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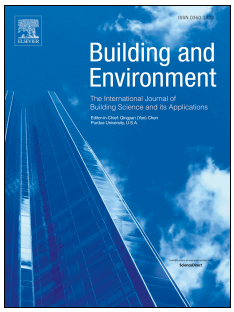

Physical characteristics of Bangkok and its urban heat island phenomenon

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Physical Characteristics of Bangkok and its Urban Heat Island Phenomenon

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ABSTRACT

Since 2000, Bangkok has maintained an average temperature rise of 0.1˚C per annum. Temperatures peaked during summer days at approximately 34˚C, was 4°c higher than the night peak. Day temperatures in both Bangkok and its neighboring provinces remained slightly different, while during the morning and evening the temperature in Bangkok rose higher than its neighboring provinces by 1˚C during the summer, and by almost 2˚C higher during the winter. Data was collected from 59 weather stations in and around Bangkok at three-hour measurement intervals during all three seasons at five year intervals in 2000, 2005, 2010 and 2015, and this data was used to create thermal contour data. In this period there was some retention of urban heat mass during the afternoon and evening which slows down the cooling rate of the urban area when compared to surrounding areas.

Bangkok is divided into 50 areas, each with different physical characteristics which also affect the urban heat island. The city's physical variables were calculated from geographic data derived from the Department of City Planning, Bangkok Metropolitan Administration, including street area ratio, water area ratio, public area ratio, building coverage ratio (BCR), and floor area ratio (FAR). Key indicators of urban heat island include temperature and cooling rates. From this data, it was found that urban physical characteristics had a significant impact on the magnitude of the urban heat island, particularly the floor area ratio (FAR) and building coverage ratio (BCR), in which temperature levels at 10 p.m. and thermal cooling rate between 4 and 10 p.m. had a correlation value of over 0.50.

KEYWORDS

Urban heat island, Urban street canyon, building coverage ratio, floor area ratio, cooling rate

1. INTRODUCTION

Bangkok is the capital and the largest city in Thailand and occupies 1,500 square meters. 15 million people live and work in the city, living, in buildings such as single-family houses in the suburban zone, and in 500 high-rise buildings in the inner-city area. The rapid growth of Bangkok has resulted in land-use changes from agricultural usage to streets and construction. Clusters of overcrowded high-rise buildings is the key cause of urban heat islands (UHI).

Urban heat islands are considered as one a significant problem of the 21st century caused by urbanization and industrial development. Heat is generated from urban structures, reflection of solar radiation, and anthropogenic sources [1]. UHI is a good explanation of the temperature difference in urban areas and in their surrounding rural areas [2]. The factual description of an urban heat island is as a hot air mass in the shape of an inverted bowl over areas of crowded buildings and construction areas in the city [3]. UHI rapidly increases temperatures when there is a low air temperature, while this slows when there is a high air temperature. Thus, the difference between the maximum and minimum temperature decreases [4].

Urban heat island intensity is measured from the difference in temperature in the urban area and the surrounding rural area. In Birmingham, England it is 13°C, [5] 10°C Rotterdam, Netherlands, [6] 9°C in Paço do Lumiar, Brazil, [7] 4°C in Singapore, [8] while in the city of Muar in Malaysia it is 4°C in the day and 3.2°C at night [9]. In Thailand, Jongthanom [10] measured a temperature difference of 3°C to 4°C depending on the time period and season. In Bangkok, the highest UHI intensity is 6 to 7°C in the dry season and the average temperature in Bangkok is 0.8°C higher than the surrounding areas [11]. Increasing city temperatures has great effects on thermal comfort and the spread of pollution caused by traffic [12], decreasing underground water levels, land subsidence [13], changing local wind patterns, rainfall, the health of urban people, and increasing energy use [14].