Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 180 (2017) 462 – 470

Procedia Engineering

www.elsevier.com/locate/procedia

International High- Performance Built Environment Conference – A Sustainable Built Environment Conference 2016 Series (SBE16), iHBE 2016

The Objective and Methodology of Urban Climate Map for the City of Xiamen

Shuyu Liu, Daifeng Song*, Bo Yu

School of Architecture and Civil Engineering, Xiamen University, Xiamen, 361005, China

Abstract

Aiming at mitigating urban climate issues, from the perspective of the correlation between the morphology of underlying surface and urban climate, based upon Xiamen's natural, economic and social conditions and urban development strategies, new approaches for compiling urban climate map for the coastal city in southeast Fujian province are explored. With the idea of problems-solving and cost-control, the approaches are anchored in the assessment of the differences between the theoretical value of urban climate issues distribution which are calculated with morphological zoning and corresponding observed results, therefore the main objective of climate analysis is redefined to locate areas where inappropriate constructions occur and map the city according with a hierarchy of carrying capacity of urban climate environment. Findings show that the Xiamen urban climate map produced with mentioned approaches may lay a foundation for generating customized urban design strategies along with providing quantitative analysis from urban climate research.

Peer-review under responsibility of the organizing committee iHBE 2016

Keywords: Urban climatology; carrying capacity; urban planning; urban climate map.

1. Instruction

As a best bridge between urban planning and urban climatology, urban climate map system can scientifically guide urban planning and decision-making for sustainable development [1]. As an information and evaluation tool, the concept of urban climate map ("UCMap") was created by German researcher Prof. Knoch in the 1950s and introduced to other countries after 1980 [2-3]. As a tool for translating climatic related information into urban planning process, urban climate map can indicate the status quo of urban climate environment and probable urban

* Corresponding author. Tel.: +86 18959208056; fax: +86-592-218-8959.
E-mail address: songdf22@163.com

Peer-review under responsibility of the organizing committee iHBE 2016
doi:10.1016/j.proeng.2017.04.205

climate issues in two-dimensional maps, and evaluate climate function of each individual zone and clarify challenges for spatial planning [4-6]. As it can help urban planners understand the effect of urban climatic issues solving on decision making in urban planning, urban climate map can bridge the gap between urban climatology and urban design [7-9]. Practices show that it is necessary for cities in different climate zones to find appropriative way to evaluate the carrying capacity of urban climate environment based on the diversity of available resources and practical challenges. A research project was carried out to produce urban climate map for the city of Xiamen in 2014-2015 to enable planning authorities to take care of the urban climate and its interrelation with urban structures.

At present, there are two common ways to establish an UCMap system .One is based on outdoor human comfort evaluation, the other is based on regional climate function identification. The former can hardly avoid the issue of objectivity when evaluate the effect of meteorological factors on human body. And most relevant research works ultimately had to use qualitative analysis methods such as questionnaire survey to determine the classification threshold in terms of human comfort feeling. The latter can indicate the climate function of different regions, but it is hard to define the actual disturbance of the development of each region on original urban climate function. Considering the diversity and huge scale of urban sprawl in China, it is necessary for each city to explore custom-made ways to present and mitigate urban climate issues, and to rethink the objectives and method of compiling UCMap. The research focused on developing and implying localized approaches for the city of Xiamen, as well as providing technical reference for the other coastal cities in southeast Fujian province in China.

2. Objectives and tasks

2.1. Framework condition

The objectives of establishing UCMap system must be based on a further investigation of natural, economic, social and other basic framework conditions. With an area of 1699.39 km^2,the city of Xiamen lies between Zhangzhou plain and Quanzhou plain and is located at 24°26′46″ N 118°04′04″ E, where Jiulong River meets the sea. Since 1980, Xiamen has been changed into a central city of southeast coastal areas, a shipping center and a most popular tourism destination from a front fort. In the 21st century, under the guidance of the 'trans-island development' strategy, the integration of Xiamen island and coastal region is realized. According to the draft of Urban Master Plan for Xiamen (2010-2020), the land for construction will increase to 440km^2 in 2020 and the main structure of urban layout will be composed of one island, one belt, and dual-core via the development of new towns, the concentration of industrial parks, as well as the decentralization of traffic infrastructure. All urban clusters will be separated by sea, mountains and ecological corridors and will be blended into natural environment.

The city has a monsoon humid subtropical climate, characterized by long, hot and humid summers and short, mild and dry winters. The monthly mean temperature in February is 12.4°C (285.5K), while in July it is 27.8°C (300.9K). The annual mean temperature of northwestern Xiamen, which mainly consists of mountainous terrain, is lower than other parts. The mean annual rainfall is around 1350mm (53in). Monthly average relative humidity of the August is 85%. Due to the impact of land and sea breezes as well as monsoon, the annual average wind speed is about 2.7m/s and is on a downward trend from the 1950s. Meanwhile, with the influence of topography, the prevailing wind direction of each zone shows great diversity from observational data.

2.2. Characteristics of Xiamen's urban climate issues

Along with the economic boom, the urban climate issues of Xiamen have been deteriorating during past three decades. In summer, days of high-temperature, cloudburst and smog were continuously increasing, while the atmospheric visibility and the sunshine duration were decreasing. Extreme weather events occurred more frequently. By 2012, the average annual temperature has risen from 20.1°C (293.3K) to 21°C (294.1K) and its uptrend is particularly obvious in the new century. The average annual relative humidity has declined from 78% (in 1990's) to 72% or even lower. From 1954 to 2004, the annual rainstorm days of Xiamen increased from 3 days up to 5 days.

It should be noted that the number of annual smog days surged since the year of 2003, which is called "the first year of private auto age in China". Meanwhile, the duration of smog events kept growing up to 7 days and continuous 3-days of haze occurs several times per year. In addition, the prevailing wind of Xiamen is not always