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A simple technique to classify urban locations with respect to human thermal comfort: Proposing the HXG scale

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ABSTRACT

An attempt is made to present a new scale to study urban microclimates and outdoor thermal comfort using simple in-situ measurement data. For this purpose, six urban locations with distinct physical characteristics are selected in a metropolitan city, Chennai. At each location, three streets with diverse orientations (North–south; East–west and Northeast–southwest) are identified and their microclimatic conditions are monitored during the summer months of April, May and June. The variations in microclimate are studied using ANOVA single factor test and later, correlated with the site's physical characteristics. The assessment of microclimate and outdoor thermal comfort is done using Physiological equivalent temperature (PET).

The results show that the site physical factors like the H/W ratio and green cover index show poor and moderate correlations respectively (R^2 of 0.016 and 0.445) when regressed with the mean PET. In this regard the proposed *HXG* (read as H cross G) scale displays satisfactory correlation ($R^2 = 0.648$). The *HXG scale* constitutes a product between the height to width (H/W) ratio and green cover percentage of a location and provides a fair idea about the locality's microclimatic conditions. This method to study and classify urban microclimates may prove useful in the context of urban design and planning.

1. Introduction

In recent years, human thermal comfort in outdoor locations has gained much attention in the context of urban microclimate studies. Comfortable outdoor locations in a city have multiple advantages- ranging from savings in energy to an improved social quality of life. They also have a significant bearing on the comfort perception of the indoor ambience [1]. Such studies are particularly crucial for tropical regions where most of the urbanization would take place in the coming decades [2]. Tropical climatic conditions are often characterized by very high air and globe temperatures during summer. This makes it even more important to get equipped with a thorough understanding of microclimatic implications of urbanization in these regions. In addition, the formulation of a scale that gives a relationship between an urban location's physical characteristics and its microclimate would be useful for architects, urban planners and climatologists.

Prior to this, most studies concerning urban microclimate have focused on the phenomenon known as the 'Urban heat island'. These studies deal with the comparison of maximum air temperatures between an urban location and its rural neighborhoods. These studies provide good information regarding dispersion of air temperatures across various land uses in a city [3–5]. However, from human bio-meteorological point of view, the knowledge of air temperature alone is not sufficient. The energy budget of a human person in an outdoor location is influenced by many factors [6]. In this regard, various thermal comfort indices, relevant to outdoor settings, have been proposed that take all the necessary climatic parameters into account [7]. One such commonly used index is the Physiological equivalent temperature (PET) [8], which has been used in this study as well. The relevance of urban climatology to urban planning and design has been discussed in detail by Eliasson and Givoni in their respective works [9,10] and it is also mentioned that the application of this knowledge in this field has been limited.

Current studies on outdoor thermal comfort and urban street microclimates are done using numerical modeling methods or by conducting relevant field measurements of meteorological data. According to Arnfield [11], the latter method consumes more time and is more expensive. However, from a realistic point of view, field measurements exhibit more accurate results and provide a wholesome understanding. Also, these detailed data collecting parameters makes it little difficult for the performance of such studies in every town and climatic zone. In this study, however, an attempt is

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