow, S.J.; Cochran, B.; Kahn, P.H.; Lawler, J.J.; Levin, P.S.; Tandon, P.S.; Varanasi, U.; Wolf, K.L.; et al. Nature contact and human health: A research agenda. *Environ. Health Perspect.* **2017**, *125*, 075001. [[CrossRef](#)] [[PubMed](#)]
- Fathi, S.; Sajadzadeh, H.; Sheshkal, F.M.; Aram, F.; Pinter, G.; Felde, I.; Mosavi, A. The role of urban morphology design on enhancing physical activity and public health. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2359. [[CrossRef](#)]
- Norwood, M.F.; Lakhani, A.; Fullagar, S.; Maujean, A.; Downes, M.; Byrne, J.; Stewart, A.; Barber, B.; Kendall, E. A narrative and systematic review of the behavioural, cognitive and emotional effects of passive nature exposure on young people: Evidence for prescribing change. *Landsc. Urban Plan.* **2019**, *189*, 71–79. [[CrossRef](#)]
- Gentin, S. Outdoor recreation and ethnicity in Europe—A review. *Urban For. Urban Green.* **2011**, *10*, 153–161. [[CrossRef](#)]
- Hartig, T.; Mitchell, R.; De Vries, S.; Frumkin, H. Nature and health. *Annu. Rev. Public Health* **2014**, *35*, 207–228. [[CrossRef](#)]
- Wolsko, C.; Lindberg, K.; Reese, R. Nature-Based Physical Recreation Leads to Psychological Well-Being: Evidence from Five Studies. *Ecopsychology* **2019**, *11*, 222–235. [[CrossRef](#)]
- Sepe, M. COVID-19 pandemic and public spaces: Improving quality and flexibility for healthier places. *Urban Des. Int.* **2021**, *26*, 159–173. [[CrossRef](#)]
- Milovanović, A.; Kostić, M.; Zorić, A.; Dordević, A.; Pešić, M.; Bugarski, J.; Todorović, D.; Sokolović, N.; Josifovski, A. Transferring COVID-19 challenges into learning potentials: Online workshops in architectural education. *Sustainability* **2020**, *12*, 24. [[CrossRef](#)]
- Van Eck, E.; van Melik, R.; Schapendonk, J. Marketplaces as Public Spaces in Times of The COVID-19 Coronavirus Outbreak: First Reflections. *Tijdschr. Voor Econ. En Soc. Geogr.* **2020**, *111*, 373–386. [[CrossRef](#)]
- Cheshmehzangi, A. Identity and Public Realm. *Procedia Soc. Behav. Sci.* **2012**, *50*, 307–317. [[CrossRef](#)]
- Liu, J.; Deng, Y.; Wang, Y.; Huang, H.; Du, Q.; Ren, F. Urban nighttime leisure space mapping with nighttime light images and POI data. *Remote Sens.* **2020**, *12*, 541. [[CrossRef](#)]
- Stevenson, D. The Arts and Entertainment: Situating Leisure in the Creative Economy. In *A Handbook of Leisure Studies*; Springer: Berlin/Heidelberg, Germany, 2006; pp. 354–362. ISBN 9780230625181.
- Liu, H.; Da, S. The relationships between leisure and happiness—A graphic elicitation method. *Leis. Stud.* **2020**, *39*, 111–130. [[CrossRef](#)]
- Boyce, P.R.; Eklund, N.H.; Hamilton, B.J.; Bruno, L.D. Perceptions of safety at night in different lighting conditions. *Light. Res. Technol.* **2000**, *32*, 79–91. [[CrossRef](#)]
- Jackett, M.; Frith, W. Quantifying the impact of road lighting on road safety—A New Zealand Study. *IATSS Res.* **2013**, *36*, 139–145. [[CrossRef](#)]
- Vogiatzaki, M.; Zerefos, S.; Tania, M.H. Enhancing city sustainability through smart technologies: A framework for automatic pre-emptive action to promote safety and security using lighting and ICT-based surveillance. *Sustainability* **2020**, *12*, 6142. [[CrossRef](#)]
- Rezvani, M.; Sadra, Y. Sociological Explanation of Fear of Crime in Public Spaces Case Study Mashhad. *Sociol. Criminol. Access* **2019**, *7*, 1–11. [[CrossRef](#)]
- Cho, Y.; Jeong, H.; Choi, A.; Sung, M. Design of a connected security lighting system for pedestrian safety in smart cities. *Sustainability* **2019**, *11*, 1308. [[CrossRef](#)]
- Mouratidis, K. Built environment and leisure satisfaction: The role of commute time, social interaction, and active travel. *J. Transp. Geogr.* **2019**, *80*, 102491. [[CrossRef](#)]
- Jansen, F.M.; Ettema, D.F.; Kamphuis, C.B.M.; Pierik, F.H.; Dijst, M.J. How do type and size of natural environments relate to physical activity behavior? *Health Place* **2017**, *46*, 73–81. [[CrossRef](#)] [[PubMed](#)]
- Smith, O. Holding back the beers: Maintaining ‘youth’ identity within the British night-time leisure economy. *J. Youth Stud.* **2013**, *16*, 1069–1083. [[CrossRef](#)]

29. Cao, Y.; Bai, Z.; Zhou, W.; Ai, G. Gradient Analysis of Urban Construction Land Expansion in the Chongqing Urban Area of China. *J. Urban Plan. Dev.* **2015**, *14*, 05014009. [\[CrossRef\]](#)
30. Kim, Y.-L. Data-driven approach to characterize urban vitality: How spatiotemporal context dynamically defines Seoul's nighttime. *Int. J. Geogr. Inf. Sci.* **2020**, *34*, 1235–1256. [\[CrossRef\]](#)
31. Henderson, K.A. The Imperative of Leisure Justice Research. *Leis. Sci.* **2014**, *36*, 340–348. [\[CrossRef\]](#)
32. Stewart, W. Leisure Research to Enhance Social Justice. *Leis. Sci.* **2014**, *36*, 325–339. [\[CrossRef\]](#)
33. Ngesan, M.R.; Karim, H.A.; Zubir, S.S. Human Behaviour and Activities in Relation to Shah Alam Urban Park during Nighttime. *Procedia Soc. Behav. Sci.* **2012**, *68*, 427–438. [\[CrossRef\]](#)
34. Jacobs, J. *The Death and Life of Great American Cities*; Vintage Books: New York, NY, USA, 1961.
35. Cartwright, K.; Mitten, D. Examining the influence of outdoor recreation, employment, and demographic variables on the human-nature relationship. *J. Sustain. Educ.* **2017**, *12*, 1–20.
36. Otto, S.; Pensini, P. Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Glob. Environ. Chang.* **2017**, *47*, 88–94. [\[CrossRef\]](#)
37. Salata, F.; Golasi, I.; Falanga, G.; Allegri, M.; De Lieto Vollaro, E.; Nardecchia, F.; Pagliaro, F.; Gugliermetti, F.; De Lieto Vollaro, A. Maintenance and energy optimization of lighting systems for the improvement of historic buildings: A case study. *Sustainability* **2015**, *7*, 10770–10788. [\[CrossRef\]](#)
38. Jägerbrand, A.K. New framework of sustainable indicators for outdoor LED (light emitting diodes) lighting and SSL (solid state lighting). *Sustainability* **2015**, *7*, 1028–1063. [\[CrossRef\]](#)
39. Kostic, A.M.; Kremic, M.M.; Djokic, L.S.; Kostic, M.B. Light-emitting diodes in street and roadway lighting—A case study involving mesopic effects. *Light. Res. Technol.* **2013**, *45*, 217–229. [\[CrossRef\]](#)
40. Kostic, M.; Djokic, L. Recommendations for energy efficient and visually acceptable street lighting. *Energy* **2009**, *34*, 1565–1572. [\[CrossRef\]](#)
41. Palmer, M.; Gibbons, R. Smart lighting for smart cities. In *Solving Urban Infrastructure Problems Using Smart City Technologies*; Elsevier: Amsterdam, The Netherlands, 2021; pp. 485–499.
42. De Paz, J.F.; Bajo, J.; Rodríguez, S.; Villarrubia, G.; Corchado, J.M. Intelligent system for lighting control in smart cities. *Inf. Sci.* **2016**, *372*, 241–255. [\[CrossRef\]](#)
43. Brock, K.; den Ouden, E.; van der Klauw, K.; Podoynitsyna, K.; Langerak, F. Light the way for smart cities: Lessons from Philips Lighting. *Technol. Forecast. Soc. Change* **2019**, *142*, 194–209. [\[CrossRef\]](#)
44. Cacciatore, G.; Fiandrino, C.; Kliazovich, D.; Granelli, F.; Bouvry, P. Cost analysis of smart lighting solutions for smart cities. In Proceedings of the 2017 IEEE International Conference on Communications (ICC), Paris, France, 21–25 May 2017; pp. 1–6.
45. Strielkowski, W.; Veinbender, T.; Tvaronavičienė, M.; Lace, N. Economic efficiency and energy security of smart cities. *Econ. Res. Istraž.* **2020**, *33*, 788–803. [\[CrossRef\]](#)
46. Gagliardi, G.; Lupia, M.; Cario, G.; Tedesco, F.; Gaccio, F.C.; Lo Scudo, F.; Casavola, A. Advanced adaptive street lighting systems for smart cities. *Smart Cities* **2020**, *3*, 1495–1512. [\[CrossRef\]](#)
47. Ewert, A.W. Outdoor recreation and global climate change: Resource management implications for behaviors, planning, and management. *Soc. Nat. Resour.* **1991**, *4*, 365–377. [\[CrossRef\]](#)
48. Shahavuddilz, A.; Noovazuan, M.H.; Yaukub, M.J.; Kadamddin, A.; Mahamod, M.F. The effects of different land uses on the temperature distribution of a humid tropical urban centre. *World Appl. Sci. J.* **2011**, *13*, 63–68.
49. Aalto, H.E.; Marcus, L.; Torsvall, J. Towards a social-ecological urbanism: Co-producing knowledge through design in the Albano Resilient Campus project in Stockholm. *Sustainability* **2018**, *10*, 717. [\[CrossRef\]](#)
50. Oğuz, D.; Çakci, I. Changes in leisure and recreational preferences: A case study of Ankara. *Sci. Res. Essays* **2010**, *5*, 721–729.
51. Gold, S.M. *Recreation Planning and Design*; McGraw Hill: New York, NY, USA, 1980.
52. Maric, J.; Aleksandra, D.; Antonic, B.; Furundzic, D.; Parezanin, V. The Effects of Open Space on Reducing Workplace Stress: Case Study of Business Park in the Post-Socialist Urban Setting. *Sustainability* **2021**, *13*, 336. [\[CrossRef\]](#)
53. Gehl, J. *Cities for People*; Island Press: Washington, DC, USA, 2010.
54. United Nations Human Settlements Programme (UN-Habitat). *UN-Habitat Globalactivities Report 2015. Increasing Synergy For greater National Ownership*; UN: Nairobi, Kenya, 2015.
55. Spirn, A.W. Ecological Urbanism: A Framework for the Design of Resilient Cities (2014). In *The Ecological Design and Planning Reader*; Island Press/Center for Resource Economics: Washington, DC, USA, 2014; pp. 557–571.
56. Andersson, C. Public Space and the New Urban Agenda. *J. Public Sp.* **2016**, *1*, 5. [\[CrossRef\]](#)
57. *Place Identity, Participation and Planning*; Hague, C.; Jenkins, P. (Eds.) Routledge: London, UK, 2004; ISBN 0415262410.
58. Winter, P.L.; Selin, S.; Cervený, L.; Bricker, K. Outdoor recreation, nature-based tourism, and sustainability. *Sustainability* **2020**, *12*, 81. [\[CrossRef\]](#)
59. Boyce, P.R.; Gutkowski, J.M. The if, why and what of street lighting and street crime: A review. *Light. Res. Technol.* **1995**, *27*, 103–112. [\[CrossRef\]](#)
60. Iqbal, A. Inclusive, Safe and Resilient Public Spaces: Gateway to Sustainable Cities? In *Urban Transition—Perspectives on Urban Systems and Environments [Working Title]*; IntechOpen: London, UK, 2021. [\[CrossRef\]](#)
61. Lefebvre, H. *Critique of Everyday Life*; VERSO: London, UK; New York, NY, USA, 1991; ISBN 9781626239777.
62. Lynch, K. *The Image of the City*; The M.I.T. Press: Cambridge, MA, USA, 1960; ISBN 0262620014.

63. Golledge, R.G. Human Wayfinding and Cognitive Maps. In *Wayfinding Behavior: Cognitive Mapping and Other Spatial Processes*; Johns Hopkins University Press: Baltimore, MD, USA, 1999; pp. 5–45.
64. Rakonjac, I.; Jerković-Babović, B. Fluidity of open public space boundary. In *Birth in Music New Born Art, Book III. Proceedings of 13th International Conference FILUM, Serbian Language, Literature, Art—New Born Art, Kragujevac, Serbia, 26–27 October 2018*; Mandić, B., Atanasijević, J., Eds.; FILUM: Kragujevac, Serbia, 2019; pp. 379–390.
65. Spasenović, V.; Rakonjac, I. Mapping Belgrade’s Cultural and Historical Ambiental Unities: Application of Psychogeographic Methodse. In *Birth in Music New Born Art, Book III. Proceedings of 13th International Conference FILUM, Serbian Language, Literature, Art—New Born Art, Kragujevac, Serbia, 26–27 October 2018*; Mandić, B., Atanasijević, J., Eds.; FILUM: Kragujevac, Serbia, 2019; pp. 391–399.
66. Spasenović, V.; Rakonjac, I. Atmospheric Unities of Skadarska Street In Belgrade. In *Expressiveness and Intimacy in Music and Such Small Things: Intimate in Art and Culture. Proceedings of 14th International Conference FILUM, Serbian Language, Literature, Art, Kragujevac, Serbia, 25–27 October 2019*; Mandić, B., Atanasijević, J., Eds.; FILUM: Kragujevac, Serbia, 2020; pp. 219–229.
67. Lefebvre, H. *The Production of Space*; Blackwell Publishing: Oxford, UK; Cambridge, UK, 1991.
68. Leontiadis, S. The Architecture of Public Open Urban Spaces, How to Define a Syntax in the Contemporary Urban Environment. In Proceedings of the PHIDAC III International Symposium, Novi Sad, Serbia, 21–23 September 2011; University of Novi Sad: Novi Sad, Serbia, 2011; Volume 1, pp. 141–148.
69. Zlatanova, S.; Yan, J.; Wang, Y.; Diakité, A.; Isikdag, U.; Sithole, G.; Barton, J. Spaces in Spatial Science and Urban Applications—State of the Art Review. *Int. J. Geo-Inf.* **2020**, *9*, 58. [[CrossRef](#)]
70. Madanipour, A. *Design of Urban Space. An Inquiry into a Socio-Spatial Process*; John Wiley & Sons: New York, NY, USA, 1996.
71. Bell, P.A.; Fisher, J.D.; Baum, A.S.; Greene, T.C. *Environmental Psychology*; Holt, Rinehart & Winston: London, UK, 1990.
72. Rakonjac, I. *Phenomenon of the Open Public Space Boundary and the Emphasis of its Prominence by Lighting*; University of Belgrade, Faculty of Architecture: Belgrade, Serbia, 2016.
73. Sumartojo, S.; Pink, S. Moving Through the Lit World: The Emergent Experience of Urban Paths. *Sp. Cult.* **2018**, *21*, 358–374. [[CrossRef](#)]
74. Ebbensgaard, C.L. Making sense of diodes and sodium: Vision, visuality and the everyday experience of infrastructural change. *Geoforum* **2019**, *103*, 95–104. [[CrossRef](#)]
75. Rakonjac, I.; Fotirić, N.; Rajković, I.; Gašić, M. Lighting Features Life Cycle Analysis for a Lighting System. *Struct. Integr. Life* **2016**, *16*, 81–86.
76. Rakonjac, I.; Dokić, V.; Gašić, M.; Jerković-Babović, B. Contemporary lighting solutions in the historic urban landscape: Project-oriented approach. In Proceedings of the 5th IPMA SENET Project Management Conference, Belgrade, Serbia, 19–21 May 2019; Obradović, V., Todorović, M., Eds.; Atlantic Press: Belgrade, Serbia, 2020; Volume 108, pp. 143–150.
77. Gehl, J. *Life between Buildings: Using Public Space*; Island Press: Washington, DC, USA, 2011.
78. People Place. *Design Guidelines for Urban Open Space*, 2nd ed.; Marcus, C.C., Francis, C., Eds.; John Wiley and Sons: New York, NY, USA, 1998.
79. Green, J.; Perkins, C.; Steinbach, R.; Edwards, P. Reduced street lighting at night and health: A rapid appraisal of public views in England and Wales. *Health Place* **2015**, *34*, 171–180. [[CrossRef](#)]
80. Ceccato, V.; Nalla, M.K. Crime and fear in public places: An introduction to the special issue. *Int. J. Comp. Appl. Crim. Justice* **2020**, *44*, 261–264. [[CrossRef](#)]
81. Van Rijswijk, L.; Haans, A. Illuminating for Safety: Investigating the Role of Lighting Appraisals on the Perception of Safety in the Urban Environment. *Environ. Behav.* **2018**, *50*, 889–912. [[CrossRef](#)] [[PubMed](#)]
82. Di Salvo, S. Innovation in lighting for enhancing the appreciation and preservation of archaeological heritage. *J. Cult. Herit.* **2014**, *15*, 209–212. [[CrossRef](#)]
83. Cafuta, M.R. Visual perception and evaluation of artificial night light in Urban open areas. *Informatologia* **2014**, *47*, 257–263.
84. Đokić, V.; Rakonjac, I. Analysis of the Way and Surroundings in Which Lighting Forms Architectural Ambience Within Public Open Space: Case Study of the Skadarlija Pedestrian Zone in Belgrade. In Proceedings of the 12th International Conference—Standardization, Prototypes and Quality: A Means of Balkan Countries’ Collaboration, Izmit, Turkey, 22–24 October 2015; Erdoğan, N., Ed.; Kocaeli University: Izmit, Turkey, 2015; pp. 119–126.
85. Navarrete-Hernandez, P.; Vetro, A.; Concha, P. Building safer public spaces: Exploring gender difference in the perception of safety in public space through urban design interventions. *Landsc. Urban Plan.* **2021**, *214*, 104180. [[CrossRef](#)]
86. DiLaura, D.L.; Houser, K.W.; Mistrick, R.G.; Steffy, G.R. *The Lighting Handbook*; Illuminating Engineering Society of North America: New York, NY, USA, 2011; ISBN 978-0-87995-241-9.
87. CIE Technical Committee 4-44. *CIE 115—Lighting of Roads for Motor and Pedestrian Traffic*; CIE: Vienna, Austria, 2010; Volume 37.
88. B.S.I.S. *BSI Standards Publication Road Lighting Part 2: Performance Requirements*; B.S.I.S.: Sacramento, CA, USA, 2015.
89. Yin, R.K. *Case Study Research and Applications: Design and Methods*; Sage: Thousand Oaks, CA, USA, 2018.
90. Kostić, M. *Vodič Kroz Svet Tehnike Osvetljenja [The World of Lighting Technology Guide]*; Minel-Schreder: Beograd, Serbia, 2000.
91. Mecanov, D. Mogućnosti (re)definisanja i predlog periodizacije graditeljskog nasleđa. *Nasleđe* **2007**, *8*, 151–170.
92. Marušić, D. Prikaz konkursnih projekata 1965–1975. *Arhit. Urban.* **1975**, *74–77*, 45–84.
93. Blagojević, L. *New Belgrade: Contested Modernism*; Faculty of Architecture: Belgrade, Serbia, 2007.



94. Đukić, A. New Belgrade: Visions, plans and realizations 1950–2014. In *Planning Capital Cities. Belgrade, Bucharest, Sofia*; Doytchinov, G., Djukić, A., Ionitã, C., Eds.; TU Graz: Graz, Austria, 2015; pp. 160–173.
95. Backović, V. *Socio-Spatial Development of New Belgrade*; Čigoja: Belgrade, Serbia, 2010.
96. Petrović Balubdžić, M. *Planning and Designing the Belgrade Urban Waterfront Structure: Urban Landscape Transformation and Treatment of Heritage*; University of Belgrade, Faculty of Architecture: Beograd, Serbia, 2018.
97. Vuković, K. The Nightlife in Serbia’s Capital has been Touted as the Best in the Balkans—And These Rafts Make Every Night Feel Like a Friday. Available online: <https://www.bbc.com/travel/article/20170822-belgrades-floating-river-clubs> (accessed on 20 November 2021).
98. Shurvell, J. Best of Belgrade, Serbia. Available online: <https://www.forbes.com/sites/joanneshurvell/2019/09/30/best-of-belgrade-serbia/?sh=323e53d02ecd> (accessed on 20 November 2021).
99. B.S.I.S. *BSI Standards Publication Road Lighting of Lighting Classes*; B.S.I.S.: Sacramento, CA, USA, 2014.
100. Hebert, P.; Sammons, T.; Kang, M.; Lee, H.J. Pedestrian and bike path illumination for safety and security: Empirical pre- and post-field studies by a university team. *Urban Transp. XIX* **2013**, *130*, 745–755. [[CrossRef](#)]