Influenced Factors of Heat Islands Effect Temperature Increase: Case Study Pathum Thani province, Thailand

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Abstract

The resulting heat affects temperature and associated with urban development in the formation of heat islands. Objective studies the causes of the occurrence and analyzes the amount of heat in air and surface. The process of preparing an energy budget at a constant average temperature system. However, the rising temperature in this study caused by factors related to nature and human action, where the excess calorific value generated from human use of electricity causes temperature changes and climatic characteristics.

Keyword: Heat island effect, Increase temperature, Pathum Thani

Introduction

Urban development raises the temperature of the city. Urban Geography with physical dynamics and urban planning complex and disordered. Urban winds were less capable of absorbing air pollution, heat transfer, and ventilation than in suburban areas. This arises from the relationship between area size, spaces, and the master plan. Ultraviolet radiation, along with the heat build-up on the city's surface, combined with heat from human artefacts and facilities such as buildings, car fuel combustion, and heating air conditioning. Changes in urban climate and rising temperatures in the atmosphere happen.(Ivajnšič, Kaligarič, & Žiberna, 2014) (Choudhury, Das, & Das, 2019; Levermore, Parkinson, Lee, Laycock, & Lindley, 2018; Yang, Huang, & Tang, 2019; Zheng et al., 2019)

The urban population causes dehumidification and heat production. Decreased relative humidity behaviour due to increased energy demand, especially in homes and office buildings, higher air temperatures have a fivefold effect on energy consumption.(Gu & Li, 2018; Guattari, Evangelisti, & Balaras, 2018; Santamouris, 2014; Schwarz, Schlink, Franck, & Großmann, 2012; Sobrino, Oltra-Carrió, Sòria, Bianchi, & Paganini, 2012; Zhu et al., 2019) The use of air conditioning in the building has endless heat transfer.(Bueno, Roth, Norford, & Li, 2014; Gros, Bozonnet, & Inard, 2014) Ventilation in a well-ventilated environment can reduce the risk of viral respiratory infection (COVID 19) and reduce heat release as needed. In the energy cycle, 70 per cent of absorption occurs in the atmosphere19 per cent, and 51 per cent of the Earth's surface. (Change, 2007; Kiehl J. T., 1997) Excessive heat and urban surfaces contribute to the urban warming of islands and rising air temperatures. Dehydration and heat absorption balance affect the energy balance that can reduce the heat to the ground level. (Zhang et al., 2019; Zheng et al., 2019)The possibility of urban heat island formation from water loss of local evaporation has a positive effect on ambient temperatures. (Oke, 1987)

Objective

1. Study the causes of heat islands from urban development.

2. Analyze the amount of heat generated in the city.

Method

1. Study climate data from the Meteorological Department and the city geographic location. Land use,

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maps, and aerial imagery of Pathum Thani Province in 1999-2019.

2. Collecting air temperature survey and statistical data such as daily energy consumption of the urban population, along with the record of land use, and the covered environment.

3. Calculate the amount of heat and the ratio of the thermal energy produced on the atmosphere and the surface. Each cell covers an area of 1 square kilometre: area of the structure, water, green, and bare area.

Results

Pathum Thani physical characteristics consist of construction area, bare area, green area, and water area.

It found that Pathum Thani physical characteristics consist of construction area, bare land area, green area, and water area. 20 years, the physical characteristics of Pathum Thani Province in its figure-ground have significantly changed the urban surface from 1999 to the present. Construction expansion and bare land areas counter the decline and scattering of green and water areas.

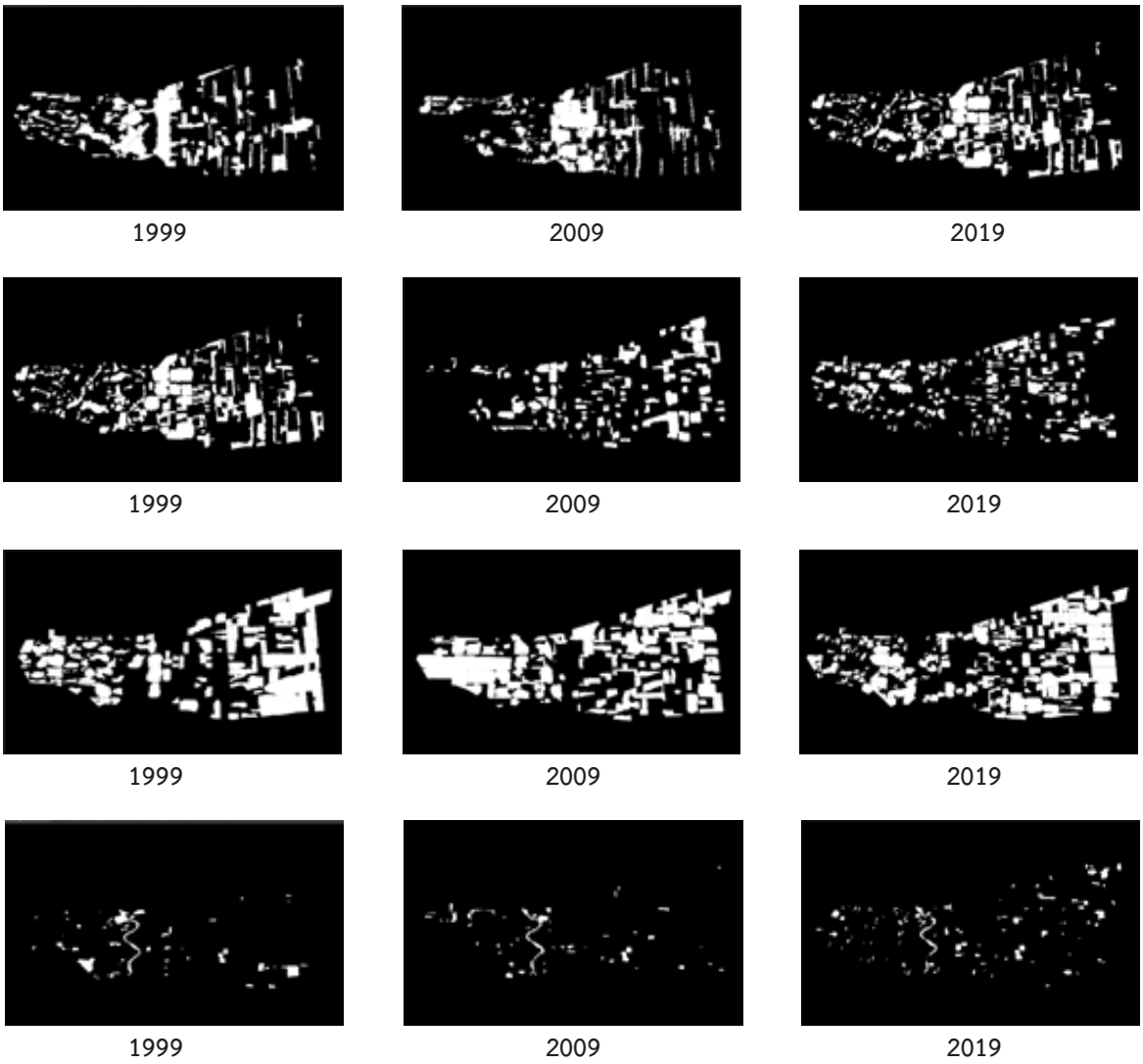

Figure 4. The water area in 1999, 2009 and 2019.

Table 1. Ratio the proportion of land use and the percentage of utilization.

Year/Land use	Construction	area(%)	Green area(%)	Bare land area(%)	Water area(%)
1999	22	25	49	4	
2009	35	20	43	2	
2019	45	15	38	2	

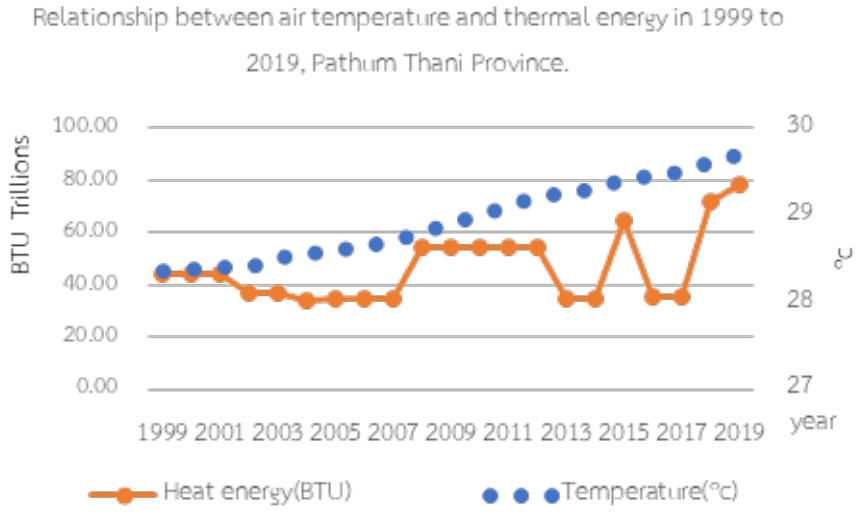

Figure 5. Relationship between air temperature and thermal energy, Pathum Thani Province.

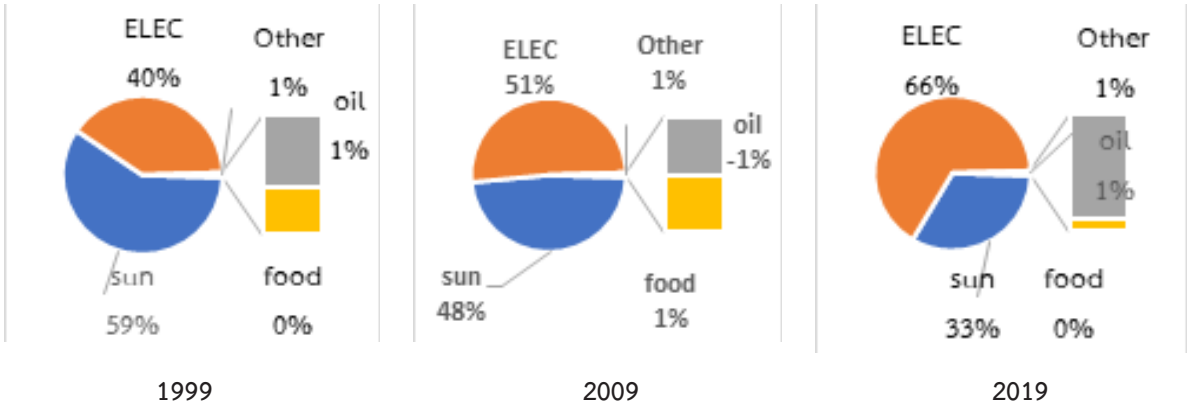

Figure 6. The proportion of thermal energy generated in the year 1999, 2009 and2019, Pathum Thani Province.

The proportion of land use and the percentage of utilization. There was a tendency of green and water areas to decrease in each period of 10 years to 1/2 of the original proportion. On the other hand, the construction and bare land areas expanded approximately 10 per cent of the original proportion.

The picture shows that from 2002 to 2007, the five years when the cost of thermal energy decreased. Rather, the constant air temperature, where thermal changes influenced by rainfall and wind speed. Due to the behaviour of the movement of heat directed from a hotter to a cooler region and more than five years, the air temperature drops significantly.

The proportion of thermal energy generated in the year, Pathum Thani Province The percentage of electricity consumption increased by approximately 10 per cent over the course of 10 years or 1 per cent per year.

Table 2. Ratio the proportion of thermal energy generated from heat sources.

Year/ Heat sources	Sun (%)	Elec (%)	Oil (%)	Food (%)
1999	59	40	0.6	0.4
2009	48	51	0.5	0.5
2019	33	66	0.9	0.1

The heat sources generated in the city are accumulated in the air from solar energy, electricity, oil, and food. Especially, all activities of human-caused, as heat from electricity has risen within 20 years, a progressive rate in line with urban physical expansion and a key factor in urban air temperature changes.

From the picture, it found that seasonal rainfall (represented in September) tends to decrease. The summer rainfall (represented by May) showed higher rainfall, especially in 2017 with high summer rainfall countering the lower evaporation. Combined with annual relative temperature and relative humidity data, found that summer rainfall may not affect air temperature reduction. Rather, may change in air temperature that affects air dehumidification.

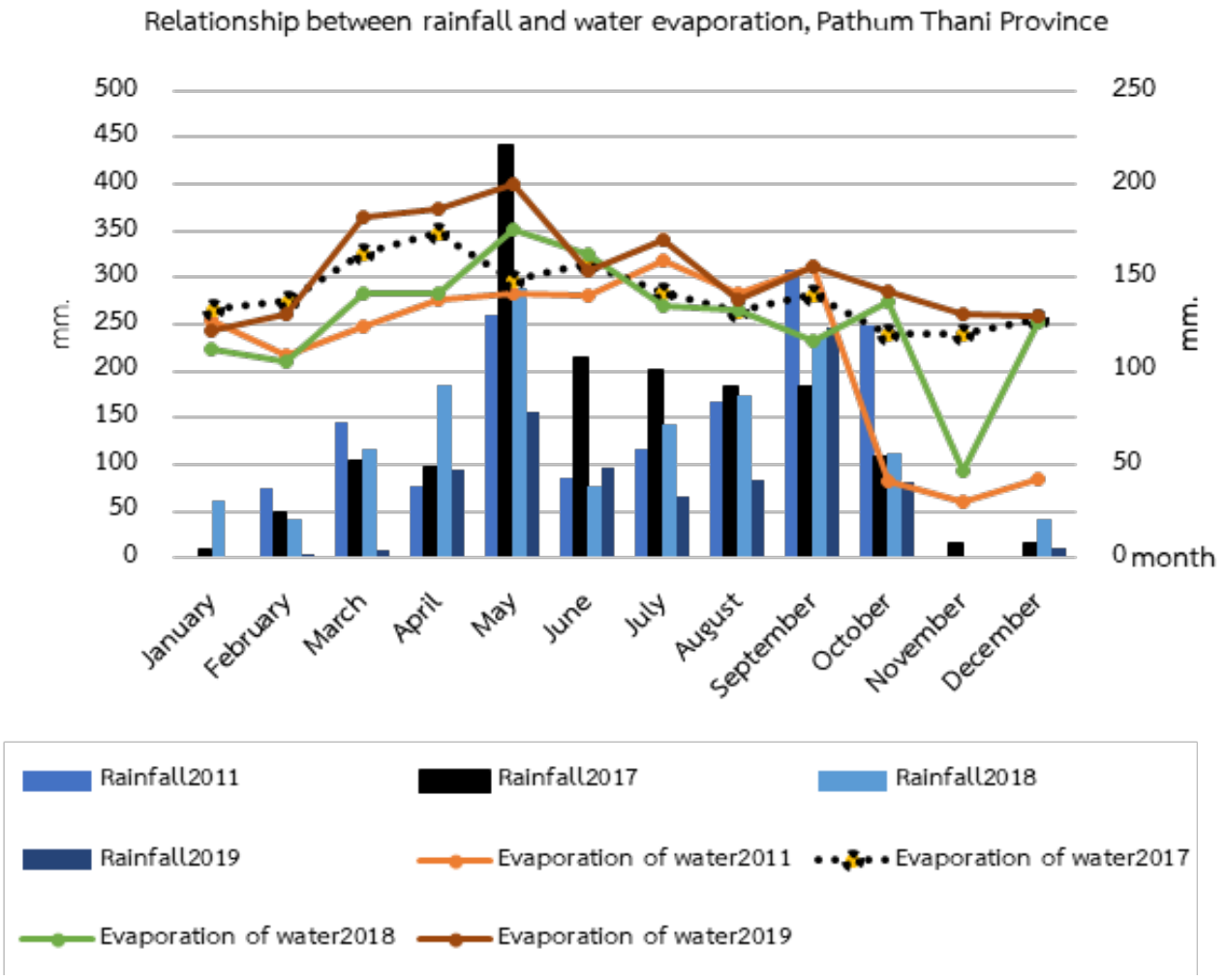

Figure 7. Relationship between rainfall and water evaporation, Pathum Thani Province.

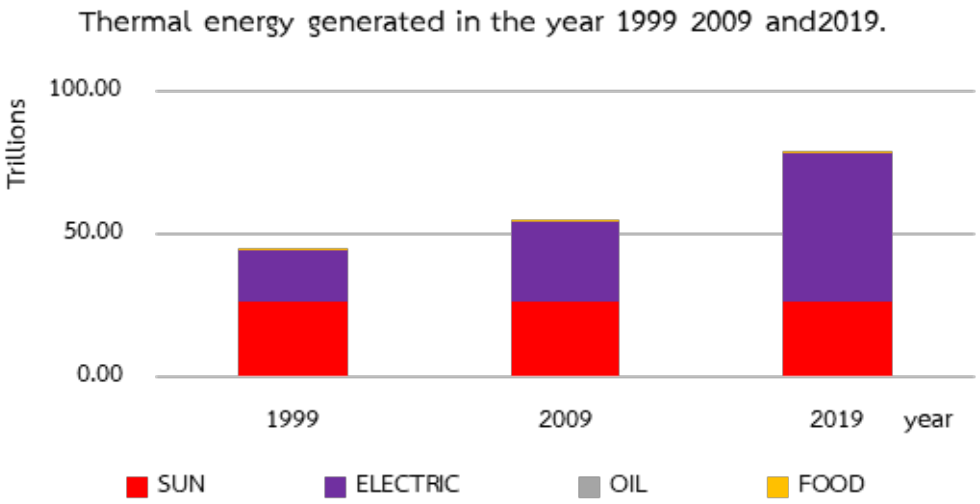

Figure 8. Thermal energy generated in the year 1999, 2009 and2019, Pathum Thani Province.

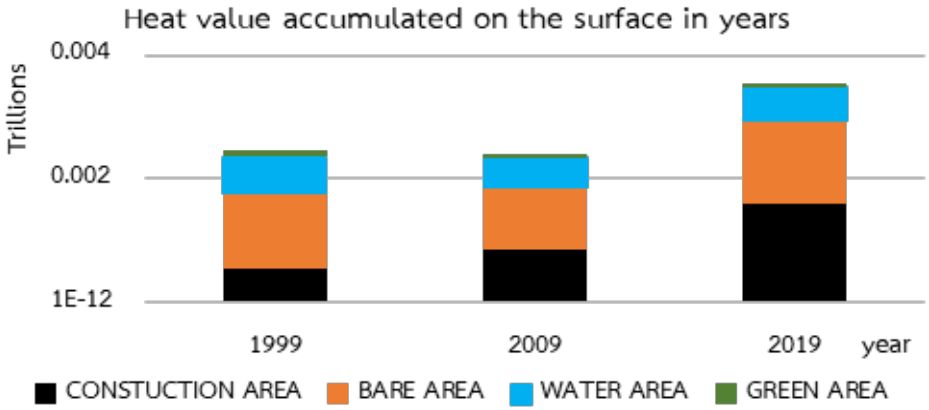

Figure 9. Heat value accumulated on the surface in years 1999.2009 and2019, Pathum Thani Province.

The results of calculating the amount of heat in the air from four sources: solar radiation, electricity, oil, and food, showed that the solar heat content was constant at 26 trillion BTU due to the influence of latitude. The amount of heat generated by electricity was higher in 1999, about 18 trillion BTU, about 27 trillion BTU in 2009, and 51 trillion BTU in 2019. A snapshot of 80 trillion BTU of cumulative heat comes from human facilities and human life cycle activities that transfer energy into the atmosphere. (Figure 8.)

The results of calculating the amount of heat accumulated from the surface characteristics were construction group, mainly concrete and asphalt, bare land, green, and water areas found that in 1999 and 2009, there was a total cumulative heat amount of 2 billion BTU, while in 2019 increased to 3 billion BTU from the construction group of 1 billion BTU and about 6 hundred million BTU of bare land areas. This causes large amounts of surface heat to accumulate, which leads to the formation of urban heat islands. (Figure 9.)

The surface and atmospheric energy balancing process was a value calculated from the average percentage of solar energy into the earth, absorbing approximately 70 per cent and reflecting 30 per cent. Solar energy at the receiving area and constant proportion since 1999 Up to 2019 equals 26 trillion BTU. (Figure 10.)

The results of calculating the difference between air and surface heat values from 1999 to 2019 (symbol: blue) found that excess heat minus the thermal energy generated in the balancing process. (symbol: orange) The result was equal to the excess heat, equal to the thermal energy generated by the electricity (symbol: grey and purple equal), indicating that the higher temperature, in this case, was caused by excess heat. Electricity consumption in 1999 amount to 18 trillion BTU, 2009 amount to 27 trillion BTU and 2019 equal to 51 trillion BTU. (Figure 11.)

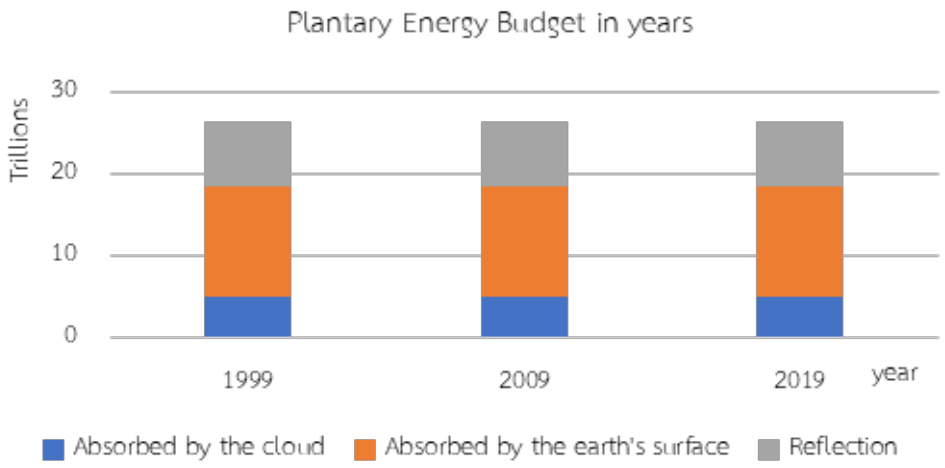

Figure 10. Planetary Energy Budget in the years1999. 2009 and2019, Pathum Thani Province

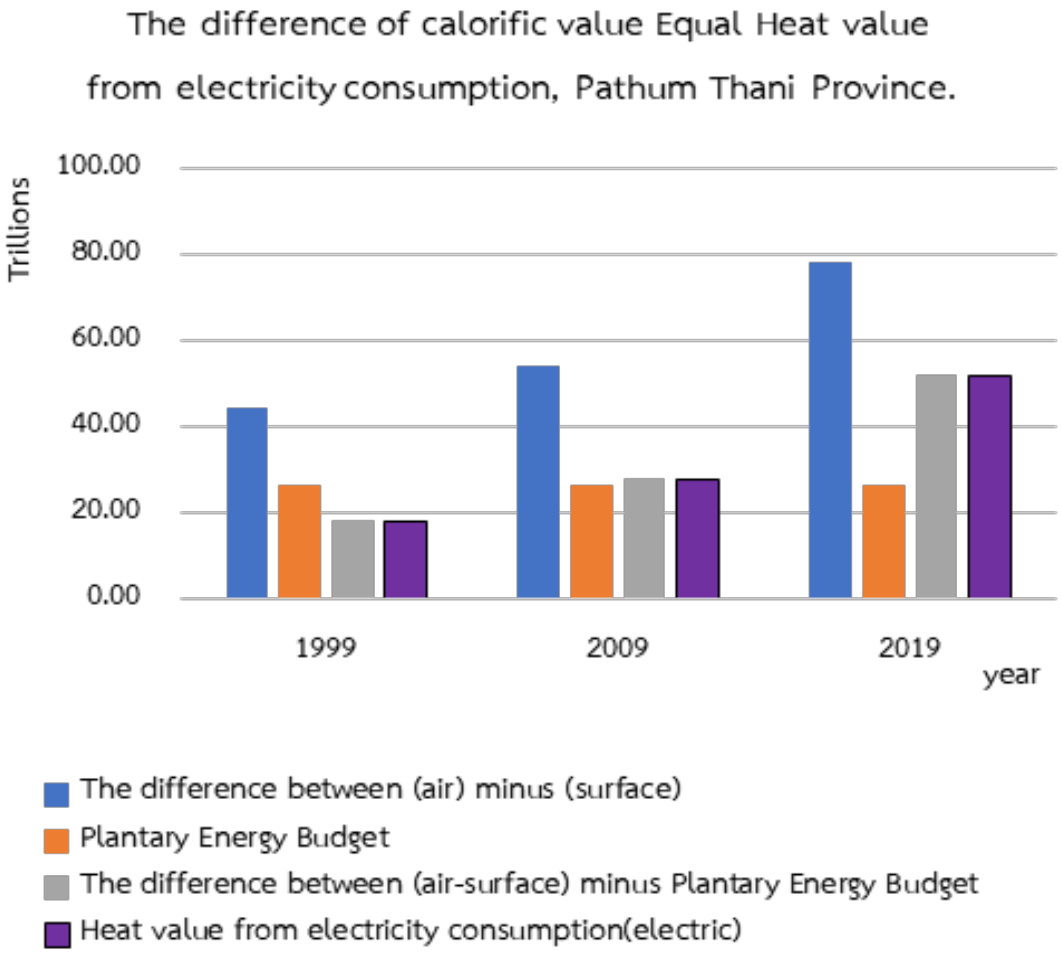

Figure 11. The difference of calorific value Equal Heat value from electricity consumption in the years1999. 2009 and2019, Pathum Thani Province.

Conclusion

In hot and humid climates such as Thailand, a case study in Pathum Thani, Bangkok's metropolitan area, physical activity in the city expanding to support congestion from the metropolis. Planning and controlling urban growth from one of the causes of land surface changes caused by urban development is a major cause of urban heat islands. The heat-accumulating material surface combines with the heat released by using various energy sources. In a city with a growing population, the physical appearance of the city is changing, and heat accumulates on the surface of the land. The accumulation that occurs in the atmosphere reveals an increase in average temperature as a result of urban heat islands, increasing the average monthly rainfall. But humidity reversed the opposite way. These physical characteristics are more suitable for cold regions where surface materials are used that absorb heat accumulated and release heat when it reaches a balance between the atmosphere and the earth's surface than in tropical humid countries such as Thailand.

Surface materials for Thailand absorb heat and release heat into the atmosphere. Buildings are exposed to solar radiation throughout the day, especially at the roof and ground planes. Concrete and asphalt have low insulating properties. The thermal capacity of this type of material is 800 – 1000 J/kg-K. Low specific heat capacity, transmits heat to the interior quickly for areas used at night. On the other hand, it is high, transmits less heat, and slows (Time-Lag) for areas used during the day.

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