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Analysis of the microclimatic and human comfort conditions in an urban park in hot and arid regions

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ABSTRACT

Urban parks have complex surface structure that produces an environment with specific microclimatic qualities. These qualities affect the balance of energy of the human body and are applicable to an individual's thermal perception. They have impacts on using outdoor spaces especially in hot and arid regions. This study investigates users' thermal comfort in an urban park in Cairo, Egypt. The investigation was carried out during the hot and cold months using subjective surveys and field measurements. The campaign consisted of a subjective survey using questions on the perception of the thermal environmental applying seven-point ASHRAE 55 thermal sensation votes (TSV) in nine different zones in the urban park. At each zone, the thermal environment parameters – air temperature, solar radiation, air relative humidity and wind speed were measured. Through these data, the values of the Physiologically Equivalent Temperature (PET) were calculated in each zone using the RayMan model. The current people clothing and metabolic rate were recorded. The results of the field measurements were compared with judgements about the thermal environment. Results demonstrate that differences in the PET index among these zones due to different sky view factors (SVF) and wind speed. Results revealed an alteration in human comfort sensation between different landscape zones. This paper suggests that the thermal requirements of visitors and qualities of the local climate should be carefully considered when designing landscapes for the future urban parks in the hot and arid regions.

1. Introduction

Comfortable and healthy microclimate conditions are necessary for any type of environments. People are exposed to varying types of stress in the urban environment. The most influential one is the microclimatic conditions, which vary significantly from rural areas [1]. The reasons include the adjustment of the surface structure in terms of proportion of the built up area, 3D geometry of the buildings and vegetation [2,3]. These properties affect urban climate phenomena such as the urban heat island (UHI) and the variation in the radiation fluxes. Recent studies revealed that outdoor thermal environment factors, including air temperature, wind speed, relative humidity and solar radiation, affect assessment of thermal comfort, e.g., thermal perception and satisfaction [4].

People are frequently exposed to weather during recreation and leisure in the outdoor spaces. Hence, a comfortable thermal environment is particularly significant to the satisfaction of such spaces. A number of investigations revealed that people thermal assessments of an environment may extensively impact their usage of that place [5–7]. There is evidence that thermal comfort in the outdoor spaces and acceptable thermal range vary from the indoor thermal comfort due to psychological and behavioural factors [6,8–10].

Climatologists and designers have tackled urban climate in different ways, including scaling, relevant variables and objects of study [11]. Several researches reported that the integration of the climate and thermal comfort dimensions from one hand and the design process from the other hand is inadequate because of poor interdisciplinary work. Climatologists are more concerned with the causality of the urban climate, while designers are more interested in the effects of environmental forces on buildings and their impacts on thermal comfort of their users. The urban climatology concentrated first on the urban heat island (UHI) and moved progressively to micro-scales as the urban geometry was found to be decisive in the UHI [12,13]. By contrast, designers focus initially on indoor climate of individual buildings, on design strategies, and on the resulting energy needs for maintaining internal comfort

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