Available online at www.sciencedirect.com
ScienceDirect
Renewable Energy 33 (2008) 1019–1023
RENEWABLE ENERGY
www.elsevier.com/locate/renene

Conceptual differences between the bioclimatic urbanism for Europe and for the tropical humid climate

O.D. Corbella*,[1], M.A.A.A. Magalhães

Faculdade de Arquitetura e Urbanismo, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Received 19 September 2006; accepted 14 March 2007
Available online 12 June 2007

Abstract

This article makes part of a series of conceptual papers to continue the discussion about how architecture and urbanism interact with climate, in tropical regions. Students engaged in normal courses of architecture in tropical regions, particularly in South America, develop their knowledge based on concepts generated in the developed countries—usually related to cold environments. Consequently, these students acquire wrong ideas about urban design of open spaces. Integrating urbanism and climate in tropical countries is still very incipient as an approach and many lecturers reject it, since they prefer to continue with a more formal one, dictated by most of the dominant countries. The herein paper underlines several different concepts and perspectives that separate the two conceptions, leading to a reflection about the subject.

Keywords: Urbanism and climate; Tropical countries; Environment; Urban design

1. Introduction

Continuing a series of conceptual articles about the constructed environments and climate in a tropical climate situation [1–3], this article discusses urbanism (or the architecture of public spaces) and its interaction with the environment—normally defined according to the climate of European countries [4–8]—from a tropical country's perspective.

The main changes that urban design should go through are unnoticed in the work of a designer—since his/her theoretical concepts about shape, esthetics, and landscaping have been elaborated without considering local climate and, consequently, without considering the needs of the users, either. As European open spaces need protection against cold winds as well as to take advantage of solar radiation and of low sky luminance, the different climatic conditions in the tropics should be considered for the benefit of all users.

Many of the conceptual differences between the approach to urbanism design in the tropics and in the European countries are not well understood, mostly as a consequence of the economic and, moreover, the cultural dependency since colonial times. Unfortunately, Latin American universities are still working with this uncontested colonialist frame of mind. Thus, the purpose of integrating urbanism and climate in tropical countries is still very incipient (see for example Ref [9]). The several points of view referred in this paper intend to contribute with a reflection about the subject.

2. Concepts about the interaction between climate and urban design

The microclimate of an environment in the tropics—regions characterized by low latitude and excessive solar radiation—is determined by the thermodynamic balance between absorbed solar energy and dissipated energy, based on four mechanisms: the emission of long wave radiation (from the surrounding surfaces), the materials heat conduction, the water evaporation, and heat convection from surfaces to the air [10–12].

*Corresponding author.
E-mail addresses: ocorbella@terra.com.br (O.D. Corbella), mariama@ism.com.br (M.A.A.A. Magalhães).
[1]CNPq researcher.

0960-1481/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.renene.2007.04.004

Energetic balance of external surroundings near the building can lead to two questions: how microclimate elements affect energy consumption in the architectonic space [13] and how the building system affects the microclimate [14].

The manifestation of heat islands is a principal topic to consider. It depends directly on urban design, such as the streets and the grid shapes, the location of green spaces, the building ensemble that modulates the environment shape, the recovering materials, and the quality of surfaces.

In general, reaching thermal comfort and decreasing the electrical energy consumption in the tropics is possible, by working with an urban design that modifies the wind path in a convenient way, the shadows, and the presence of water. The constructed environment with different colored surfaces and with reflective properties is also important in order to control the in-coming solar energy and the wind.

3. Heat islands

Heat islands are microclimate regions with temperatures higher than in their surroundings [15–17]. In countries with cold climate, they are advantageous during the winter time, since they decrease the demand of energy for heating. In tropical countries, these islands may occur when the heat dissipation by infrared radiation is smaller than the thermal energy increase due to a large exposition to solar radiation. They become larger or smaller depending on the size of sky view factors and ventilation, and also on the urbanization design. They directly influence the air-conditioning consumption of electric energy [13].

It is worth mentioning that the rate of ventilation in open spaces may rise or may lower the heat islands' temperature (the latter could be called a "cold island"). Surface colors of paved surroundings with different temperatures, emissivity and reflectivity, different diffusivity and effusivity of materials can modify an environment causing uncomfortable sensations to their users, who withdraw from using the spaces [18]. These elements are important to determine wind standards disturbances, turbulences, and doldrums, and to determine the wind shadow spaces.

Heat islands formation is not always bad. It depends on the influence on the people's thermal comfort and on the energy consumption through air conditioning. It should be acknowledged that temperatures fluctuate throughout the day. A region could be a heat island during the day and a cold island at night, or vice versa. If we take the building occupation period into consideration—or the occupation period of a town section, whose buildings use follows the same pattern—a heat island may lose its importance. For example, a nightly heat island in a district of buildings with daily occupation, such as office-buildings, does not interfere in the thermal comfort issue nor in terms of energy consumption through air conditioning. The same occurs with a daily heat island in a section of buildings with nightly use. If avoiding heat islands formation was possible by urban design, what needs to be taken care of is to prevent their occurrence during the day, in daily occupied sections, and at night, in nightly occupied areas.

That is why several geometric relations that link buildings height and streets width to heat islands need revision based on the above concepts. There is no doubt that the relationship between daylight versus height will not change, but the results may vary when promoting or obstructing the wind corridors. At the same time, the sky view factors must be read from a different perspective in relation to European urban projects, since the differences of solar exposition as well as of infrared emissions should be taken into account.

Therefore, the daily occupation of urban sections should have reduced sky view factors to avoid a great exposition to solar radiation and to be less permeable to daily winds, which bring air masses with higher temperatures than that of the microclimates. Nightly occupation sections, as dormitory buildings quarters, should have large sky view factors and be permeable to winds, so as to dissipate the hot air masses formed during the day.

Regarding the soil occupation, it must be reminded that all anthropogenic heat sources contribute to increase the heat islands temperatures. As it was said, in the case of cold countries, these islands behave as sources that help to produce thermal comfort sensation, which is not true in the tropics. Just to have an idea of how much heat people may produce, it could be compared to the energy that comes from the sun: the solar energy that the city of São Paulo receives by square meter of the horizontal surface is of 150 kWh/m^2 month. The average energy produced by each inhabitant, per square meter, is of 187 kWh/m^2 month, i.e., 20% more energy than the incident solar energy. Certainly, this average proportion increases when considering zones of greater population density—it is well known that park temperatures are always lower than in inhabited areas. The fact that the towns present lower temperatures during weekends confirms the anthropogenic heat contribution to heat islands formation. Many authors have registered the correlation between zones of industrial, commercial, and services concentration—based on a great deal of concrete—and the raise of temperature and pollution.[2]

Therefore, contrary to the conclusions of the cold countries urbanism, cities in the tropics should not have a compact shape, but rather a loose shape of built environment, in order to reduce the possibilities of heat islands. It must be highlighted that this constitutes a real problem in huge cities, but not when it comes to small ones.

4. Streets and grids shapes

The possibility of using local winds to low the buildings' thermal charge also depends on the town's shape. Streets orientation and the shape of its grids were—or are—determined by the European cultural influence or by traffic engineers (town planned for cars flow and not for

[2]LOMBARDO [19] referred to a correlation between heat islands in São Paulo, in regions with more than 3000 inhabit/ha, more than 20 years ago.