Spatiotemporal Analysis on the Squatter Development: A Case Study in Kampung Baru, Kuala Lumpur

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As a Malay Agricultural Settlement gazetted in 1900, Kampung Baru (Kuala Lumpur) has been subjected to prolonged national interests (e.g. economic, social, environment and politic) and it is pressured by modern and future development. Theoretically, the Urban Heat Island (UHI) phenomenon is prevailed in the area, but only few studies have been carried out to address the issues in a quantitative manner. Therefore this study aims at providing better insight the UHI phenomenon in Kampung Baru (Kuala Lumpur) and explicitly examining the temperature pattern and its vicinity effects. The field survey was conducted to collect the temperature and relative humidity using mobile survey method. Additionally, the fixed weather station had been installed starting from October 2013 in the study area and the data were compared with the rural area data from the Malaysia Meteorological Department. Thus, the intensity of UHI was estimated based on the difference between urban and rural temperature. In conclusion, this research quantified the UHI in Kampung Baru, and it can be a critical input to the urban development planning in a changing environment.

Keywords: urban heat island; fixed and mobile measurement; Geographic Information System; urban planning; climate change.

1.0 Introduction

Urban heat island (UHI) is not a new phenomenon occurs in large cities or metropolises around the world. Rizwan *et al.* (2008) stated that the city, which has the total population more than three billion, would directly expose with UHI effect and it will be increasing every year. Strictly, urban heat island (UHI) is a phenomenon where the urban jungle areas temperature is getting warmer than in rural areas, especially during nocturnal.

Mitigating the effect of UHI should be claimed as the heart element in the urban design (Giridharan *et al.,* 2005; Givoni, 1998). Various factors are examined to identify the cause of UHI occurrence such as the lack of green vegetation in an area due to

the rapid development, the materials used to build skyscrapers, geometric shapes of a city, dimensions of buildings, anthropogenic heat and other additional factors, e.g. climate change and geographical position of the area (EPA, 2008).

In Malaysia, the phenomenon of UHI has been detected as early as the 1970s. Sham (1973) used a traverse survey to study the micro climate in Kuala Lumpur and found that the central district area have higher temperature value compared to the rural area around the city. Another finding was the heat island intensity is greater during calm and clear sky nights compared to the daytime. Elsayed and Che (2012) measured the UHI intensity during the nocturnal around the Kuala Lumpur city. They found that the nucleus of UHI is shifted to Puduraya area from the Chow Kit area with the increasing intensity equivalent to 1.5°C. Zakiah (2004) provided understanding and consciousness on the importance of comfortable outdoor living for Kuala Lumpur citizen indicating the difference temperature from 5°C to 8°C at the vegetated and densely built-up area.

Following the above mentioned about UHI in Kuala Lumpur, there is an unique area known as Kampung Baru. It is an isolated 'island' in the middle of a developing city, Kuala Lumpur. Due to its strategic location from the city of Kuala Lumpur, but far from excessive development made the Kampung Baru is the interesting area to investigate the UHI phenomenon due to the effect of high rise buildings to the low rise buildings and the air flow in the area.

This research investigates the effect of heat island in the rural area (Kampung Baru) and its temperature variation compared to the surroundings. We hypothesize that Kampung Baru have influenced by the heat island phenomenon even it is considered as a rural area because its location surrounded by the high rise high density buildings. A preliminary result is presented and critically discussed.

2.0 Literature Review

In Malaysia, the low-rise residential area classified as 'village' is situated in the heart of Kuala Lumpur known as Kampung Baru. Every city has its uniqueness with respect to the geographical location, cultural, architectural and history (Oke, 2006). Kampung Baru also has its own historic cultural since it was opened in 1899. Total population in the Kampung Baru is around 45000 per year. With the advance of the neighborhood development, Kampung Baru becomes an isolated island with generally low rise structures. Hence, it is an interesting and unique part to study about the weather pattern of isolated island in the middle of concrete jungle such as Kuala Lumpur. This diversity makes the trilling more challenging and climate comparison becoming more interesting (Oke, 2006).

Some of the earliest studies have focused on the effect of UHI in the Kuala

Lumpur city since 1972 (Elsayed, 2009; Ahmad and Norlinda, 2004; Shaharuddin, 1997). However, there is no detailed study has been carried out to which focused on Kampung Baru itself to see the variation of weather pattern and effect of UHI at suburban area due to its located less than 1 km from the high rise buildings for instance Kuala Lumpur City Center (KLCC), Kuala Lumpur Tower (KL Tower) and other high rise buildings in Kuala Lumpur as well as the effects of density.

There are various methods and techniques which have been conducted to study the urban airflow and UHI within and beyond cities. The study required measurements to be made such as wind flow and climate changes at several horizontal and vertical levels and some of the measurements are above the average height *(*Di Sabatino *et al.,* 2010). The change of temperature can be alarming system to the occurrence of negative impact to the future generation if no appropriate action is taken.

The previous studies carried out in the Kuala Lumpur city reported that UHI brings five major effects; thermal comfort, human health, pollution, society economic and meteorological and climatology. Therefore, policy makers, local government and engineers must be considered the factors that contribute to the formation of UHI before designing and redevelop the area (Giridharan *et al.,* 2005).

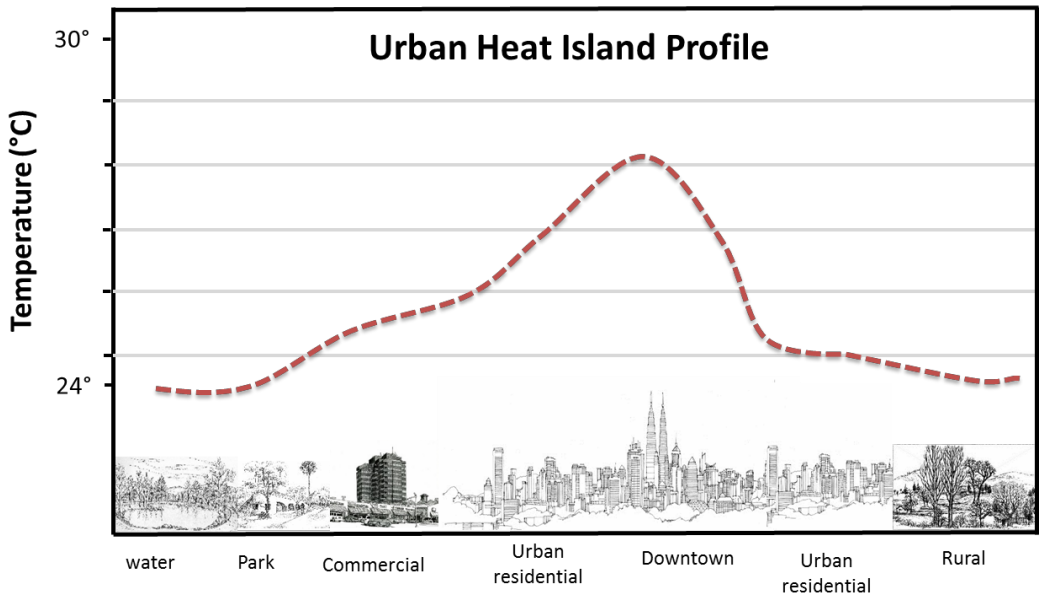

Figure 1: A general urban heat island profile (Reproduced from Wong *et al.,* 2011).

3.1 Methodology

3.2 Selection of UHI Variables

Considering the Kampung Baru geography, the following variables are selected to map out the UHI effect and temperature variations; different temperature between

urban and rural area, effect of building materials to the temperature, and temperature plotting pattern at Kampung Baru its neighbourhood area. Therefore, implications of these variables are chosen to assess the effects of Kampung Baru in Kuala Lumpur.

3.3 Protocol for Field Measurement

One fixed station was installed at Universiti Teknologi Malaysia approximately 1 km from Kampung Baru. For the fixed station, data are collected using a Campbell scientific weather station which was installed on the top of MJIIT building and the data stored in a logger net. The instrument was set up at 10 minutes interval. Three important weather parameters; temperature, relative humidity and wind speed are measured constantly in twenty-one months (September 2013 until May 2015).

While in April and May 2015, the mobile measurement technique was carried out in Kampung Baru and covered approximately 500 meter from its boundary. The routes for mobile measurement were planned to have the better understanding on how the land use pattern will affect the temperature (Figure 2). Figure 3 shows the detailed of different land uses and their locations during data collection. It is very important to relate the causes of UHI at Kampung Baru from its neighborhood. Temperature and relative humidity were collected during the mobile measurements conducted.

(a) (b)

Figure 2: Routes of the survey a) land-use category along the mobile survey routes b) mobile survey routes.

The mobile measurements were conducted using a motorcycle equipped with two-separated Hobo pro-V2 including the shielded solar radiation (Figure 4). Both instruments were collected the temperature and relative humidity data continuously at one second interval. The observations time were done at night from 8.30 pm to 10.30 pm for days from 24th April 2015 until 8th May 2015, with the speed of vehicle of about 20-30 km/h. The routes was covered Kampung Baru and 500m from its boundary were

surveyed for selected 6 days from 24th April 2015 till 8th May 2015.

In many previous studies, the urban heat island is higher after the sunset compared to the daytime largely due to some factors such as urban geometry and heat absorbed by the buildings due to re-emission (Giridharan *et al.,* 2005; Rizwan *et al.,* 2008 and Wong *et al.,* 2011). Heat is generated from many factors for instance sun, air conditioners, antrophogenic heat and automobiles (Rizwan *et al.,* 2008). Hence, this research is conducted during the night time to minimize the heat factors and clearly see the effect of urban heat island occurs at study area.

No.	Elements	Figure	Location
1	Water / pond		Taman Tasik Titiwangsa
2	Park		Taman Tasik Titiwangsa
3	Highway / commercial area		Along Jalan Tun Razak
4	Urban Residential		Kampung Baru (study area)

5	Downtown		Kuala Lumpur city center
6	Mountain / rural		Hutan Simpan Bukit Nenas

Figure 3: Difference types of land-use category collected in the mobile measurement.

Figure 4: Two sets of Hobo Pro-V2 were used during the mobile measurement.

4.1 Results and Discussion

4.2 Fixed station analysis

UHI is determined by comparing the high temperature in the urban area compared to the rural area especially in a night-time (Shaharuddin, 1997). Four meteorological station data from the Malaysia Meteorological Department (MMD) was compared to the MJIIT weather station in order to determine the existence of UHI in case study area. One meteorological stations located in Petaling Jaya (3° 06' N, 101° 39' E) was chosen as stations at urban area. One auxiliary station (FRIM Kepong (3° 14' N, 101° 38' E) located in the rural area are purposely selected and further analysed. Figure 5 shows the temperature different and variation of three weather stations data. Eight-month temperature data were presented from October 2013 to May 2014. We analysed the only eight-month data due to the limited information provided by MMD.

The result revealed that the high temperature occur at urban area such as MJIIT and Petaling Jaya (see Figure 5). Not surprisingly, the rural area especially FRIM

Kepong has resulted in the lowest temperature compared to the other stations. Kampung Baru has higher temperature between 1-2 °C compared to the rural areas e.g. Forest Research Institute Malaysia (FRIM) Kepong.

4.3 Mobile measurement analysis

As a result of mobile measurement analysis, we presented the correlation between land-use category and temperature pattern. The measurements route were performed at different land-use types such as pond (water), park, commercial, urban residential, downtown and rural area. Figure 6 shows the value of temperature for each day observations at different land use category, while Figure 7 presents the temperatures value plotted on the graph.

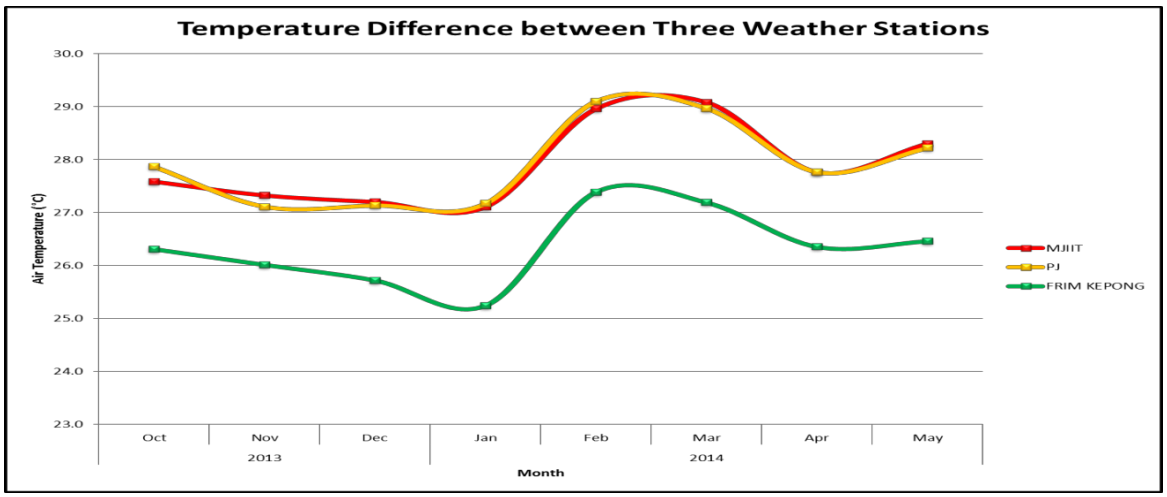

Figure 5: Temperature difference between MJIIT, Petaling Jaya (PJ) and FRIM Kepong for eight months continuous observations.

	24-Apr-15	26-Apr-15	4-May-15	5-May-15	6-May-15	8-May-15
Pond	29.1	28.3	25.7	29.8	29.7	27.6
Park	28.5	28.2	25.4	29.2	29.5	26.9
Commercial	29.2	28.5	25.0	29.3	29.5	27.4
Urban Res	29.4	29.0	25.7	30.4	30.8	28.3
Downtown	29.0	28.8	25.7	30.2	30.5	28.1
Urban Res	29.4	29.0	25.7	30.4	30.8	28.3
Rural	28.6	28.2	26.3	29.8	30.2	27.8

Figure 6: The value of temperature for mobile measurement.

For the 4th May 2015, the graph pattern shows different than others. As expected, the results for water area (pond) and rural area (mountain) are coolest compared to the other area because they are the important elements in reducing temperature. However the trends reported on 4th May are found contradict than aforementioned finding. The reason is because the measurement on that day was carried out directly

after the rain stop. This finding supported that the urban heat island is not significant with the measurement obtained during-or after the rain.

Except for the 4th May 2015, the graphs show that urban residential (Kampung Baru) is the hottest area compared to the other area for all observation days. The results are clearly shown that study area is characterized by hottest temperature even when it compared to the downtown area. It is worth mentioning that this result is constant for each observation day. Even though the difference is less than 0.4°C, it is vice versa from the expectation because the downtown is expected hottest temperature during the night-time compared to other area. Nevertheless, Kampung Baru is not considered as a high-rise building zone. The main reason is perhaps contributed from the effect of the surroundings infrastructures such as highway (heavy traffic) and high rise buildings, made the study area is very compact area.

For the green area comparison, the results show that the green area with roadside trees coverage contributed to the cooler temperature in the surrounding city. Compared to Hutan Simpan Bukit Nenas, a park at Taman Tasik Titiwangsa is cooler. This result is constant for each observation day except for 4th May 2015. The reason is supported by the observation at a park located in Taman Tasik Titiwangsa where the roadside tree exists while for Hutan Simpan Bukit Nenas, the observation is limited by the highway zoning.

A combination of greenery area with water element can be lowered the temperature compared to the standalone greenery area. Taman Tasik Titiwangsa shows the lower temperature compared to Hutan Simpan Bukit Nenas at each day of observation

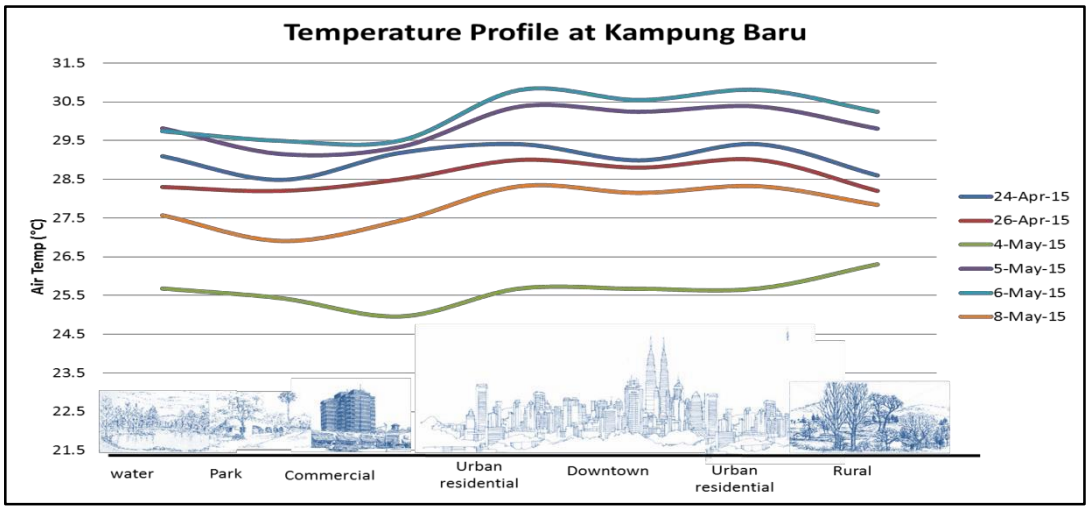

Figure 7: Temperature distribution based on mobile measurement.

5.0 Conclusions

This paper presents the quantification of UHI in Kampung Baru (Kuala Lumpur). It is one of interesting areas in this country in term of its strategic location and future development interest. We collected substantial number of field data supported by the climatic and GIS analysis. Remarkably, this study revealed the presence of UHI in Kampung Baru. Even more interesting that the study area is far from the intense development and low number of high-rise buildings, made the temperature have been affected by the surrounding development and environment. This finding is supported by the measurement recorded in Petaling Jaya station. It also indicated that the temperature in the study area is fairly same with the station. It is worth mentioned that Petaling Jaya weather station was installed at the centre of Petaling Jaya's city, which is one of busiest city in the Malaysia.

The study also shown that Kampung Baru is affected by its surrounding by reporting highest temperature compared to the other places a result of the mobile measurement. From the six days observation, a higher temperature value was found in Kampung baru compared to the downtown area. It can be said that the low-rise residential area will trap warmer air temperature if it has compact buildings and the surrounded by high rise buildings. This research can be extended to other areas with the developed methodological framework and functional implementation.

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