FACTORS OF THE URBAN SPACE SUPPORTING RECREATION AND THEIR INFLUENCE ON THE ENVIRONMENT

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Abstract
The paper focuses on the investigation of the dependence of specific elements of urban space, which also support recreation, on selected environmental influences. The basic functions of urban space include not only the satisfaction of physiological needs, but also psychological needs. Urban space is usually closely related to urban planning, which includes parts of the landscape to which the settlement pattern is related. For the purpose of this research, public green spaces and water areas were chosen as the monitored elements in urban space. The database included 518 points in which the above dependency was investigated. The points represented physical locations on the map, which were located in the city centre of Brno and the adjacent urban districts. The dependence under consideration is detected using a non-parametric test that allows comparing two groups or conditions without assuming that the data are normally distributed. The results of the research defining the examined dependencies can help those involved in urban planning to understand more about the importance of public green spaces and water areas so that their recreational potential can be exploited at the same time.

Key words: Environment, dependence, nonparametric test, green spaces, water areas.

Introduction

Cities occupy 2% of the Earth's surface, but consume 60-80% of energy and produce about 75% of emissions. (Yang et al. 2021, Bibri et al. 2020) Modern urban planning is now seeking to take environmental factors more seriously into account in urban planning. Environmental and ecological urbanism is an urban architectural landscape style that focuses on the ecological aspects of the city. These considerations include the amount and type of green space as well as the amount, size and type of water bodies. (Ostarek 2021)

Heat waves are getting longer, more intense and also more frequent, which has a negative effect on the physical and mental health of urban dwellers. At the same time, these adverse effects can be mitigated. (Yang et al. 2021) One indicator of urban climate is the higher nighttime temperature in cities compared to rural areas. This phenomenon is known as the urban heat island. (Vescovi et al. 2005) Increased evaporation can reduce air temperature, thereby mitigating the heat island and increasing the thermal comfort of residents. Published studies show that shaded areas of a city can reach up to half the temperature of unshaded areas. The problem of overheating in urban areas is generally where there is not enough green space. In addition, publications also point out that green spaces play an important role in overall climate regulation and protection from noise, dust and exhaust fumes. (Yang et al. 2021) For this reason, the integration of green spaces into a compact functional urban environment is suggested. These include urban parks, street greenery, green corridors, community gardens, greening of waterways, courtyards, roof gardens and vertical gardens. Urban greenery can shade buildings, regulate the urban microclimate, mitigate the heat island effect and promote biodiversity. It also reduces energy consumption to air condition buildings. The ability of greenery to reduce carbon dioxide through photosynthesis contributes to reducing the carbon footprint. (Fok et al. 2018)

The rise and renovation of green spaces in cities has also increased the availability and use of these places for recreational activities. Physical exercise can be observed in parks of widely varying sizes. The same is true for recreational activities such as reading, sunbathing or playing chess. The development of biodiversity then extends these activities to the experience of birdsong, butterfly watching, etc. In addition, urban greenery acts as a pull factor for tourism. Tourism can be supported by its ecological and cultural benefits, as together with its cultural or historical function, it can attract more tourists and ecotourism environments. (Fok et al. 2018) In terms of psychology and medicine, the presence of greenery in the city helps in regenerating human fatigue, promoting eyesight, digestion, and maintaining body temperature. (Trstenjak 1984) Professor Franek from the University of Hradec Kralove states that the sight of natural scenery leads to improved memory and concentration. Patients in hospitals recovered faster when they had a view of trees from their beds. Children with

attention deficit disorders had fewer symptoms when in nature. Other sociological research indicated that women living in apartment buildings surrounded by greenery concentrated better than women who lived in apartments without green surroundings. (Franek et al. 2002)
Some authors include water areas (blue space) in green spaces. In fact, most water bodies contain vegetation and thus function as green spaces within the ecosystem, even though they are hidden under water. (Gaston 2010) Water is also commonly used in urban planning as a decorative element of public places. (Kleerekoper et al. 2012) Its cooling effects have been studied for a long time. For example, in 2009, Chinese scientist Xu studied the effect of a body of water on thermal comfort for tropical days with air temperatures above 35 °C, and his results suggest that bodies of water with a surface area greater than 2 104 m2 significantly cool coastal zones. (Mei et al. 2009) A Polish model study in 2004 pointed out that small ponds (4 m2) also cool their surroundings. (Robitu 2003) Other scientific work highlights the cooling effect of a lake with a temperature of 15 °C, where it can achieve a reduction of 1.5 °C to 2 °C in areas close to the lake. At the same time, this study concludes that the size of the water surface has a non-linear effect on air temperature. This means that several smaller lakes have an impact on a larger area of a city than one large lake. Water bodies can also affect temperature in more distant areas, with cooler air originating from the lake being driven by the wind to create an airflow over a range of several kilometers. The cooling effect is closely related to the water temperature and the time of day. While in spring, when the water surface is cold, it has a cooling effect on the air temperature, in autumn, when the water is heated and the water temperature is higher than the air temperature at night, it has a warming effect. Here it can be seen that lakes within a city can be a cooling feature during the day, but can also be responsible for warming the air during the night hours. In this way, the lake acts as a buffer to the diurnal temperature cycle. (Theeuwes et al. 2013)

Materials and methods
The subject of this paper is to investigate and find the dependence of specific elements of urban space, which also support recreation, on selected environmental influences. Public green spaces and water areas are selected as elements of urban space. Day noise, night noise, immission and temperature were chosen as the environmental factors for which the influence was investigated. The schematic of the investigated relationship and the links between the investigated elements and influences are shown in Figure 1.

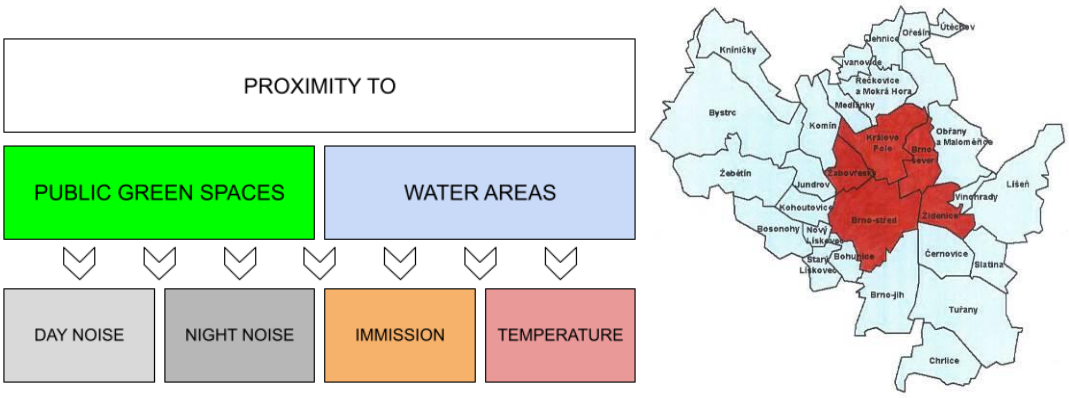

Fig. 1: The schematic of the investigated elements and influences with showing the locations of the study area Brno city

First, a process of searching, selecting and evaluating selected sites in the area was carried out. In these sites, 518 points were identified and data and information were collected with respect to the subject of investigation. The points represented physical locations on the map, which were located in the city centre of Brno and adjacent urban districts, as shown in Figure 1.
Subsequently, data on the selected environmental factors for which the effect was investigated were compiled. Noise was determined from a noise load model at a height of 4 m above ground level, for daytime hours between 6 and 22 hours, and for nighttime hours between 22 and 6 hours available from the noise map produced by ENVING. The data on immissions reflect the total immission load of NO2 in the average annual concentration, obtained from the available feasibility study on the territory of the city of Brno. Temperature data were obtained from hyperspectral imaging of the Brno city area on the last day of August 2019 from the UrbanAdapt project application.
Testing and statistical analysis was performed using the nonparametric Mann-Whitney test, which allows comparison of two groups or conditions without assumptions that the values are normally distributed, corresponding to a Gaussian normal distribution. The Mann-Whitney test determines

whether there is a statistically significant difference between two unrelated, independent groups on a dependent variable. This test was chosen on the basis of verifying and then rejecting the normality of the collected data.

Results

Non-parametric Mann-Whitney test was performed at 0.05 level of significance, 95% confidence interval. Separately for the urban space element of public green space and water areas. The chosen limit value for the distance between public green spaces and water areas is based on experience from previous research.

Tab. 3: Descriptive statistics of results from the Mann-Whitney test for public green spaces.

VARIABLE	POINT ESTIMATE	95% CI	W	P-VALUE	ADJUSTED P-VALUE
DAY NOISE	5,000	0,001;5,001	67539,5	0,0041	0,0037
NIGHT NOISE	0,000	0,000;5,000	67042,5	0,0100	0,0086
IMMISSION	0,600	0,000;1,130	66469,0	0,0253	0,0243
TEMPERATURE	2,000	1,000;3,000	79133,0	<0,0001	<0,0001

Table 1 provides useful descriptive statistics for the two independent groups of public green spaces being compared. The first group includes public green spaces in close proximity (being within 300 m of the selected point). The second group does not include public green space in close proximity (being further than 300 m from the selected point). Based on the statistical test, a significant median difference was found for all environmental effects examined due to public green space in close proximity to the selected physical point examined.

Tab. 4: Descriptive statistics of results from the Mann-Whitney test for water areas.

VARIABLE	POINT ESTIMATE	95% CI	W	P-VALUE	ADJUSTED P-VALUE
DAY NOISE	5,000	0,000;5,000	68137,5	<0,0001	<0,0001
NIGHT NOISE	5,000	5,000;4,999	69338,5	0,0100	0,0086
IMMISSION	0,990	0,710;2,120	66833,0	0,0002	0,0002
TEMPERATURE	2,000	1,000;3,000	67795,0	<0,0001	<0,0001

Table 2 provides useful descriptive statistics for the two independent groups of water areas being compared. The first group includes water areas in close proximity (being within 1 km of the selected point). The second group does not include water areas in close proximity (being further than 1 km from the selected point). Based on the statistical test, a significant median difference was also found identically for all environmental effects examined due to water bodies in close proximity to the selected physical point examined.

The adjusted p-value is more accurate. The unadjusted p-value is higher than the adjusted p-value, so it is considered a more conservative estimate.

Discussion

It is verified from the research and publications focusing on the issue of examining environmental impacts in the urban environment that green and water areas that help regulate the climate will need to be taken into account when planning cities or new construction in cities. The authors of this paper have taken inspiration from these researches and publications and in their case study they have investigated the relationship between green and water areas respectively and the selected environmental factors obtained from available public sources. It has been shown that the creation and restoration of public green spaces and water areas in cities has the potential to improve the overall climate while harnessing their recreational potential.

Conclusion

The aim of this research was to investigate selected elements of urban space that also support recreation in relation to selected environmental dependence. These were public green spaces and water areas. The dependence was demonstrated on specific factors - day noise, night noise, immissions and temperature. Data on specific values were obtained from publicly available sources. For this purpose, the authors compiled a database in which the above dependence was examined. A statistically significant effect on environmental factors was demonstrated in the case of public green spaces within 300 m of the investigated site and in the case of water areas within 1,000 m of the investigated site.

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Souhrn

Článek se zaměřuje na zkoumání závislosti konkrétních prvků městského prostoru, které současně podporují rekreaci, na vybrané vlivy životního prostředí. Sledovanými prvky v tomto výzkumu jsou zvoleny veřejná zeleň a vodní plochy. Faktory životního prostředí tvoří hluk ve dne, hluk v noci, imise a teplota. Do databáze je zařazeno celkem 518 bodů, ve kterých je výše uvedená závislost zkoumána. Body přestavují fyzická místa na mapě, která se nacházejí v centru města Brna a navazujících městských částech. Uvažovaná závislost je zjišťována pomocí neparametrického Mannova-Whitneyho testu. Tento test byl zvolen na základě ověření a následného zamítnutí normality shromážděných dat. Na základě výsledku statistického testu byl zjištěn významný mediánový rozdíl, tedy statisticky významný vliv na faktory životního prostředí v případě veřejné zeleně do 300 m od zkoumaného místa a v případě vodních ploch do 1 000 m od zkoumaného místa. Bylo prokázáno, že vznik a obnova veřejné zeleně a vodních ploch ve městech má potenciál zlepšit celkové klima a zároveň využít jejich rekreační potenciál. Výsledky výzkumu tak mohou napomoci osobám zabývajícím se plánováním v městském prostoru více porozumět významu veřejné zeleně a vodních ploch.

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