DIFFERENCES IN SURFACE TEMPERATURES RELATED TO VARIOUS PORTION OF VEGETATION AND PAVED SURFACES

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Introduction

Microclimate of urbanized areas is demonstrably different particularly during summer months in comparison with the microclimate of open landscape. One of the factors remarkably affecting the microclimate of the cities is prevailing hard surface at the expense of vegetated cover.

While the urban heat island is less of a problem in temperate climates, it is unwanted in low and mid latitude cities as it contributes to increase the cooling load and results in increased energy use (TAHA, 1997). Vegetation is an important design element in improving urban microclimate and outdoor thermal comfort in urban spaces in hot climates (SPANGENBERG, 2004). Although many authors contributes to vegetation and its cooling effect in the cities of hot climate, due to more extreme weather during summer months caused by climate change it is very important in the cities of temperate climate as well. The main benefits of vegetation beneficial in both climates are reduced solar radiation and lower air temperature caused by shading of the trees and evapotranspiration.

Field measurements by SHASHUA – BAR, HOFFMAN (2004) showed that some tree-aligned streets and boulevards in the Tel-Aviv area, Israel, had 1–2,5 °C lower air temperatures than non-vegetated streets at the hottest part of the day (15:00 h). The main cooling effect of the vegetation due to shading is evident on surface temperatures. According to CHATZIDIMITRIOU et al. (2005) that applied the simulation software ENVI-met (BRUSE, 2006) to the climate of Thessaloniki, Greece, found interesting temperature decrease for tree-aligned streets up to 20°C lower surface.

Materials and methods

The entries of the microclimate, such as the relative air humidity and the surface temperature, have been selected at 4 places in the town residential area of Nitra town and had been observed from June to August 2012.

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

Locality n.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 forms of vegetation with various 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. This area has different conditions created by paved surface and it has higher density of buildings surrounding this locality, mostly. There is minimum vegetation mostly represented by alley of deciduous trees (Betula pendula Roth) with rare sub-canopy of evergreen shrubs (Taxus baccata L.). Both of the localities contain different ratio of grass area, built-up area and area with greenery. There were two more localities observed, - locality n.3 Internát (dormitory of the UKF) that has a 71 - 90% of vegetation to paved surfaces and the locality n. 4 Agroinštitút with 16 – 50% of vegetation.

All 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 surface temperature of the localities being monitored, were recorded each time at the same spots - sub localities (spot n.1 - spot with a grass surface, spot n. 2 - transition between grass and vegetation cover, spot n. 3 – vegetation cover, spot n.4 – transition between vegetation cover and paved surface, spot n. 5 – paved surface, spot. 6 - transition between grass and paved cover and the last spot – spot n.7 - spot 2 m remote from a building). 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

Comparing the surface temperatures of the localities OC Mlyny and the Park as the localities that assumingly should be the most contrasting because of their ratio of paved and unpaved surfaces, the surface temperatures at the locality OC Mlyny were remarkably higher. The spot with the highest measured temperature 26, 2 °C at an average was the spot n.7 – spot 2m remote from the building. The lowest measured surface temperature was recorded at the locality OC Mlyny at the spot n. 3 - vegetation cover with an average surface temperature 21, 7 °C. According to the recorded data, the difference between these mentioned observed spots was 4, 5 °C (Fig. 1).

Concerning about the locality Park, the lowest temperature was recorded as well as at the locality OC Mlyny at the spot n. 3 – vegetation cover that reached the value 20, 4 °C. The highest surface temperature was recorded at the spot n. 1 – spot with a grass surface and simultaneously at the spot n. 6 – spot at the transition of a grass and paved surface with an average value of surface temperature 23, 3 °C, what means 2,9 °C difference between these monitored spots (Fig. 1).

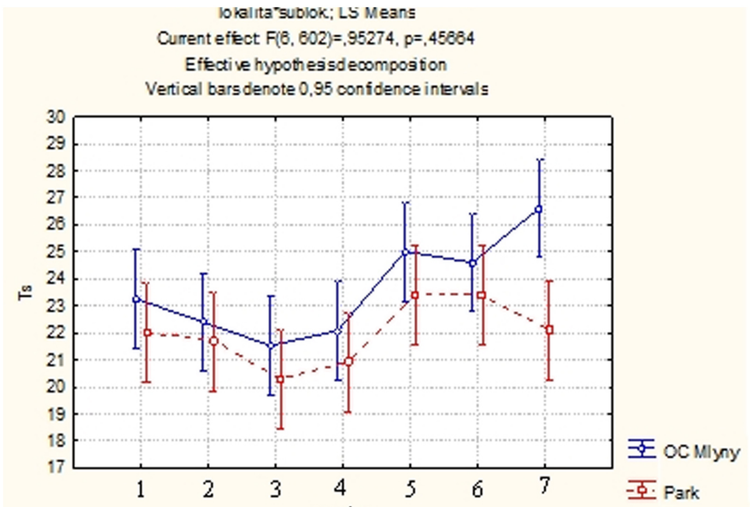

Fig. 1 Surface temperatures of the observed spots at the monitored localities OC Mlyny and the Park during summer months

According to our expectations, similarly at the localities Internát and Agroinštitút as at the localities OC Mlyny and Park, the lowest surface temperature recorded during summer months was measured at the spots with vegetation cover. We may allege that remarkably highest values of surface temperatures were reached at the paved surfaces. At the locality Agroinštitút the highest measured surface temperature was at the spot n. 5 - paved surface meanwhile at the locality Internát, the highest recorded surface temperature was at the paved spot n. 7 – spot 2m remoted from a building. Noticeable differen ce of surface temperatures was observed at the locality Agroinštitút between the spots n. 3 - covered by vegetation and spot n. 5 covered by paved surface that came to 4, 3 °C. At the locality Internát the difference between spot n. 3 - covered by vegetation and the spot n. 7 – spot 2 m remote from a building is the difference in surface temperatures 3, 7 °C (Fig. 2).

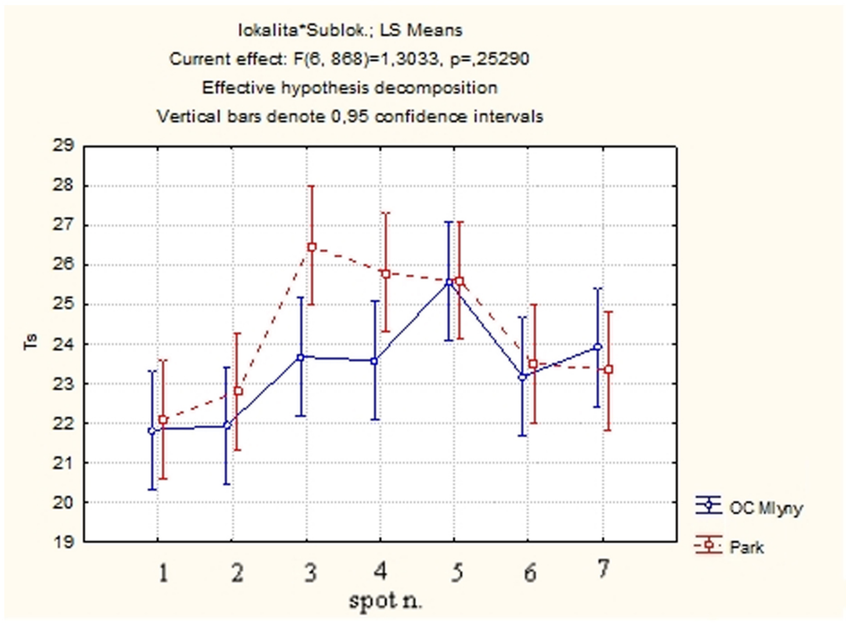

Fig. 2 Surface temperatures of the observed spots at the monitored localities Agroinštitút and the locality Internát during summer months

Moreover we compared the entire highest measured average surface temperatures recorded at all of the localities. At each locality the highest recorded value was selected amongst all of the monitored spots. This value was compared with the lowest recorded surface temperature. The highest surface temperature amongst all of the observed spots during summer months was reached at the spot n. 7 – spot 2m remoted from the building of the locality OC Mlyny at 15.00 on 9th of June 2012 with the value 45, 1 °C. Interesting was also the difference between the air temperature and the surface temperature of the observed spot that was 9, 9 °C. The lowest surface temperature 32, 4 °C at this locality recorded at that time was reached at the spot n. 3 – covered by vegetation. So the difference between the reached maximum and minimum represents 12, 7 °C.

At the locality Park the maximum of surface temperature 48, 7 °C was reached 10th of July 2012 at 15:00 at the spot n. 5 – covered by paved surface. The minimum in surface temperature reached at this locality was recorded at the transition of vegetation cover and paved surface at a value 27, 1°C. With comparison it was set that the difference between the particular spots at the Park is 21, 6 °C.

At the locality Agroinštitút the highest reached value of surface temperature was recorded 17th of June at 15:00 when the surface temperature at the spot n. 3 with paved surface reached 44, 9 °C, meanwhile the air temperature reached 31, 6 °C. The minimum of surface temperature was recorded at the spot n. 3 – covered by vegetation at the value 26, 9 °C. The difference of these two values of surface temperature does 18 °C.

At the locality Internát the maximum of surface temperature reached 50, 2 °C on 9th of July 2012 at 15:00 at the transition of the vegetation cover and the grass. For your interest, the air temperature at that time reached 33, 6 °C. The lowest value recorded at this locality was at the transition of vegetation cover and paved surface and does 32, 4 °C, so the difference between the reached maximum and minimum in surface temperature is represented by 17, 8 °C.

Conclusions

We may conclude that statistically significant differences between the monitored spots according to the different structure of surface materials were demonstrated. We may allege that the surface temperature is highly dependent on the type of surface that was monitored at each of the observed spots.

However we may resume, that the type of used surface material in the cities is very important as according to the surface cover the cities may become overheated especially during hot summer months. Besides the rationally used surface material, the vegetation cover has its meaning and function in the cities as well. The microclimatic function of the vegetation was approved in our research, where we proved the unbeatable function of the vegetation in the urbanized area. The vegetation cover may reduce the energy losses and alleviate the microclimatic differences. We may resume that with reasonably chosen surface materials and with appropriate landscaping we can notably enhance the microclimatic conditions of urbanized areas.

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