POCKET PARKS. THE CONTRIBUTION OF SCATTERED GREEN SPACES TO THE IMPROVEMENT OF URBAN MICROCLIMATES

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ABSTRACT

Global warming and the urban heat island (UHI) phenomenon threat to render open urban spaces hostile or even dangerous during summer days. The problem concerns a great part of the world population considering the ongoing assemblage of people in cities. Enriching the urban fabric with natural landscapes qualifies as the best solution. However, the redevelopment of the functional parts of the urban fabric is a particularly difficult task, especially in times of financial crisis. But small, unused pieces of land are often found in cities, which are more easily converted into green neighborhood parks (pocket parks). In order to investigate the impact of the dispersion of these spaces on the urban microclimate, the present dissertation analyzes a section of eleven building blocks in the center of the city of Serres. Concerning the hypothesis of the conversion of ten existing unused small spaces into parks, the result is the improvement of the climatic quantities and thermal comfort during the summer season. In conclusion, the dispersion of small neighborhood parks in the city is a useful tool to mitigate the UHI phenomenon and at the same time a method of upgrading the urban fabric and the quality of life of the residents.

KEYWORDS

Climate change; Pocket parks; Thermal comfort; Urban green; Urban reconstructions

1 INTRODUCTION

During the last half century, the urbanization of the planet has been constantly intensifying. According to forecasts [1], in 2050, cities will host 70% of the world's population while the corresponding figure was just 30% in 1950. As a result, maintaining and improving the quality of life of citizens is an intractable issue for the science and practice of urban planning.

Among other things, the enlargement of cities is associated with the intensity of the Urban Heat Island phenomenon [2]. In large urban centres, differences in temperature are recorded compared to the suburban area, reaching 12°C [3]. The synergy of the phenomenon with the rising heat waves due to climate change intensifies the concern of the scientific community [4].

The thermally inhospitable environment of cities, whenever it occurs, traps people indoors with negative effects on their physical and psychological condition, their socialization and in general on their health and quality of life [5]. Along with the review of the role of open urban spaces [6], there is a need for their holistic redesign, including their microclimate redesign.

Greenery qualifies as the best solution to modern urban environmental problems.

The enrichment of the urban fabric with

elements and spaces of the natural landscape benefits the local climate and restores the attractiveness of open spaces for the citizens [7]. In addition, it is proposed by the scientific community as a key measure to mitigate the intensity of UHI [8].

The necessary, for this purpose, regeneration of the densely populated city centres encounters several obstacles, mainly the absence of unstructured areas and the inability of converting structured areas due to the great value of the land. Usually the free public spaces are limited to the sidewalks, often not large enough to be enriched with greenery. The imperative need for cities to be green leads science and practice to seek other spaces and methods, such as planting roofs and walls of structures [9].

As an alternative, there is also the proposal of the utilization of smaller spaces, usually of no use, which can be more easily located in city centres [10]. Their transformation into pocket parks benefits the microclimate of their neighborhood and attracts locals to develop mild activities within them [11].

The present dissertation focuses on the benefits of the above method, after the distribution of pocket parks in the urban fabric in a certain density (one in each building block). It examines the effects on the microclimate of spaces that are converted into parks and their neighborhoods and on the temperature of the wider area during the summer season.

2 METHODOLOGY

The conclusions of this dissertation are drawn through the comparative analysis of a densely populated area of eleven building polygons in the centre of the city of Serres (41o05'B, 23o33'A) and some proposed interventions, using the Envi-met software [12]. The simulations utilized data from the mapping of geometry and plantings, the identification of thermophysical characteristics of structures and the meteorological records of a station operated by the Municipality of Serres in a nearby area with similar characteristics. The analyses target the typically warmest time and day of the summer season, as the worst-case scenario, the 15th hour of July 15th.

As a working hypothesis, ten spaces were located, one in each building polygon in the area, which are offered to be turned into parks. Three of the above spaces were designed in a greater level of detail to deepen the study of the effect the parks have on the microclimate of their neighborhood and the thermal comfort of the locals. Methods should be described here.

3 STUDY AREA AND UPGRADE SUGGESTIONS

3.1 Study Area Analysis

The area of Serres chosen to be studied is enclosed by Kilkis St, Paleologou St, Kioutacheias St, 8th May 1821 St and Merarchias St. (Figure 1). It is part of the most densely populated urban unit with 221 inhabitants / ha. It covers an area of 9.2ha, with the 69% being urban blocks which have an elongated shape in a north- south direction.

The buildings contain residences and a small number of shops. Their height ranges from 4 to 27m. The area is divided into two urban sectors with different building conditions. Thus, its northern part is more densely built up with taller buildings (Table 1).

About 55% of building polygons remain unstructured but only 3% remain without concrete coating or other waterproof material. The streets of the area have a similar width and the ratio is H/W=1 in most cases. Planting is limited to sidewalks, where occasionally there are rows of deciduous trees, 10m high.

Communal free spaces are absent from the specific study area. The spaces that are converted into parks, as a working hypothesis of the study, belong mainly to the courtyards of the building blocks. Overall, the 3.4% of building blocks were recorded as potential pocket parks, but it was preferred to limit the percentage to 2.7% in order to maintain the character of a small park and to apply the conclusions in those areas of cities where it is more difficult to find similar spaces.

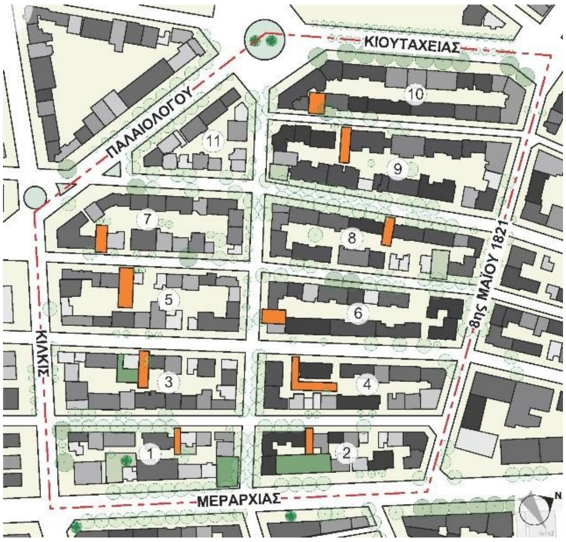

Figure 1. Study area and the proposed pocket parks.

Table 1. Analysis of building blocks.

Building block		1	2	3	4	5	6	7	8	9	10	11
Area	m^2	5477	4542	5743	5058	6231	5719	6038	6157	8104	7144	3746
Uncovered	%	59,3	60,5	53,8	51,4	60,6	53,1	55,2	55,9	50,7	49,7	57,0
Uncoated	%	22,5	18,4	6,0	0,4	0,3	0,3	0,3	7,0	3,3	0,6	0,9
Max height	m	20,0	24,0	18,0	27,0	19,0	24,0	18,0	27,0	24,0	24,0	18,0
Mean height	m	11,8	17,2	12,8	17,4	12,7	19,6	15,0	17,9	18,9	18,6	11,5
Allowed. S.F.		1,40	2,40	1,40	2,40	1,40	2,40	1,40	2,40	2,40	2,40	1,40
Est. S.F.		1,28	1,94	1,79	2,36	1,36	2,63	1,86	2,2	2,63	2,53	1,34

3.2 Upgrade proposal

The creation of pocket parks initially attracts residents of the wider neighborhood [11]. Thus, they are designed to offer new opportunities for recreation, socializing and mild activities while improving the microclimate. The transformation of the selected areas into parks follows the following basic characteristics:

- The replacement of the floors and their underlays: the new floors are made of water-permeable natural materials in a suitable underlay to achieve the enrichment of the subsoil and the retention of moisture. The floors that are proposed to be of such kind are the stabilized soil, the vegetated soil and the natural rocks placed on the ground.
- Planting areas with tall deciduous trees in appropriate locations and densities to achieve shading of most floors
- Planting with low shrubs and perennials to beautify the area and enhance cooling through evapotranspiration.
- The utilization of the liquid element for the improvement of the microclimate with the construction of fountains mainly in sunny parts of the area.
- The combination of fixed and mobile urban equipment (tables, seats, toys) to make each park attractive to locals and to be able to use it differently during all seasons and hours of the day.

In order to indicate ways of combining the above basic principles for the production of an architectural proposal for the new parks, a draft study was prepared using three of them (Figure 2). The trees and pergolas were used in a variety of heights and relations among each other to draw conclusions about their effect on the microclimate of the park.

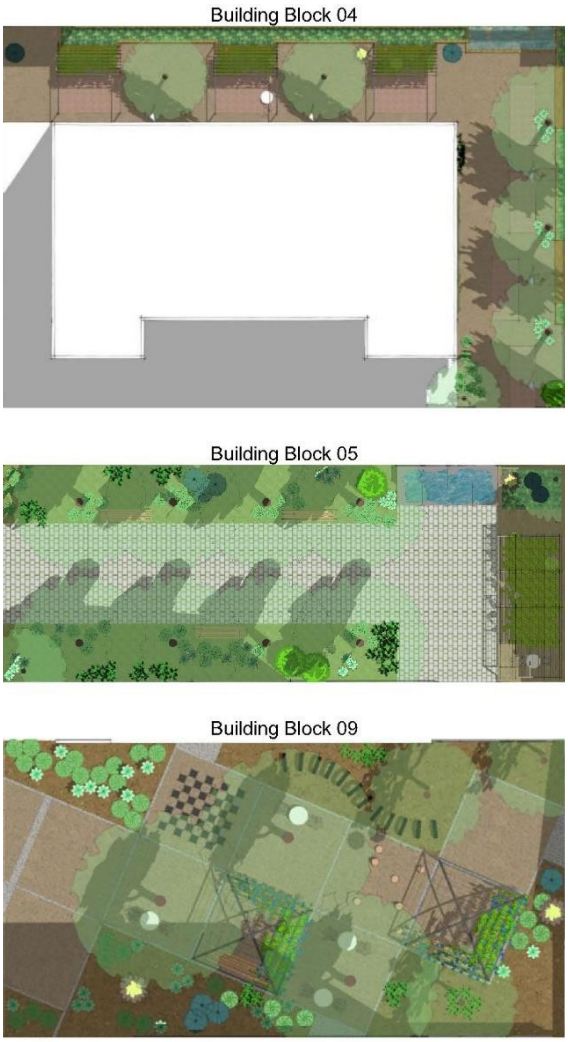

Figure 2. Park design proposals

4 RESULTS AND DISCUSSION

As mentioned, the simulations of the climatic factors in the study area targeted the hottest summer day. From the results of a 24 hours cycle, the 3rd hour at noon was chosen as the worst case. The measurements and diagrams focused on the level of +1.40 from the ground, to cover both the pedestrians and the seated users of the space.

During the analysis of the study area, as it is today, air temperatures between 33.67°C and 35.50°C are recorded. The highest temperatures are recorded on the widest roads around the area and at the roundabouts, where asphalt paving and the absence of shading predominate. It is distinctive that the same areas show the highest average radiant temperatures reaching 78°C. As expected, the thermal discomfort is reflected in the values of the PMV index above 3 (very hot) and up to 7. It should provide a concise and precise description of the experimental results and their interpretation. This section may be divided by subheadings.

After the creation of the 10 parks, the air temperature decreases to 0.5°C (Figure 3). This reduction is concentrated in the new parks and spreads through the neighborhood decreasing according to the distance from them. The decrease in temperature seems to have a spatial effect on a larger scale in the northern part of the area which already has more shading. Also, we can observe the relation of the distribution to the direction of the winds.

Figure 3. Comparative analysis of air temperature.

In those parts of the area that were selected based on the variety of their characteristics (street orientation, distance from the park) the values of climatic factors were recorded in an hourly pace. All parts show a drop in air temperature throughout the day, with the largest being in the areas near the parks (Figure 4).

Trees, in combination with flooring materials, seem to significantly reduce the average radiant temperature in the parks, as shown by the study of Chatzidimitriou & Yannas [13]. In the case of the area studied, this reduction is at least 7-10°C in all parks while it can reach 30°C where it initially had remarkably high values. According to the simulations of the three selected parks we observe that the use of tall trees for this purpose is preferable to the use of pergolas.

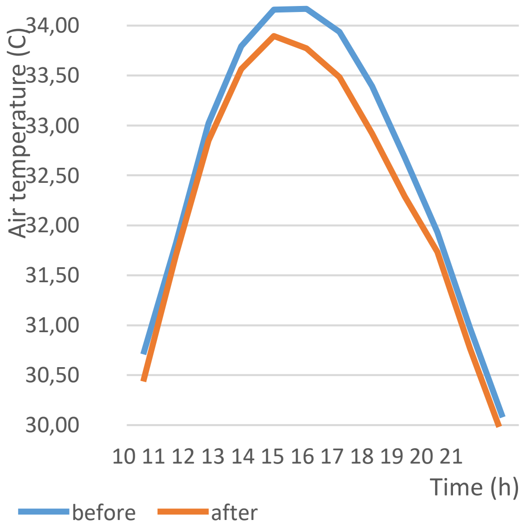

Figure 4. Comparison of temperatures during the day at a point near a park.

The improvement of the microclimate is also reflected in the thermal comfort index PMV. Its value was reduced up to 4 units in all parks. The new value, close to 3, is considered a significant improvement for the given time of year and day, compared to the initial extreme conditions. The analysis of the three selected parks shows the influence of shading types (trees, pergolas) on the PMV index as well as the concentration of this reduction at a short distance from the parks (Figure 5).

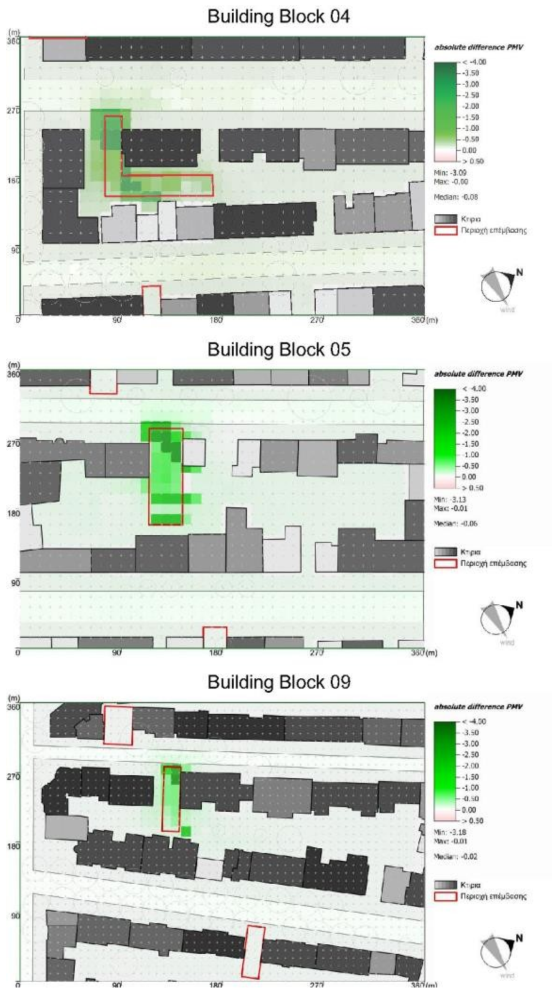

Figure 5. Comparison of PMV values in selected parks.

5 CONCLUSIONS

To regenerate the densely populated urban centres, while enriching them with elements of the natural landscape, the transformation of small spaces of no use into neighborhood parks can compensate for the lack of free space.

Comparative analysis in the study area showed that despite their small size the interventions reduced the average air temperature of the total area. As expected, the areas inside and near the new parks showed the largest decrease (0.5°C). This effect on temperature spreads spatially in the neighborhood to a greater extent in this part of the area which already has more shading because of the taller buildings and trees.

In addition, the improved microclimate of the parks, compared to their neighborhood, can attract the locals. This strengthens their social interactions, level of activity and health.

In conclusion, the distribution of small pocket parks in the city is a useful tool to mitigate the UHI phenomenon and at the same time a method of upgrading the urban fabric and the quality of life of the residents.

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