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Impact of Urban Morphology Parameters on Microclimate

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Abstract

Urbanization process has dramatically influenced urban climate and environment. In the urban planning and design practice, there are several important parameters such as sky view factor, floor area ratio, site coverage ratio and building stories. These parameters can determine the urban morphology. This study shows the impact of urban morphology parameters on urban microclimate. It aims at provide suitable ranges of parameters which are beneficial for the thermal comfort of urban pedestrians. As a result, recommendations are given for government agency and urban planners in the urban design process.

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Keywords: parametric study; urban morphology; sky view factor; microclimate; thermal comfort

1. Introduction

According to the statistics from the National Bureau of China, the urban population accounted for more than half (54.78%) of the country's population in 2014. Megacities in China, such as Beijing, Shanghai, Guangzhou, Shenzhen, are facing a significant pressure to extend their land to accommodate their increasingly high population. The urbanization process brings a lot of benefits. In the meantime, the highly densified urban development causes many problems related to urban climate, air pollution, ecosystems, energy consumption, traffic and health.

Urbanization provokes major modifications on natural landscape. For instance, soils have been transformed into roads and pavement. Consequently, greenery has been vastly reduced. Considering these major changes, weather conditions within the urban canopy layer exhibit the clearest signs of inadvertent modifications [1]. Urban morphology

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influences urban microclimate, and vice versa. Therefore, effective urban design with the consideration of local climate has become an important and urgent task for the cities with high building densities.

Climate responsive urban design requires comprehensive and vast knowledge in different fields. This includes climatology, geography, urban planning, architecture, energy engineering. This study tries to focus on links between microclimate and urban morphology. The latter has significant impact on Urban Heat Island (UHI) effect and energy use in buildings. The objective of this paper is to demonstrate microclimate analysis on a hypothetical district varying urban morphology parameters. And it aims at improve the efficiency of using urban space, enhance thermal comfort in cities and reduce energy consumption.

2. The Variables to Characterize the Building Environment

Problems related to urban climate are so complex that it is impossible to include every variable into the analysis to quantify the microclimate impact of the built environment. So, it is crucial to choose the right variables [2].

2.1. Sky View Factor (SVF)

The main reason of the UHI is the urban–rural temperature difference in the nocturnal cooling processes, which are primarily forced by outgoing long wave radiation. In urban areas the 3D geometrical configuration of the urban surface cover plays an important role in the restriction of long-wave radiative heat loss. It also contributes to intra-urban temperature variations below roof level [3] [4]. The highest UHI intensity is generally higher in the nighttime than daytime [5]. The Sky View Factor (SVF) is the most appropriate parameter describing the urban geometry [4]. The SVF is defined as the ratio of the radiation received (or emitted) by a planar surface and the radiation emitted (or received) by the entire hemispheric environment [6]. Therefore, it is a dimensionless measure between zero and one [7]. The regression analysis of field measurements indicates a strong negative relationship between SVF and UHI [8].

2.2. Urban density parameters

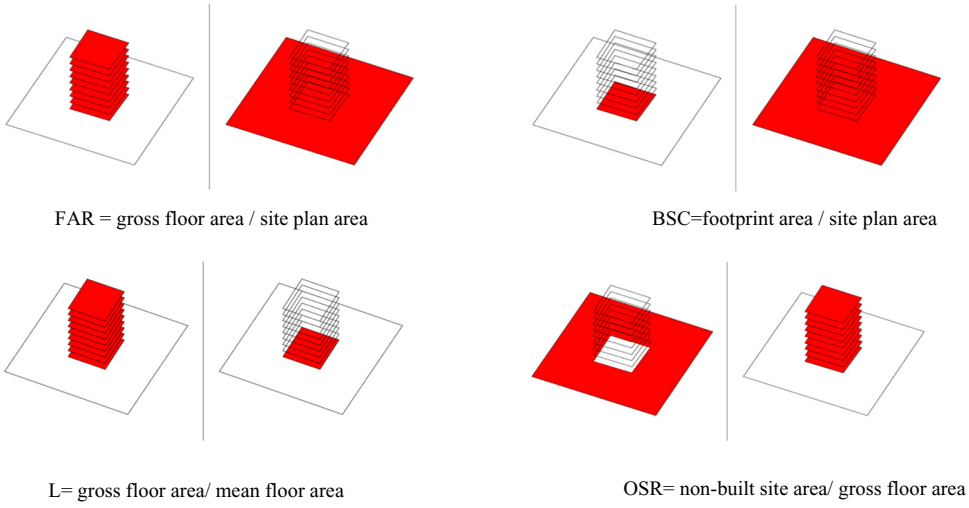

Fig. 1. The diagram of indicators included in ‘space-mate’

Pont, M. B. established a comprehensive density indicators diagram tool to characterize urban geometry [9]. The tool is called ‘Space-mate’ (Fig.1). It makes possible to describe an urban environment by using a set of density variables (FSI, GSI, OSR and L). These quantities can be used both to describe and characterize, as well as prescribe different urban environments.