Abstract

This study was conducted to study the effect of urbanization on Urban Heat Island (UHI) phenomena in Kota Bharu, Kelantan. The purpose of this study is to identify the phenomena UHI found in Kota Bharu as a result of urbanization. The study focused on two primary data primary data through field studies and secondary data of Kota Bharu Islamic City Council (MPKB-BRI). Method crosses the field temperature was carried out using motor vehicles involving fourteen Kota Bharu stations, which includes the downtown area to the suburbs to measure temperature, humidity and wind speed for five days from 27 March 2018 until 31 March 2018. The data collected are twice a day in the evening and evening between 14:00 and 16:00 and between 20:00 and 22:00. The data were analyzed using statistical software for the social sciences (SPSS), Microsoft Excel Window and geographic information systems (GIS) software. The study found that concentrated UHI phenomenon in the downtown area that includes the KB Mall and Gas Station Shell suburb of the Sultan Ismail Petra Airport report, Chengal Village, Village Corps and Zainudin furniture. The difference in Intensity Urban Heat Island (IUHI) value is also shown in the study that recorded IUHI at Kota Bharu is 2.39°C during the day, compared the value IUHI is 1.57°C at night. Overall, urbanization activity in Kota Bharu has led to the phenomenon of UHI in this area. Therefore, effective measures must be applied to reduce these phenomena and ensure the comfort of life without affecting the environment.

Keywords: Urbanization, Urban Heat Island (UHI), downtown, suburbs

I. Introduction

Urban Heat Island (UHI) is defined as a city microclimate phenomenon with a higher average temperature distribution than the surrounding area [XVI; XIV]. UHI
is not a new phenomenon that exists and is formed in most major cities in the world today. This situation has also been experienced by most major cities in Malaysia for decades at the end of the last century. The area of the city is the highest area experienced physical change. Almost every day, the process of replacing the forest with the buildings is ongoing. This influenced by the economic activity found in a country such as manufacturing, construction, transport and human activity which increased the temperature in surrounding area especially in urban areas. The quality of the city environment is getting worse every year [X].

The rate of temperature increase can be illustrated by the urbanization effect that is carried out in an area that results in the formation of the UHI. This is a serious matter and requires immediate preventative measures. Hence, how far the urbanization factor in influencing UHI in Kota Bharu, Kelantan is an important objective in this study. In addition, the study also attempted to elaborate on several ways to overcome the UHI problem. This is because, the contribution of land use change due to forestry is a contributor to the increase of atmospheric carbon dioxide gas. Factories are growing fast which led to a huge job opportunities and improving the standard of living as well as increase in population growth. Industrial area contributes to the impact of greenhouse gases in urban areas, resulting from carbon dioxide emissions [X]

II. Methodology

Research Area

Kota Bharu and nearby areas are selected to conduct studies on the formation of UHI. The study area is also not only concentrated in Kota Bharu but there are two stations covering PasirPekan area, Kelantan Tumpat colony SMK Agama Falahiah and Motorcycle Parts Store. In addition, the features of Bandar Kota Bharu include several aspects such as land use, weather and climate. In terms of land use, Kota Bharu is involved with various sectors, such as administration, trade, finance, culture and education.

Therefore, the area for observation activities is selected based on the city center to the suburbs to identify the temperature distribution and the rate of formation of UHI in an area linked to the factor of land use during the Kota Bharu colony. Fourteen (14) stations were selected within the Kota Bharu Territory under the Municipal Council of Kota Bharu City of Islam (MPKB-BRI) and Ketereh District Council (MDK) and detailed locations according to coordinates (Fig. 1).

In addition, the distribution and land area of the Kota Bharu colony (Table 1). The agricultural area recorded a total of 21,847.26 hectares or 54.70 per cent and followed by a residential area of 13,167.66 hectares or 32.97 per cent. Meanwhile, the main land uses are aquaculture and aquaculture of 41.37 hectares or 0.10 per cent, water reserves of 3,266.65 hectares or 8.18 per cent, vacant land of 1,582.55 hectares or 3.96 per cent and coastal area of 31.51 hectares or 0.08 per cent. The Kota Bharu area located at the mouth of the Kelantan River has a high risk area or is sensitive to small development. Therefore, the built-up area of Kota Bharu is mostly concentrated...
in Bandar Bharu, Ketereh-Lanas, KubangKerian, PasirTumboh, PengkalanChepa, WakafCheYeh, Panji and Kota.

![Fig.1: Distribution of Observation Station in Kota Bharu](image)

**Table 1: Current Land Use in Kota Bharu**

| Land Use                    | Area (Hectare) | Percentage (%) |
|-----------------------------|----------------|----------------|
| Agriculture                 | 21,847.26      | 54.70          |
| Built-up Area               | 13,167.66      | 32.97          |
| Livestock and Aquaculture   | 41.37          | 0.10           |
| Water Body                  | 3,266.65       | 8.18           |
| Empty Land                  | 1,582.55       | 3.96           |
| Shore                       | 31.51          | 0.08           |
| **Total**                   | **39,939.80**  | **100.00**     |

**Data Source**

In general, the data required in this study is divided into two groups, primary data and secondary data. Secondary data is obtained through observation, observation and survey processes conducted in the study area. This data involves temperature, air humidity and wind speed. Meanwhile, secondary data is obtained from various printed or electronic sources such as books, brochures, research reports, scientific training, relevant paperwork and internet links. Reports issued by government and private agencies are categorized as secondary data which are essential to reinforce the evidence obtained. Secondary data is data verified, published and used by various parties to conduct research.

The process of retrieving this data takes five days for 14 different study areas. Therefore, temperature data, wind speed and air humidity are taken for five days per station. The observations begin on March 28, 2018 until April 1, 2018. There are two different times in the observation activity of an observation station for one day, which
is noon and night. During noon, the observations will start at (1400-1600), while the night time observations will start at (2000 until 2200), (I). This observation time is also referred based on past studies conducted by (II; III; V; VI), for the activity of observing temperature data.

**Analysis Method**

The study also has three main findings, primary data through observation activities and photographs taken through observation. In addition, secondary data is obtained through various departments such as MPKB-BRI. Suggestions for the use of software to be used are Microsoft Excel and Statistical Package for the Social Science (SPSS) and ArcGis to present data in various diagrams and graphs. Map from ArtGis format will be converted into shapefile and will be analyzed using Kriging Interpolation technique to show the temperature distribution pattern in the study area.

Moreover, urban heat island effect does have a significant effect on temperatures on a local scale. Several models for estimating the magnitude of this effect can be used such as the kriging method (IV). Through a proper modeling method will unravel the factors that are responsible for heat island development and providing a basis for the development and application of sustainable adaptation strategies (XIX). Furthermore, information from the observation method, especially the surrounding area photographs are printed and analyzed to illustrate the situation in the surrounding area. This will, in turn, reinforce the description of primary and secondary data collected. In addition, this study also uses an average temperature analysis by urban-rural temperature profile to identify the value of IUHI in Kota Bharu (VII).

\[ \Delta T_{u-r} \]  

Which,

\[ T : \text{Average Temperature Change} \]

\[ u : \text{Average Temperature in Urban Area} \]

\[ r : \text{Average Temperatures in Rural Areas} \]

(Source: Oke 1987)

**III. Results and Discussions**

**Urbanization Level in Kota Bharu**

Urban Heat Island (UHI) is not a new phenomenon and it occurs in most major cities in the world today. This situation has also been experienced by most major cities in Malaysia for decades since the last century (XV). In Kelantan, the Kota Bharu colony is the most developed area under Kota Bharu Local Plan compared to the other Nine Colonies. The increase of population in Kota Bharu is very positive, in 1991 there were 374,957 people and increased by 31 per cent in 2000, which was 406,662 people. In addition, Kota Bharu is the catalyst for a major development organization in the State of Kelantan with the presence of Pengkalan Chepa and Lundang industrial estate plots to provide employment opportunities to the residents.
Therefore, this area becomes the main focus area of the population. Additionally, the presence of premier education and institutional centers such as University Malaysia Kelantan (UMK), Hospital UniversitySains Malaysia (KubangKerian), University Malaya Islamic Academic and Arabic Language Center (YIK) at KedaiMulong, MARA Junior College MaktabPasirTumbuh, Kota Bharu Teachers' College and a cottage study are a driving force for migration to the area. In addition, development in Kota Bharu also takes into account the objectives of the National Urbanization Policy (DPN), "Creating a City of Vision with Communities and Prosperous Life Through the Development of the Municipal Development".

The Formation of Urban Heat Island in Kota Bharu

There are two urban centers in the area of study in Kota Bharu, six suburban and six rural areas that are set up in this study and have various types of land use such as business land use and services, housing, institutions and facilities, and green areas (Table 2).

**Table 2: Land Use and Status Station in Kota Bharu, Kelantan**

| Station | Location Name | Land Use | Location |
|---------|---------------|----------|----------|
| 1       | KB Mall       | Business and Services | Urban    |
| 2       | Satay Malaysia| Housing   | Suburban |
| 3       | University Malaysia Kelantan | Institutions and Facilities | Suburban |
| 4       | Lapangan Terbang Sultan Ismail Petra | Stranded Land | Rural |
| 5       | SMK Agama Falahiah | Institutions and Facilities | Suburban |
| 6       | Motorcycle Parts Store | Housing | Rural |
| 7       | Gas Station Shell | Facilities | Urban |
| 8       | Kompleks Belia Dan Suaran Negeri Kelantan | Institutions and Facilities | Suburban |
| 9       | Pejabat Urusan Ekspres Perdana | Wasteland | Rural |
| 10      | Pasar Borong Wakaf Che Yeh | Business and Services | Suburban |
| 11      | Pasaraya G-Orange, Bandar Baru Tunjung | Business and Services | Suburban |
| 12      | Kampung Kor, Kadok | Stranded Land | Rural |
| 13      | Kampung Chengal, Ketereh | Green Area | Rural |
| 14      | Zainudin Perabot | Housing | Rural |

Fig. 2 showed the analysis of the results of the study conducted in Kota Bharu based on temperature observation data based on 14 stations. This parameter is analyzed
Based on location of urban, suburban and rural areas. It is found that the average temperature in the urban areas is higher compared to suburban and rural areas. The highest average temperature reading in urban areas was 35.05 °C, whereas suburban and rural recorded temperature at 33.93 °C and 32.63 °C respectively. It is clearly seen that Kota Bharu is experiencing urbanization based on the average temperature recorded. Also, Kota Bharu caused urban microclimate increase which leads to the formation of UHI in urban areas compared to rural areas.

![Fig. 2: Average Temperature at Daytime in Kota Bharu](image)

While the temperature distribution during night in Kota Bharu is more concentrated in the downtown area (Fig. 3). The temperature of the three areas from urban to rural areas clearly shows a significant difference. It is noted that the highest average temperature in urban areas is 29.55 °C, while suburban and rural areas have the highest average temperatures of 28.73 °C and 27.62 °C at night. Therefore, it is noteworthy that UHI phenomena are also more pronounced in urban areas compared in suburban areas.

![Fig. 3: Average Night Time at Kota Bharu according to Area](image)
The Formation of the Urban Heat Island in Kota Bharu

Urbanization is the biggest contributor to anthropogenic factors as a driving force for the formation of UHI. This situation mostly occurs in the urban areas where packed with human activities such as urbanization and industrialization. The weather parameter data analyzed using ArcGis 10.3 to show temperature distribution during the day and night (Fig. 4). Temperature data was taken on a field observation in 14 stations covering the whole of Kota Bharu district and comprising the city center, suburban and rural. This data is recorded for five days and has two different times during afternoon (noon) and night time. Thus, a visualization has been established to show the average temperature distribution during the day. The station one and seven is the city center, while the sub-station consists of two, three, five, eight, 10 and 11 stations, the four, six, nine, 12, 13, and 14 stations. daytime, UHI formation is concentrated in downtown and sub-urban areas comprising stations one, seven, and 10 where the average temperature is between 33.52°C and 33.93°C to 34.33°C.

Similarly, the average night temperature distribution in Kota Bharu at night was analyzed using ArcGis to represent the temperature pattern or UHI into simple visibility. It was found that at night, the formation of UHI was also concentrated in the urban area, comprising one station where the average temperature was between 29.24 °C and 29.59 °C. This is, in line with the study conducted by (XIII). Meanwhile, rural areas such as four, nine, 11, 12, 13 and 14 stations are lower temperatures compared to central and sub-urban areas.

Assessing the Intensity of Urban Heat Island (IUHI) in Kota Bharu

The temperature difference between the hottest area and the coldest area in Kota Bharu is known as Intensity of Urban Heat Island (IUHI) (VII; XVIII). Significant differences between urban areas and rural areas are high IUHI values. IUHI value is one of them influenced by different land use patterns between urban and suburban areas. This is because of the urbanization. Therefore, it is desirable that areas with strong urban activity will be warmer than those with less urbanization.

Fig. 4: Temperature Distribution during Day and Night in Kota Bharu Kelantan

Assessing the Intensity of Urban Heat Island (IUHI) in Kota Bharu

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Therefore, urban and rural areas temperatures that are absorbed during the week will be weighted for day and night temperatures. The average temperature for the downtown area and the suburbs during the day is 34.31 °C and 31.92 °C respectively. Meanwhile, average nighttime temperatures for Kota Bharu and downtown areas are 28.81 °C and 27.24 °C respectively. Thus, this condition shows IUHI during daytime in Kota Bharu by 2.39 °C. On the other hand, IUHI values vary by night at 1.57 °C. Hence it is concluded that there is different IUHI between the city center and the suburbs. There are many factors that influence the temperature pattern such as daytime heating and night time cooling (XII). It is clearly can be seen that the increasing rate of urbanization exacerbates the negative effects of climate change such in Urban Heat Island Intensity (UHII) (XVII).

IV. Conclusions

The results of the study conducted in Kota Bharu, Kelantan found that the formation of UHI was really present. It is evidenced by the findings that has been analyzed. UHI is concentrated in the urban areas of Kota Bharu which records the highest temperature compared to suburban and rural areas. This is because the downtown area is the main economic center, government, trade and services, facilities, utilities and infrastructure. As a result, the urban area is dominated by saturated coverings such as housing, industrial and infrastructure compared to the green areas. Urbanization will not only impact on the increase of temperature, but it will affect the relative humidity and wind speed in the area. Therefore, action should be taken to curb this phenomenon.

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