Thermal comfort and urban canyons morphology in coastal temperate climate, Concepción, Chile

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1. Introduction

The study of thermal comfort (TC) in the city has been of great importance for numerous scientists over time. Since 1485, when León Battista Alberti wrote “La Reaefificatoria”, the need to seek relationships between climate and city has not stopped (Tornero, 2006). Various authors have followed this concept, increasingly...
focusing their results on the well-being of people in urban areas (Nikolopoulou and Steemers, 2003; Nikolopoulou and Lykoudis, 2006). In this sense, it is important that the design of public spaces also consider the TC as a key variable to improve the living conditions of the city.

The TC is defined as a mental condition that indicates satisfaction with environmental thermal conditions (ASHRAE, 1966; Fanger, 1972; Vanos et al., 2010; Parsons, 2014). From an environmental perspective, the study of TC has focused on the construction of indexes and models that integrate climatic variables. For example: the Effective Temperature Comfort Index (ET), proposed by Missenard (1937); the Discomfort Index (DI) by Thom (1959); the Humidx index proposed by Lally and Watson (1960); the Burt index (1979); the MENEX model by Blazejczyk (1994); the RayMan model by Matzarakis et al. (2006); or the thermal comfort indicator Actual Sensation Vote (ASV) that was proposed by Nikolopoulou and Steemers (2003). The ASV is used to measure comfort in open spaces and requires air temperature, wind speed, solar radiation and the relative humidity of air as input. In general, these types of indexes utilize one or more climatic parameters and do not include other variables, such as thermal physiology aspects of the human body. In this sense, some thermo-physiological indexes have been used, such as the PET index (Physiological Equivalent Temperature), that is defined as the air temperature in which the human energy balance, under indoor conditions, is balanced with the same skin temperatures and sweat rates as those calculated under outdoor conditions (Matzarakis and Mayer, 1997). The COMFA index proposed by Brown et al. (1995) is also frequently used and expresses the energy balance of a person in an outdoor environment.

However, some authors (Nikolopoulou and Steemers, 2003; Thorsson et al., 2004; Tornero, 2006) indicate that these approaches are insufficient to understand the complexity of TC in open spaces; therefore, the current research trend includes perceptual parameters in the analysis. Multiple studies have highlighted the importance of conducting this type of research using additional variables for analysis, since the physiological status (thermoregulation and metabolism), the perception of people, as well as the attributes of urban space intervene at the same time (Nikolopoulou and Steemers, 2003; Mayer et al., 2008; Vanos et al., 2010). This indicator has been implemented in some European cities such as Greece, Switzerland and England, among others.

In this sense, it is important that TC studies integrate three methodological perspectives: climatic conditions, the perception of bioclimatic comfort and aspects of urban design, in order to have a background of how urban interventions can affect the urban climate and identify possible mitigation mechanisms. Some studies have focused on climatic and urban conditions such as the Urban Realm and Open Spaces – RUROS project (Nikolopoulou and Lykoudis, 2006; Wilson et al., 2008) that studies the effects of microclimate conditions on public spaces by monitoring 14 sites and 10 cities. According to this study, the most important parameters that determine the use of public space are air temperature and solar radiation, with differences depending on the time of day (Nikolopoulou and Lykoudis, 2006). These variables are strongly influenced by the geometry, shape, density and shade of urban morphology in that they are essential to understanding the formation of climatic conditions and TC (Tahbaz, 2012). For the study of urban geometry, the urban canyon is used as a unit of analysis, which is the main unit of the urban canopy (urban canopy layer) and includes the walls of the buildings and the volume of air trapped inside (Grimmond et al., 2001). In this respect, the urban geometry is one of the most important factors that contribute to the variation in urban temperature and plays a key role in altering or generating local climates (García-Cueto et al., 2007; Mayer et al., 2008; Krüger et al., 2011). In Latin America, the application is highlighted in the forested urban canyons with low-density buildings in the city of Mendoza, Argentina (Correa et al., 2012).

In this sense, the contributions of bioclimatic urbanism, which address the suitability of the urban layout to the unique conditions of climate and territory, is an important area for research in climate and urban planning (Gómez et al., 2001; García, 2006). The literature mentions some of the contributions in modeling these physical and perceived parameters (Svensson et al., 2003; Oliveira and Andrade, 2007; Chen et al., 2012; Herrmann and Matzarakis, 2012; Andreou, 2013), but few consider this approach by combining the climatic conditions, perceived comfort and urban design in public spaces. This research intends to bridge the gap between urban climatology and urban design in cities of developing countries. This could help increase the understanding of the relationship between urban canyon morphology and TC. Therefore, the research question: is the morphology of the urban canyons significant enough to modify the dominant climate in relation with TC indexes in coastal cities?

Within this context, this paper aims to develop a methodology to analyze the relationship between climatic conditions, the perception of bioclimatic comfort and urban morphology, with support from geomatic
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