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Influence of vegetation on surface temperature in urban areas

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Abstract

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There is an evident influence of vegetation on surface temperature and microclimate. To prove this statement, and to ensure the comparability, two areas with different ratio of the vegetation and the paved surface in the city of Nitra have been selected. The first area being assessed is almost fully covered by the vegetation; the second one is almost fully paved by the concrete and the asphalt. Both areas have been regularly observed during the period between March and June 2012. Taking into consideration different surfaces (paved area, turf surface, vegetation) as well as the correlation between the distance from the vegetation and its quantity, the surface temperature has been measured by tactile IR thermometer. Remarkable temperature differences between particularly observed spots as well as considerable differences between both researched areas have been noticed.

Keywords

microclimate, surface temperature, urban area, vegetation

Introduction

Shrubs, trees and vegetation cover in general have the importance and bring many benefits without any doubt. Many Slovak and foreign authors were dealing with different functions of vegetation. Classification of the various authors is not the same, but it can be said that the core of the evaluation must remain the same. The different is usually the order of importance of these functions, the hierarchy of the classification and the level of the punctuality (Supuka, 1993).

That is the reason why some of the authors evaluate the functions of vegetation according to different criteria, but none of them opposes that the vegetation is an irredeemable part of the urban organism. The greenery has a soil protecting (Lisický, 1991, Slávikova, 1992), water protecting (Punz, 1984), ecological (Young and Longcore, 2000) or even aesthetic (Supuka, 1993) function. The vegetation even creates some kind of spatial frame for social contacts so it bears even social function. In addition to the aforementioned attributes, greenery has as well as microclimatic function as it positively affects the local microclimate (Jasenka, 2011). The influence of the vegetation on the microclimate is more evident in tropical conditions, with the extreme climate and more evident differences, as Spangenberg et al. (2009) cite. The differences of the temperature of the surfaces closer to the greenery and the wholly paved surfaces without any greenery can be even up to 12 °C. In our climate conditions the authors mention smaller but evident differences between the temperature of the surrounding air of the streets with and without trees, from 0.5 °C (Grunow, 1932) up to 2.1 °C (Reháčková and Pauditšová, 2006).

The aim of the paper is to define the differences in the surface temperatures and in the relative air humidity between the spaces with plenty of greenery (City park – Mestský park) and the spaces without any greenery (space in front of the shopping mall OC Mlyny – OC Mlyny) in the period when the differences between the observed months could be quite different (from the beginning of frondescence up to the full leaf period).

Material and methods

The entries of the microclimate, such as the relative air humidity and the surface temperature, have been selected at two places in the intravilan of Nitra town from March to June 2012.

The observed areas have an allocation of 50 × 50 m. They have been selected according to very different conditions regarding to quantity and the distribution of greenery they are having.

Locality n. 1 (Fig. 1) Mestský park (City park) was selected as a representative sample for an area that is almost fully covered by greenery, with the greenery cover of 90–100%.

All elements of vegetation with all kinds of texture and structure in all of the etages are being presented on this locality. This locality has been compared with the locality n. 2 in front of the shopping mall OC Mlyny (Fig. 2). This is the area with different conditions created by the paved surface and the higher density of buildings surrounding this locality, mostly. There is minimum vegetation mostly represented by alley of de-

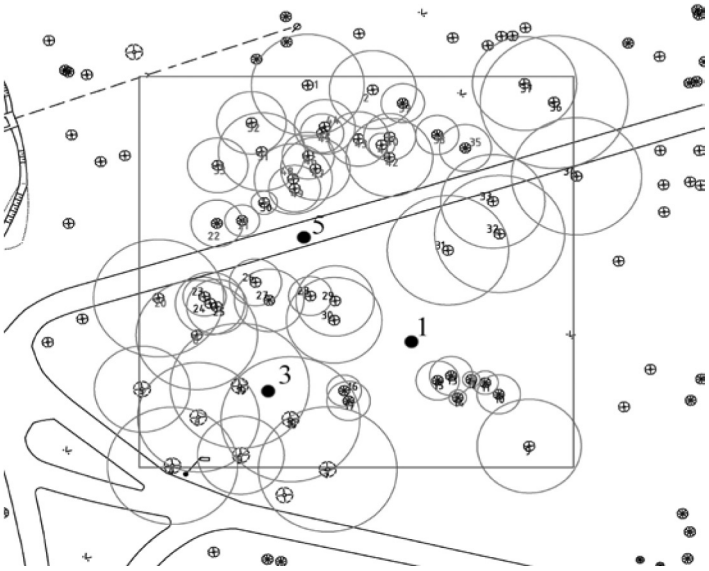

Fig. 1. Locality n. 1 Mestský park.

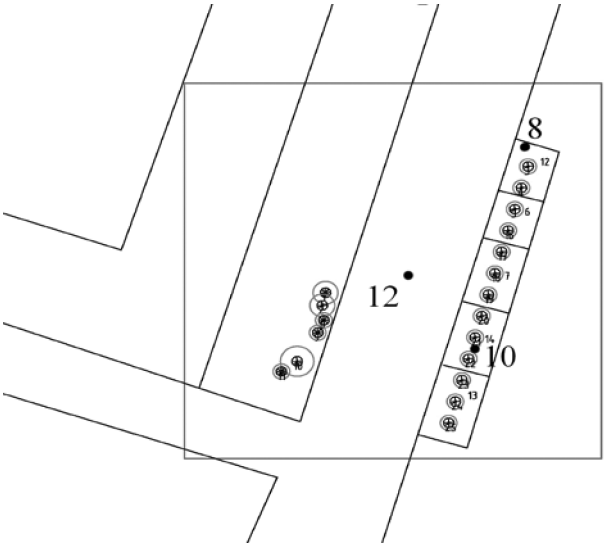

Fig. 2. Locality n. 2 OC Mlyny.

ciduous trees (*Betula pendula* Roth) with the rare subcanopy of evergreen shrubs *(Taxus baccata* L.). Both of the localities contain the grass area being in a different ratio with the built-up area and with the area with greenery.

Both of the localities were regularly monitored always in the same week of the month, starting with the second week of the month, from Monday, always at 8.00 am, 3.00 pm and 10.00 pm. The data about the relative air humidity and the surface temperature of the localities being monitored, were recorded each time at the same spots – sublocalities (Locality n. 1: spot n. 1 – spot with a grass surface, spot n. 3 – vegetation cover, spot n. 5 – paved surface; Locality n. 2: spot n. 8 – spot with a grass surface, spot n. 10 – vegetation cover, spot n. 12 – paved surface) with 5-time repeated frequency, that was later averaged. The data were measured with an infrared thermometer Testo 845 and statistically processed by the Statgraphics program by using the single factor (one way) analyses of ANOVA diffusion and LSD test.

Results and discussion

After testing the correlation of the sublocalities with surface temperatures of the monitored areas it has been found that there is not such the remarkable correlation. Based on this fact it can be alleged that the distance of the sublocality from the vegetation doesn´t have a crucial influence on the general relative air humidity (Fig. 3) or the differences are so minimal that the distance doesn´t affect the surface temperature of the monitored sublocalities at the same time (Fig. 4).

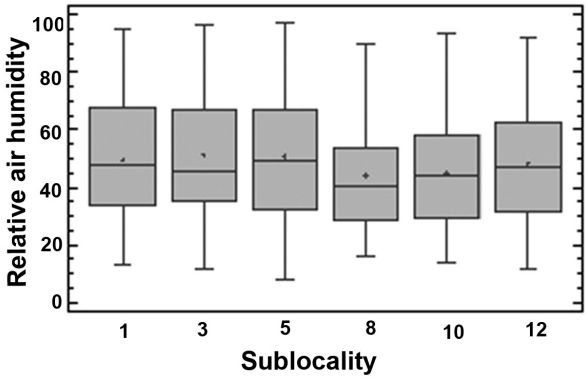

Fig. 3. Correlation of the sublocality and relative air humidity.

Arising from the sequential evaluation it can be stated that the general presence and the structure of the vegetation elements in the ratio to the built-up elements have the greater influence on the microclimate than the composition of these elements in the area. Such the ratio influences the microclimate remarkably.

The difference between the relative air humidity at the monitored period of two observed localities is remarkable – the relative air humidity at the loc. 1 Mestský park (City park) is 6% higher than the relative air humidity at the loc. 2 OC Mlyny (Fig. 5).

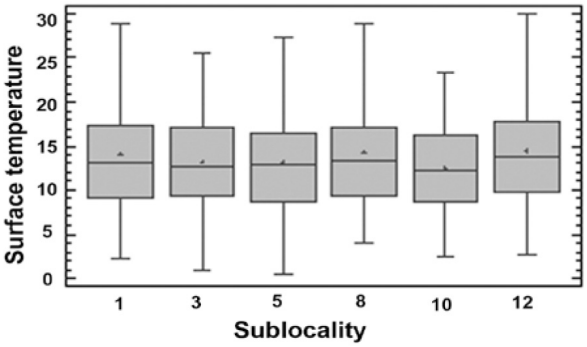

Fig. 4. Correlation of sublocality and surface temperature.

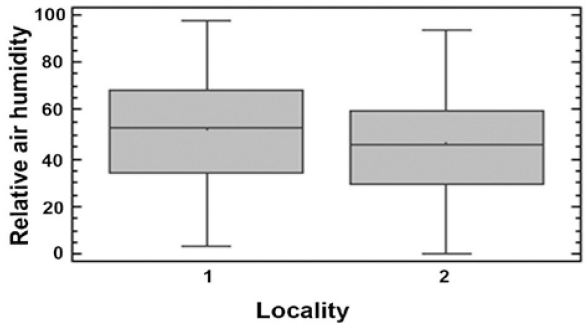

Fig. 5. Differences between the localities in relative air humidity.

The influence of the vegetation on the overall surface temperature in the monitored period is evident; the area with a higher proportion of greenery (Mestský park) is 1 °C cooler comparing the area where the proportion of the greenery is minimal (OC Mlyny) (Fig. 6).

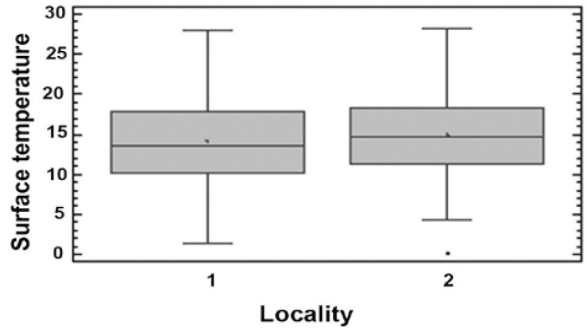

Fig. 6. Differences between the localities in surface temperatures.

The hypothesis that a particular phase of the day markedly affects the microclimatic conditions on both of the monitored areas was approved. Dealing with the relative air humidity, the air humidity at the Loc. 1 –

Mestský park (City park) is the highest in the morning, with 63% of the relative air humidity being measured. The lowest value, 20% lower than in the morning (41%) has been reflected during the lunch time. The value measured during the evenings was just a bit lower than the value measured during the mornings (61%) (Fig. 7).

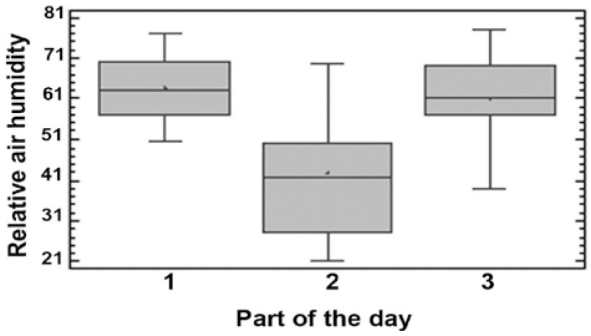

Fig. 7. Differences in relative air humidity between the phasis of the day.

The microclimatic data dealing with the relative air humidity being determined are in correlation with the changing temperature during the day – the surface temperature is higher thus the relative air humidity is lower. The surface temperature of the Loc. 1 Mestský park (City park) was the lowest one in the morning, with the average temperature of 7 °C being measured. In opposite, the highest average surface temperature reached 14 °C during the noon time. The average night surface temperature reached 9 °C (Fig. 8).

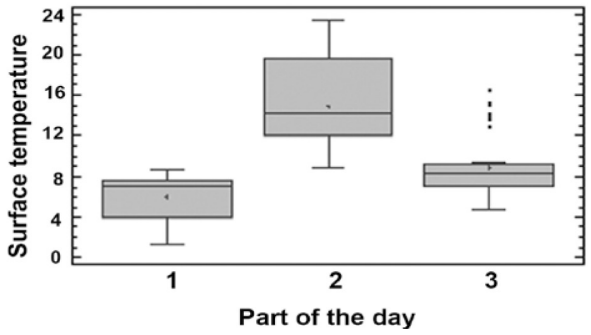

Fig. 8. Differences in surface temperature between the phasis of the day.

Similarly to the Loc. 1, the lowest average relative air humidity at the Loc. 2 – OC Mlyny, was reached during the noon time (36%), while the average relative air humidity during the morning and the evening was quite similar (50%) (Fig. 9).

Dealing with the average surface temperature in the monitored period, same as at the locality of Mestský park (City park), similarly at the locality of OC Mlyny, the highest value was reached during the noon time (18 °C). There were not such the evident differences between the average surface temperature being measured in the evening and the morning. The average surface temperature measured in the morning was 12 °C, while the average surface temperature measured in the evening was 13 °C (Fig. 10).

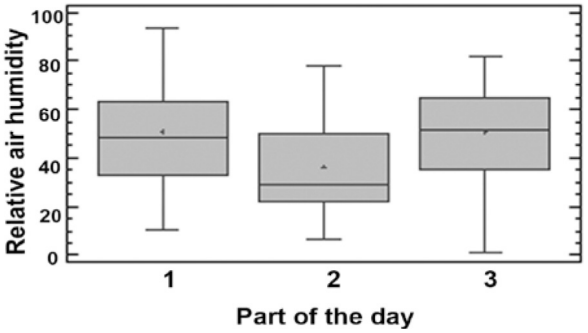

Fig. 9. Differences in relative air humidity between the phasis of the day.

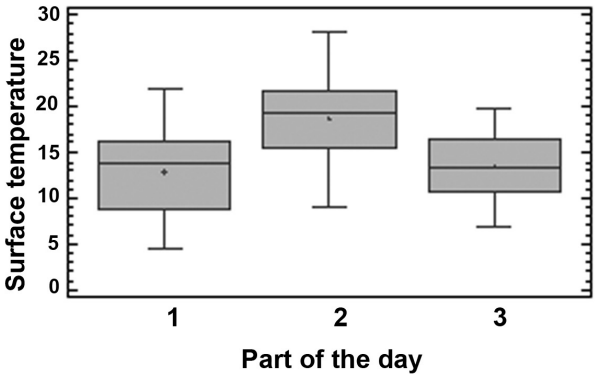

Fig. 10. Differences in surface temperature between the phasis of the day.

At the Loc. 1, same as at the Loc. 2, a relation between the diminishing relative air humidity and the increasing surface temperature was approved.

We may allege that even in the period at the very beginning of the vegetation ascend, with not so contrasting temperature amplitudes, there is a remarkable influence of vegetation on the surface temperature and the relative air humidity.

We expect that during the summer time, when the intensity of the solar radiance is higher, the differences will be even more evident. However, we may resume that the microclimatic function of the vegetation was approved and we can enhance the microclimatic conditions of the urbanized areas with correct landscaping.

Acknowledgement

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Vplyv vegetácie na teplotu povrchov v mestskom prostredí

Súhrn

Práca bola zameraná na štúdium mikroklimatických rozdielov v závislosti od množstva zelene, kde boli počas mesiacov marec – jún 2012 porovnávané dve plochy – plocha s vysokým zastúpením zelene a prevažne spevnená plocha s minimom zelene. Skúmali sa rozdiely v relatívnej vzdušnej vlhkosti a povrchovej teplote rôznych povrchov (tráva, porast, spevnená plocha), kde bol ešte sledovaný aj vzťah medzi pomerom vegetácie a spevnenej plochy ako aj vzťah medzi relatívnou vzdušnou vlhkosťou a povrchovou teplotou skúmaných povrchov. Zaznamenal sa preukázateľný vplyv vegetácie na miestnu mikroklímu, a to so zvyšujúcim sa množstvom zelene sa znižuje teplota povrchov ako aj sa zvyšuje relatívna vzdušná vlhkosť.

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