The Social Sciences 7 (4): 535-538, 2012
ISSN: 1818-5800

Trends of Urban Climatology Changes in Ipoh City, Malaysia with Special References on the Temperature of Urban Areas

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Abstract: Temperature changes in many urban areas in Malaysia due urban physical lanscape changes is known as a major contribution to the changes of quality urban life in many urban areas in Malaysia. Ipoh city is the third largest city of Malaysia where population, industrial and traffic density are relatively high increased. Therefore, it is expected that the temperature will significant increased very high. This study were analyzing the time series data of mean maximum temperature, mean minimum temperature and mean annual temperature from 1970-2000 (31 years). All raw data is collected from Malaysian Meteorology Department (MMD), Malaysia. Data is analyzed in two parts by running Linear Regression and taking anomalies of all times periods; whole period from 1970-2000, phase one 1970-1980 (11 years), 1981-1990 (10 years) and 1991-2000. Linear Regression analyzing of data used to find out the trends of temperature change of Ipoh city, Perak. It is expected that during 1970-2000 temperature will increased significantly due the changes in urban physical landscape to urban areas. Results, temperature having increased significantly for the whole period from 1970-2000.

Key words: Temperature change, urban temperature, urban physical, lanscape changes, data, Malaysia

INTRODUCTION

Since, the mid-1970's warming has been accelerating at a rate of 0.15°C per decade. Because of rapid urbanization, urban warming has become a serious problem along with global warming (Oke, 1987; Nakagawa, 1996; Rizwan *et al*., 2008; Quattrochi and Ridd, 1994). World's population lived in cities fraction rose above 50%. Over the last 100 years, the global mean temperature has increased by 0.3-0.6°C. In 2007 than 1800 years ago, only about 2% world's population lived in cities. According by United Nations demographers, >60% of the world's population will live in urban areas by 2030. The world population is expected to increase by 2.6 billion over the next 50 years from today's 6.5 billion. Remarkably however, a large part of this growth is expected to take place in developing regions of the world where about 5.3 billion people live today. The population is expected to reach 7.8 billion by 2050 in developing nations. Cities are composed of large areas of pavement and buildings and less vegetation cover compared to surrounding areas. However, they are not all built the same way nor are they built with the same material. As cities expand over time, the temperature also tends to increase and become more hottest (Gartland, 2008).

Economic growth over the increase of employment opportunities cause Ipoh population increased rapidly since the independence. This population increase has resulted in increased use of vehicles, increasing the volume of motor vehicles and traffic congestion. Sham Sani highlighting the most pollution in Malaysia is due to the economic development plans, population and urban growth and rapid expansion. The development of the city continued to expand rapidly the development of industrial areas.

This is creating new industries that create pollution problems in the physical environment. This issue is associated with Tasek Industrial Estate where there is iron and steel industry, pottery factories, cement factories and quarries (sources) and the issue of dust and smoke from vehicles (mobile sources). Dust and the black smoke emissions are issues and challenges of a major pollution source of pollution in Taman Bukit Merah, Taman Impiana Adril, Badrishah Park at Menglembu. These factors cause air pollution and rising temperatures in Ipoh, especially in urban centers.

Air pollution and rising temperatures are in addition to the sources of industrial activities including the cement industry. Industrial activities in Ipoh explore two industrial estates of Tasek and Jelapang. Industrial activity is located close to residential areas that can cause air pollution, especially industrial area not zoned. Cement industry and quarry create a dust pollution problem that can affect the temperature rise in the city of Ipoh.

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MATERIALS AND METHODS

All climatology data, especially raw data is supported from Malaysian Meteorology Department, Malaysia from the observation data. The meteorology data from 1970-2000 collected from Ipoh Airport, Meteorology Station. Ipoh area in terms of geographical location is located at latitude 40°34'U, longitude 101°5 'East. Ipoh is the 3rd largest city in Peninsular Malaysia and based on both banks of Sungai Kinta landed flat with a height of 75 m above sea level. Topography of the study area can be identified lowland and altitude is <180 m above sea level. Ipoh has a main range as permanent forest reserves and water catchment areas. Meanwhile, Ipoh surrounding by Kledang range in the Southwest 600 m tall. In the South of Ipoh sourrounding by small mounds of limestone about 160 m tall.

The time series data of mean maximum temperature, mean minimum temperature and mean annual temperature from 1970-2000 (30 years) is used to find out the changes in temperature of the metropolitan city of Ipoh. Data is analyzed in two parts by running Linear Regression and taking anomalies of all times periods; whole period from 1970-2000, phase one 1970-1980 (11 years), 1981-1990 (10 years) and 1991-2000. Linear Regression analyzing of data used to find out the temperature change of Ipoh city, Perak. Trend lines on each graph are used to get the clear finding of the results. Temperature is used as dependent variable while the time period is used as the independent variable. Temperature is specitied as (Sajjad *et al*., 2009):

$$\text{Temperature} = f(\text{time})$$

and

$$y = a + bX$$

Where:

Y = Mean temperature (minimum, maximum)
X = The time period

The analysis also shows the extent to which the relationship between variables. The relationship between the mean surface temperature maximum, minimum and the annual time series (1970-2000) can estimate the strength of the relationship between two variables can be found in (Table 1) (Baba, 1999). The trend analyses were conducted by regressing the temperature mean with time (in years). The trend, given by the linear slopes coefficient of the fitted regression lines were tested as to their significance levels (95 and 99%).

Table 1: Estimate the strength of the relationship between two variables

Value of the coefficient (r)	Relationship
0.00-0.20	Negligible
0.20-0.40	Low
0.40-0.60	Moderate
0.60-0.80	High
0.80-1.00	Very high

Baba (1999)

RESULTS AND DISCUSSION

Temperature increases due to the urbanization on Ipoh are of concern and many early studies have been conducted before this in order to understand the temperature changes. Temperature trends used in many studies is a popular ways to evaluate urban temperature changes due urban change also evaluate urban warming trends (Kato, 1996; Fujibe, 1998a, b; Chung *et al*., 2004). The interannual variation and change in temperature in Ipoh by analyzing through linear trends has shown significant result (Table 2). The linear trend lines shown with anomaly of time series of MAT, MMxT and MMiT are presented in Fig. 1-3a-c. The temperature change in

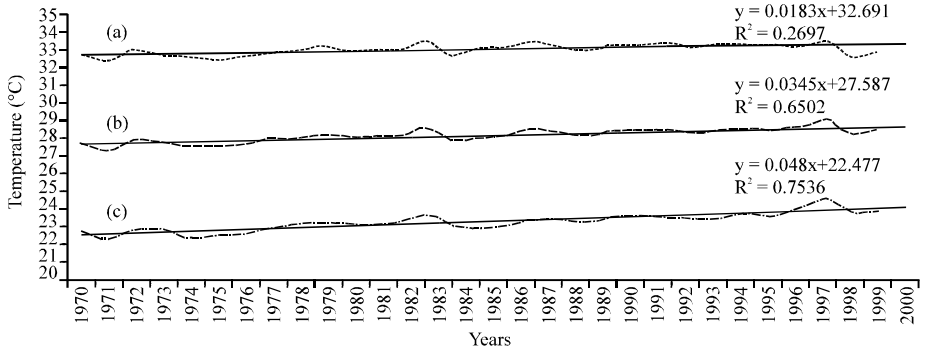

Fig. 1: Annual surface maximum, minimum and mean annual average temperature trends of Ipoh during 1970-2000; a) Maximum temperature; b) Annual average temperature; c) Minimum temperature (Anomly of mean, maximum, minimum and average temperature (1970-2000)); Anomly (°C)

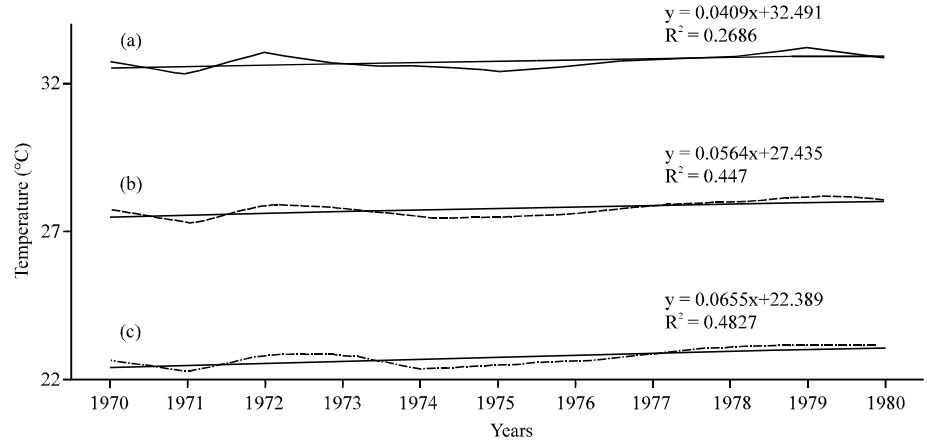

Fig. 2: Annual surface maximum, minimum and mean annual temperature trends of Ipoh during 1970-1980; a) Annual surface maximum temperature; b) Annual surface temperature; c) Mean annual minimum temperature trends of Ipoh during 1970-1980; MMxT, MMiT and MAT (1970-1980)

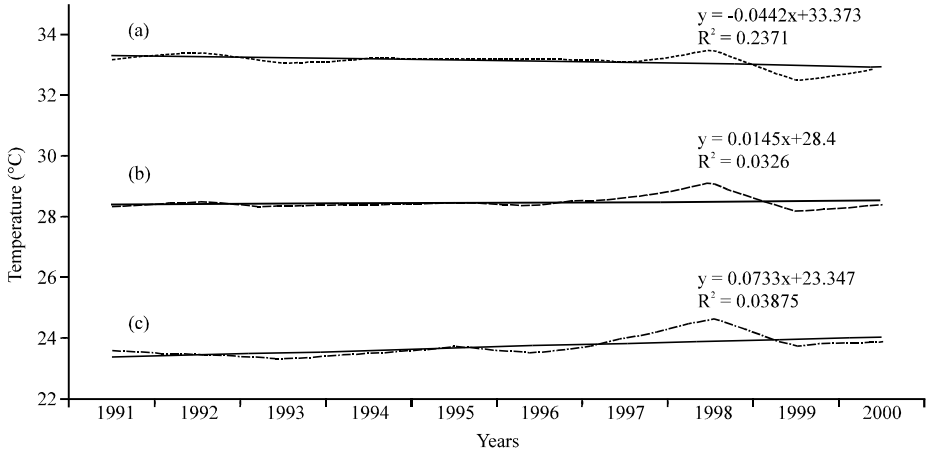

Fig. 3: Annual surface maximum, minimum and mean annual temperature trends of Ipoh during 1991-2000; a) Annual surface maximum temperature; b) Annual surface temperature; c) Mean annual minimum temperature trends of Ipoh during 1991- 2000; MMxT, MMiT and MAT (1991-2000)

Table 2: Regression results by using temperature as dependent and time as an independent variable

Temperature	Time period	Regression results	r	r^2
MAT	1970-2000	y = 0.056x+27.43	0.801	0.650
MAT	1970-1980	y = 0.033x+27.58	0.668	0.447
MAT	1981-1990	y = 0.020x+28.08	0.253	0.064
MAT	1991-2000	y = 0.013x+28.37	0.178	0.032
MMxT	1970-2000	y = 0.018x+32.69	0.519	0.269
MMxT	1970-1980	y = 0.040x+32.49	0.518	0.268
MMxT	1981-1990	y = 0.016x+33.02	0.182	0.033
MMxT	1991-2000	y = -0.044x+3.37	0.487	0.237
MMiT	1970-2000	y = 0.018x+32.69	0.867	0.753
MMiT	1970-1980	y = 0.040x+32.49	0.694	0.482
MMiT	1981-1990	y = 0.016x+33.02	0.260	0.068
MMiT	1991-2000	y = 0.073x+23.34	0.622	0.387

Significant level 0.05; MAT: Mean Annual Temperature; MMxT: Mean Maximum Temperature; MMiT: Mean Minimum Temperature

Ipoh represented with 3 time period which is 1970-1980, 1981-1990 and 1991-2000. Furthermore, all mean temperature trend for the whole period from 1970-2000 also shown increased (Fig. 1-3). The anomaly of time series of MmxT and MmiT has the most significant increase than any aother time period. MAT 1970-1980 showed a high level of relationship with the time series than MAT 1991-2000. MMxT as a whole time series 1970-2000 increased by a moderate level. MMxT 1981-1990 and 1991-2000 increased by a moderate level compared MMxT 1981-1990. MMiT 1970-2000 has increases in very high relationship level. MMiT 1970-1980 has drastic increased than MMiT 1981-1990. The changes in temperature is not uniform during the whole study period. Anomaly of mean maximum, minimum and average temperature (1970-2000), anomaly (°C) years. The anomaly data of MMiT in Fig. 1-3 is showing the high increased from 1970-1980. The

changes of minimum temperature greatly affected the mean annual temperature at Ipoh (1970-2000) that is shown in Fig. 1a-c. The overall observed data MMiT of Ipoh shows high increased during 1970-2000. In Fig. 1-3, the anomalies of second and third period. The changes of minimum temperature at Ipoh greatly affected the mean annual temperature at Ipoh (1970-2000) that is shown in Fig. 1-3a-c. In Fig. 1-3a-c also, the anomalies of second period are showing that MMiT has high change than MMxT. The increasing of intensity of MMiT is higher than the MMxT. The regression intensity of MMxT, MMiT and MAT showed significant positive trend for whole time period 1970-2000. Overall, the everage of annual mean maximum temperature and mean annual minimum temperature 1970-2000 show positive and significant effect over both period.

CONCLUSION

Trends of urban climatology changes in Ipoh city 1970-2000 showed a significant positive change where the Mean Annual Temperature (MAT), Mean Maximum Temperature (MMxT) and Mean Minimum Temperature (MMiT) having changes but little bit decreasing trends over the last 31 years for Ipoh. Overall, the urban temperature of Ipoh 1970-2000 has the greater variation, although it has slow increasing mean maximum temperature from 1981-1990 and little bid decreasing from 1991-2000.

ACKNOWLEDGEMENTS

This research was supported data by Malaysia Meteorology Department. The researchers would like to appreciate the support from Malaysia Meteorology Department.

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