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An analysis of bioclimatic zones and implications for design of outdoor built environments in Egypt

Ayman Hassaan A. Mahmoud [a,b,*]

[a] Department of Architecture Engineering, Faculty of Engineering, Cairo University, Giza 12211, Egypt
[b] Department of Architecture Engineering, The British University in Egypt, El-Sherouk City, Egypt

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ABSTRACT

Climate considerations are essential dimensions in the assessment of quality of outdoor built environments. This paper provides an analysis of bioclimatic classification of Egypt to help the environmental design of wide range of purposes, including: climate responsive design; energy conservation and thermal comfort in the outdoor built environments. The analysis of this classification uses a bioclimatic approach in which the comfort zone and monthly climatic lines were determined and plotted on the psychrometric chart. Since the mean radiant temperature (T_{mrt}) is the most important input parameter for the energy balance in outdoor environments, the charts apply the ASHRAE 55-2004 standard considering the operative temperature as a function of T_{mrt}. Analysis for each bioclimatic zone determines the potential of passive design strategies to maintain thermal comfort in outdoor spaces and to contribute to energy efficient built environment. Finally, this study suggests a design guideline matrix for landscape architectural design for the different bioclimatic zones.

1. Introduction

Environment, buildings and energy are issues facing the building professions on a global scale. There have been growing concerns about energy consumption in buildings and its likely adverse impact on the environment, and it was estimated that in 2008 buildings in the United States consume 39% of America's energy and 68% of its electricity [1]. Additionally, buildings accounted for 33% of the carbon dioxide which is the primary greenhouse gas associated with global climate change [1]. Although energy conservation is a fundamental concern in present days but human thermal comfort is the primary concern in case of environmental design. However, energy conservation becomes an important factor instead of a choice in commercial, recreational and residential built environments without compromising the human thermal comfort [2]. Using solar energy for heating and cooling, as well as enhanced ventilation, decrease the negative impact on environment. Reduction of cooling and heating costs can be accomplished through careful landscape planning. Landscape design can also reduce direct solar radiation from striking and heating up building surfaces. It can also protect buildings from reflected light carrying heat from the ground or other surfaces. A number of studies indicated that "trees" as a major landscape element contributed effectively to energy reduction in buildings (e.g., [3–5]). By reducing wind velocity, an energy conserving landscape slows air leakage in a building. Additionally, the shade created by trees and the effect of grass and shrubs will reduce air temperatures adjoining the building and provide evaporative cooling [6].

The determining of bioclimatic comfort areas is a very important act for landscape planning process. The advantages of the landscape planning studies comprising the bioclimatic comfort conditions can be informed as: decreasing of heating and cooling spending; having got a constructive effect on minimizing the urban heat island. Consequently, it has contributed the protections of ecological stability of environments [7]. The background of establishing comfort definitions and relevant thermal comfort standards has indicated that the scientific attention of comfort investigation has established to be significant in the perception of the essential human process as they relate to the interaction with surrounding environments [8,9].

Climate is considered a very fundamental element to recognize natural landscape values [10]. For more enhanced planning and management of landscape areas such as recreational purposes, there is a requirement to understand the climatic impacts on recreation-seeking humans in addition to highlighting the visual aesthetic characteristics [11]. Bioclimatic comfort researches were carried out especially in summer season [12].

* Department of Architecture Engineering, Faculty of Engineering, The British University in Egypt, El-Sherouk City, Postal Number 11837–P.O. Box 43, Egypt. Tel.: +20 2 26890000x1424, +20 10 6670260(Mobile).
E-mail addresses: amahmoud@bue.edu.eg, arch.ayman@yahoo.co.uk.
URL: http://www.bue.edu.eg

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