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Investigating the Relationship Between Urban Spaces Morphology and Local Microclimate: a study for Thessaloniki

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Abstract

The study investigates the impact of two different strategies on the amelioration of the local thermal environment regarding surface and air temperatures, in two urban districts of Thessaloniki, the morphology of which present rather similar characteristics. The examined strategies include the use of cool materials and additional vegetation and trees. The ENVI-met model v.4 is used for the microclimate simulation. The analysis revealed an important reduction of surface and air temperatures after replacing conventional coatings with cool materials while additional trees contribute to lower surface and air temperatures by the shading effect and leaves' evapotranspiration.

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Keywords: urban district; microclimate; aspect ratio H/W; Envi-met 4; cool materials; vegetation

1. Introduction

The rapid acceleration of urbanization process during the last two centuries has resulted in significant modifications of microclimatic conditions such as the rise of air temperature (Tair) in urban districts. This can be initially attributed to extensive morphological changes i.e. the replacement of natural, permeable surfaces with mineral, rough materials such as concrete and asphalt, resulting in large quantities of solar radiation stored and then re-emitted in urban areas. In addition, the low albedo of the materials that are commonly used in urban structures, contributes in larger amounts of solar radiation absorbed by building envelopes and urban surfaces, causing thus, their higher surface temperatures (Tsurf) and severe intensity of long wave radiation emission [1]. The progressive

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substitution of vegetation and green areas with mineral surfaces has also led in a decrease of latent heat flux through evapotranspiration and the corresponding cooling of air around vegetated areas [2]. Increased building heights and high roughness structure is also considered as a serious problem of modern cities due to the induced low wind velocities and the corresponding reduction of convective heat removal [3]. Moreover, the reduced opening to the sky contributes to the entrapment of shortwave and long wave radiation inside the canyons inhibiting thus, the urban cooling [4]. Given that the rise of air temperature aggravates the energy consumption used mainly for air-conditioning but also strongly affects the thermal comfort of pedestrians [5], the aim of this study is to investigate the impact of two strategies on the amelioration of the local thermal environment in terms of surface and air temperatures, in two typical urban districts of Thessaloniki. The study emphasizes on the implementation of cool coatings for the horizontal surfaces and on the presence of additional trees.

2. Description of the study area and climatic conditions

Both study areas (Fig.1 and Fig.2) have the same orientation and are located at the center of Thessaloniki. The city is situated in the northern part of Greece and climatic conditions are temperate with rather mild winters and hot, humid summers. In both sites, buildings are mainly of residential use, while open spaces are only limited to street canyons and courtyards of irregular shape between building volumes. Roofs are mostly covered by concrete pavement tiles; ground surface is shielded by asphalt and concrete paving materials whereas only a small part is covered by loamy soil and other permeable materials. Regarding vegetation, the first site (Pittakou district) presents slightly more green areas in comparison to the second one; yet, it mainly comprises of low trees, grass and bushes placed on both sides along the main streets of the study area. In the second site (Mitoudi district), planted areas, mainly involving bushes and scarcely foliated trees, are present in the courtyards between building volumes but also inside some of the study area canyons.

Fig. 1. (a) Satellite view from Pittakou area and (b) area input file on Envi-met v.4

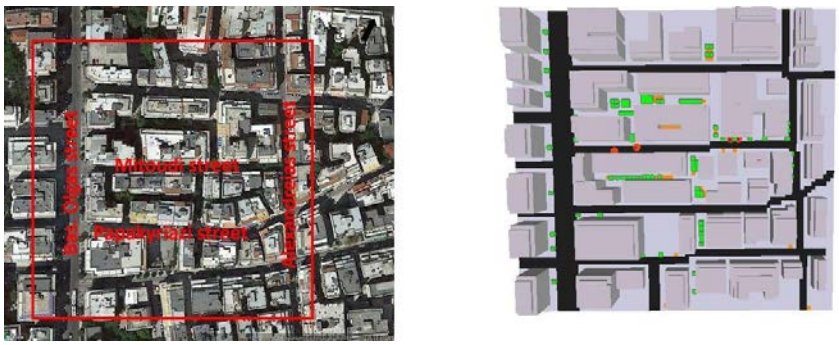

Fig. 2. (a) Satellite view from Mitoudi area and (b) area input file on Envi-met v.4