

Daytime Temperature Trend Analysis in the City of Jakarta, Indonesia

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Abstract: Temperature changes according to land use patterns become a common phenomenon in many cities around the globe. Various techniques and methods used to show the trend of temperature changes according to land use pattern in the city. One method is using temperature traverse. Based on this method of temperature measurements the north-south and east-west traverses were monitored and conducted in the city of Jakarta for the period from October 2012 to March 2013. Both the temperature traverses were carried out between 11:00 and 13:00 hrs. In general, the study found that the average monthly temperature is 34.9°C for the north south traverse with the CV of 4.4 and east-west traverse is 34.4°C with the CV of 5.6. Additionally, there was also the average temperature on weekdays (HK) for the north south and east west of 35.3°C with the CV of 3.0 and 34.8°C with the CV of 2.6 respectively. Thus, the average temperature at the time of the holidays (HC) for the north south and east west were 34.4°C and 33.7°C, respectively with the CV of 2.2 and 1.1. Furthermore highest monthly temperature trends are occurring in October of 36.2°C for the north south and 37.7°C for the east-west traverses. Conversely, the lowest in November with an average value of 33.4°C for the north-south traverse, meanwhile the lowest temperature trends for the east-west traverse in the months of November and February with an average value of monthly temperature is 32.5°C. Based on observations obtained through the temperature traverse the average value of the urban heat island intensity for the north-south traverse is 2.0 °C while for the east - west traverse is 0.7°C. The observed temperature values are very high, particularly in the HK, thus producing an impact of discomfort feeling among the city of Jakarta dwellers.

Key words: Temperature trends • Traverse temperature • The temperature of working days (HK) • Urban Heat Island Intensity (UHII) and the temperature of the holidays (HC)

INTRODUCTION

Urbanization and increase in population to the increasing impact of anthropogenic activities such as the growth of various industries to meet the needs of households in urban areas or rural areas. Increased anthropogenic activities have an impact on the development of the city as fast as supermarket building, highway, department without regard to environmental sustainability. Therefore, this situation can give to the society's loss terumanya aspects of thermal comfort, health and energy consumption [1].

Environmental quality of the less well every year [2]. One of the urban heat effect is increased and thus the temperature in the city [3]. Temperature changes in different urban areas in the surrounding region forming a "heat island" or "heat island" [4, 5].

Urban heat island phenomenon is symptomatic of rising temperatures in the central area (CBD) [6, 7]. When depicted in cross section, the form of UHI phenomenon is like an island in the middle of the highest temperature compared to surrounding areas [8]. Meanwhile, the phenomenon described in cross-sectional UHI from rural through downtown to the suburbs and rural areas will then be shaped like a mountain slope and plain. Case is shown in Figure 1.

Figure 1 shows the general profile of UHI in calm weather conditions [9]. Profile UHI phenomenon began in the rural areas that are characterized by a lot of greenery. This should give effect to the reduction in temperature in the area. Then, through a suburban area characterized by little dense trees and buildings. This condition affects an increase in temperature, thus resulting in slope in this area. Furthermore, UHI profile across the center of the

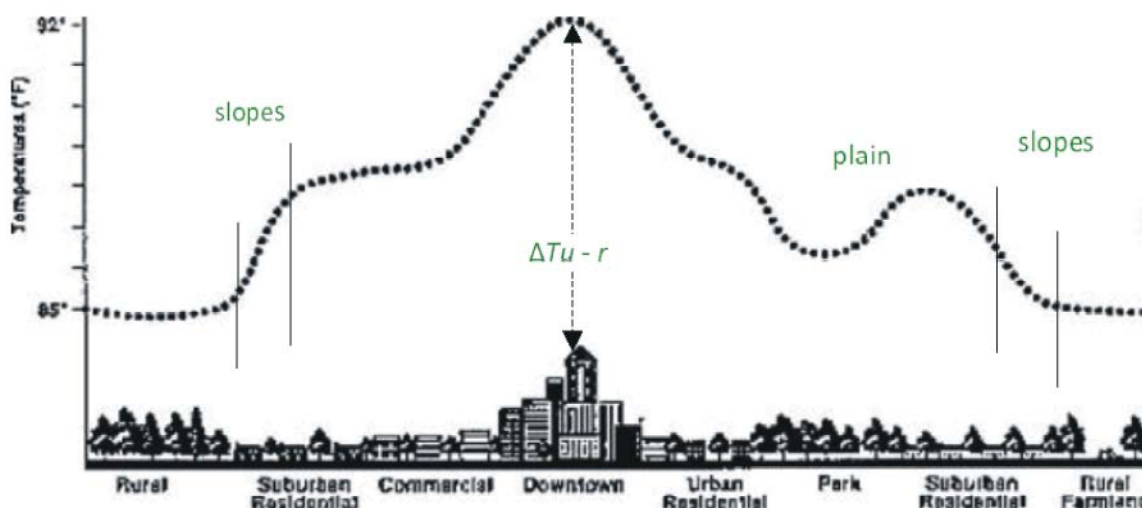


Fig. 1: General profile of UHI in calm weather impending (Modified from [9,11,3]).

area is characterized by high buildings and close to an impact on the occurrence of hot peak in the CBD. Next, go back to the suburbs with lower temperature gradients menyebabkan formation. Eventually reach rural areas with lower temperatures.

This phenomenon is very important and has become a phenomenon that needs serious attention, because it could have an impact on society discomfort [10]. Intergovernmental Panel on Climate Change (IPCC) and the United Nations Environments Programme (UNEP) is an institution set up by the World Meteorological Organization (WMO) in 1988. Both the board explained that one factor that is very climate impact on community life experienced increased significantly as temperature. Currently estimated surface temperature increase is around 2-3°C per / year. Accordingly, the description in this paper is the month the temperature trend during the day in the city of Jakarta.

Method of Study: temperature traverse measurement is a technique that is carried out while on the move. By using motorcycles were carried out manually and move from the first station to the last station in Jakarta for two traverses i.e. north-south and east-west, hidroanemometer and global positioning system (GPS). Measurements were carried out by using the study was conducted during the day at 11.00 until 13.00 West Indonesian Time (WIB). According to Iswanto [12] 11:00 - 13:00 hours is the hottest hours during the City in Jakarta. In detail, this study was conducted on holidays (HC) and weekdays (HK) for six months, which was started in October 2011

until March 2012. A total of 26 stations were selected along the north-south and 20 stations along the east-west traverses.

RESULTS AND DISCUSSION

The North-South Temperature Traverse: The study found that the monthly average daytime temperature traverse in Jakarta City for the north-south direction is 34.9°C with the CV (coefficient of variance) of 2.4, where the average highest temperature of 36.2°C was recorded at the Samantabadra STAB station, while the lowest temperature of 32.5°C was recorded at Castle Hill station Manton. The average monthly temperature in November was the lowest at 33.4°C, while the highest of 36.2°C was observed in October. However, the temperature for December showed a small variation across all stations. This is illustrated by the small value of CV (coefficient of variation) of 1.9. Based on the difference in temperature between the highest and lowest temperature therefore the UHI was only 3.3°C. The temperature traverse by month varied is the month of January with the CV equal to 4.8. During this month temperatures recorded as low as 31.3°C at the Castle Hill Marina Ancol station and as high as 37.4°C in Samantabadra STAB station. Therefore, the temperature difference was recorded rather large which was 5.6°C. For the other months, the temperature measurements showed a moderately high rate with the CV of between 3.0 to 4.0. The average monthly temperature traverses illustrated in Figure 2, while temperature traverses by month illustrated in Figure 3.

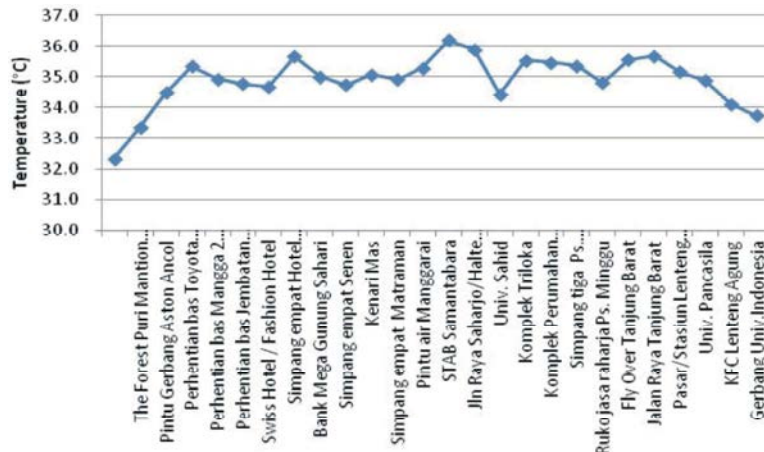


Fig. 2: Daytime temperature trends for the north south traverse

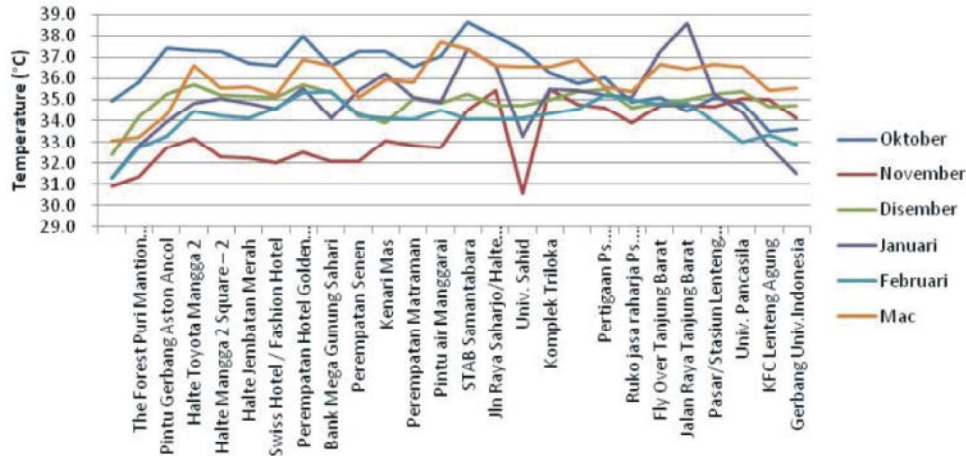


Fig. 3: Comparison of temperature trends for the north-south traverse during the day according to month

In addition, the study found an average maximum temperature of 36.9°C with the CV of 2.6. This value explains that average maximum temperatures difference is relatively small cross section with was only 3.8°C (average temperature between the lowest and highest). While the average minimum temperature of 32.9°C with the CV of 3.6 at a value higher than the maximum temperature. However, their distribution according to the stations were not much different with was only 3.8°C.

East-West Temperature Traverse: The study found that as measured the monthly average daytime temperature measurement for the east-west traverse across the city of Jakarta was 34.4°C with the CV of 1.6, where the average maximum temperature of 35.6°C was recorded at the Carrefour Cawang station, while the minimum temperature of 33.1°C was recorded the Keranji Fields Bridge station. Monthly average temperature for October was the highest 37.7°C, while February was the lowest at 32.5°C.

However, in contrast to the temperature traverse for the north-south, the temperature distribution for the month of November was not much different according to all stations. This is illustrated by the small value of CV of 1.5 smaller by 0.4 as compared with north-south temperature traverse. Based on the difference between the highest and lowest temperature therefore the UHII was only 2.2°C. Based on monthly temperature variations, it was found January was the month with the most varied temperature measurements the CV of 3.3. The lowest temperature recorded for this month was 31.9°C at the station of Bintaro Housing, while the highest temperature of 35.5°C was recorded at the station of Cawang Carrefour and therefore the temperature difference was calculated for about 3.6°C. For the other months, the temperature cross section shows a moderately high rate with the CV between 2.0 to 3.0 only. The average monthly temperature cross section illustrated in Figure 4, while the temperature of the month at the crossing of Figure 5.

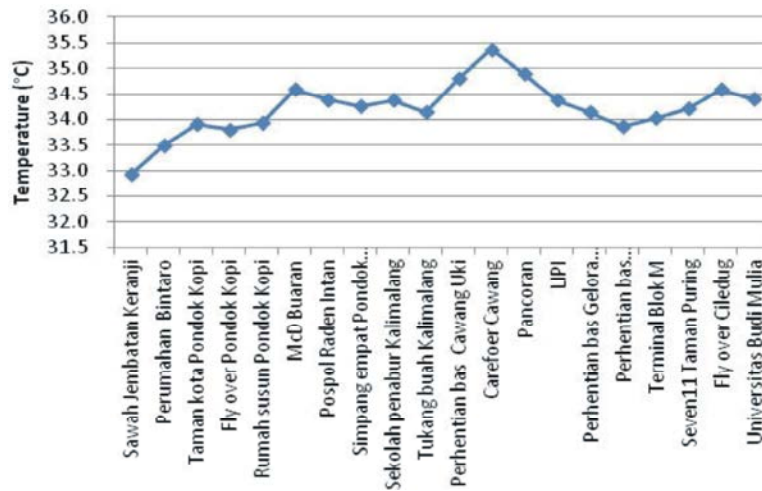


Fig. 4: Daytime temperature trends for the east-west traverse

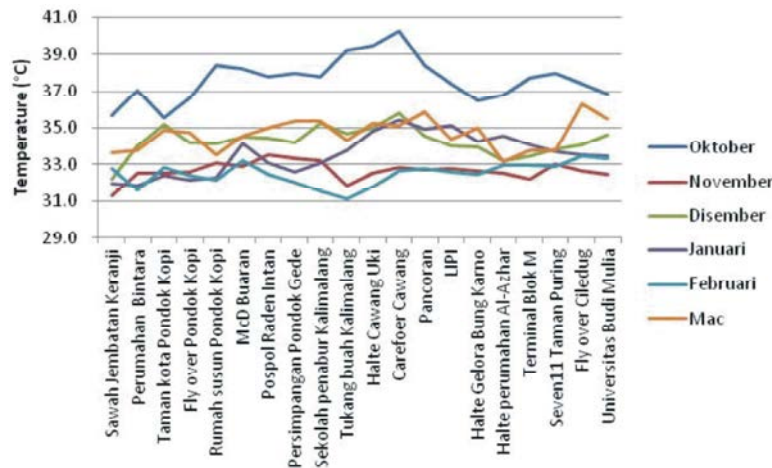


Fig. 5: Comparison of temperature the trends east-west traverse during the day according to month

In addition, the results showed an average maximum temperature of 37.7°C with the CV of 3.1. This value indicated that the recorded maximum temperature difference between stations was relatively small which was only 4.7°C (average temperature between the lowest and the highest). Meanwhile, the average minimum temperature was calculated for about 32.2°C with the CV of 1.6 which was lower by 1.5 as compared with the maximum temperature. However, it distributed according to all stations were not much different which was only 1.8°C.

Furthermore, the results showed that the north-south temperature traverse on weekdays during the day in the city of Jakarta was 35.3°C with the CV of 3.0, where the highest temperature of 36.9°C recorded at the Samantabadra STAB station, while the lowest temperature of 32.4°C recorded at The Castle Hill Mantion Ancol. On a monthly basis, the lowest temperature was observed

in February that was 33.7°C, while the highest in October of about 37.0°C. However, it was found that the temperature distribution was not much different in February with the CV 2.6. Based on this, therefore the temperature difference between the highest and lowest temperature was only 4.0°C. Moreover, the temperature variation by month showed that the month of November varied significantly with the CV of 6.7. This lowest temperatures was recorded at 29.6°C at the Sahid University station and the highest was 39.3°C at the Triloka Complex station. Therefore, the different in temperature was recorded relatively large that was 9.7°C. For the other months, the temperature displayed a moderately high rate with the CV of between 3.0 to 5.0.

Further study showed an average maximum temperature of 37.6°C with the CV of 3.4. This value indicated that the maximum temperature difference recorded between stations was relatively small that was

only 4.9°C. Meanwhile the average minimum temperature of 33.1°C with the CV of 3.2 at a value higher than the maximum temperature. However, temperature variation according to all stations was not significant, which was comparable with the maximum temperature difference of 4.9°C.

The study found that the daytime temperature traverse on holidays for the north-south traverse in Jakarta City was 34.4°C with the CV of 3.8, where the average highest temperature was recorded around 35.6°C at the Samantabadra STAB station, while the average low temperature of 32.3°C was recorded at the station of Castle Hill Mantion Ancol. On a monthly basis, the lowest average temperature was in November that was 35.5°C, meanwhile the average temperature in October was the highest that was 35.5°C. However, the temperature distribution in November and December was not much different as shown by the CV of only 2.7. This showed that the temperature difference between the highest and lowest temperatures was only about 3.2°C in November and 4.0°C for the month of December. On the other hand, the temperature variation significantly in January with the CV 5.4. In the lowest recorded temperature was found at about 30.7°C at the station of Castle Hill Mantion Ancol and up to 38.6°C as recorded at the Western Cape Road station. Therefore, the temperature difference was quite large, 7.9°C. For the other months temperature different were recorded moderately with CV values between 3.0 to 5.0 only.

In addition, the study found an average maximum temperature of 36.6°C with the CV of 3.2. This value indicated that the difference in average maximum temperatures recorded between stations was relatively small, different by only 4.0°C. Meanwhile the average minimum temperature was calculated at 31.3°C with the CV of 2.7 and this value was lower by 0.5 as compared with the CV of the maximum temperature. Therefore, the distribution was not very different which was only 3.2°C.

Furthermore, the temperature traverse on holidays (HC) during the day for the east-west traverse (October 2011 - March 2012) in Jakarta City was also studied. The study found that the average daytime temperature distribution on holidays for the east-west traverse in Jakarta City was 33.9°C with the CV of 1.2, where the average highest temperature of 34.4°C was recorded at the Cawang and Pancoran Carrefour station, while the lowest average temperature of 33.1°C was recorded at the stations of Craftsman Kalimalang. Besides, on a monthly basis, the average temperature of November was the

lowest at 30.4°C, while October was the greatest month of 36.0°C. Further analysis was, found that the November temperature distribution was not different significantly as shown by the CV value of 2.1. Temperature difference between the highest and lowest temperature was only about 3.1°C. However, December showed a larger temperature difference as shown by the CV of 4.4. The lowest temperature in December was 32.1°C as recorded at the Paddy Keranji Bridge station and up to 38.4°C as recorded at the Kalimalang Sower School. Based on this finding, therefore large temperature difference was calculated that was 6.3°C or it was greater it 3.2°C from the November temperature difference.. For the other months it showed a moderately low temperature differences with the CV values between 2.2 to 2.9 only.

The main reason of the low temperature in the area is due to rain during the measurements taken at the fruit Handyman station. Furthermore, the area was located near the river and therefore the surrounding environment has an impact on the increase in relative humidity which in turn can reduce the temperature in this area.

Besides, the study was found an average maximum temperature of 36.4°C with the CV of 2.3. As a consequent, the temperature difference between the stations was recorded only about 3.1°C. Meanwhile the average minimum temperature was calculated for about 30.4°C with the CV 2.1. Thus, the calculated temperature difference was only about 3.1°C.

Generally, the weekdays and weekends average temperature was calculated at the same strength. The highest average maximum temperature was observed in October and March. As we know, both October and March are the period of transition from the two seasons, rainy and dry season in Indonesia. The month of October is a time of transition from the dry season to rainy season. Meanwhile the month of March is a time of transition from the rainy season to the dry season. Thus, it has an impact on the occurrence of high temperatures in the study area.

Based on this study, it showed that the value of the urban heat island intensity for the north-south temperature traverse was only about 2.0 °C meanwhile the average temperature for the east-west traverse was only about 0.7°C. The observed temperature of more than 36°C is considered very high, particularly in the HK to give an impact on the discomfort feeling among dwellers in the Jakarta City. According to Givoni [13] the UHII in the subtropical reach 3°C to 5°C in the daytime. Therefore, the results showed that the UHII in Jakarta City was reasonably high. The present finding was accordance

with the study conducted by Rosmini *et al.*, (2010) in Jakarta by using air temperature data for 30 years (1981-2010). The results showed an average of UHII of about 8°C.

CONCLUSION

In conclusion, the highest average temperature during the day by month was recorded at stations located in the city center such as at the STAB Samantabadra station for north-south traverse and at Carrefour Cawang station for the east-west traverse. On the other hand, the lowest average temperature was recorded at the Sahid University station and The Castle Hill Mantion Ancol for the north-south direction and the Tailor station Kalimalang fruit and Rice Bridge Keranji for the east-west traverse.

In addition, the highest average maximum temperature was observed in the months of October and March. This is due to the fact that both October and March are the time of transition from the two seasons, rainy and dry season in Indonesia. Meanwhile, the average urban heat island intensity for the north-south temperature traverse was only 2.0°C while the east-west temperature traverse was equal to 0.7°C. UHII values in the study area increased from time to time. Therefore, it must be an effort to address an increase urban temperature in order to reduce the UHI phenomenon in the City of Jakarta.

REFERENCES

1. Tursilowati, L., 2005. Fenomena “pulau panas” perkotaan. Last Updated: 2005-12-21 12:35:41. Lembaga Penerbangan dan Antariksa Nasional-LAPAN. Bandung-Indonesia.
2. Wong, N.H., S.K. Jusuf, A.A.L. Win, H.K. Thu, T.S. Negara and W. Xuchao, 2007. Environment study of the impact of greenery in an institutional campus in the tropics. *Building and Environment*, 42: 2949-2970.
3. Shahrudin Ahmad, 2012. Mikroiklim bandar (perkembangan dan impak pulau haba bandar di Malaysia). Bangi. Universiti Kebangsaan Malaysia.
4. Tursilowati, L., E.S. Adiningsih, Safrudin, I. Risdiyanto Ubaidillah and D. Dan Yudho, 2004. Perubahan Suhu Udara Akibat Perubahan Tata Guna Dan Penutup Lahan Di Jawa Barat. http://iklim.dirgantara-lapan.or.id/index.php?option=com_content&view=article&id=85&Itemid=78. Dimuat turun pada tanggal 4 Desember 2012.
5. Shahrudin Ahmad and Noorazuan M.D. Hashim, 2010. Perubahan iklim mikro di Malaysia. Bangi. Fakulti Sains Sosial dan Kemanusiaan, Universiti Kebangsaan Malaysia.
6. Voogt, J.A., 2002. Urban heat island: Causes and consequences of global environmental change. John Wiley and Sons, Ltd. Chichester, pp: 660-666.
7. Soedomo, M., 2001. *Pencemaran udara (Kumpulan karya ilmiah)*. Bogor: Institut Pertanian Bogor Press.
8. Effendi, S., 2007. Keterkaitan ruang terbuka hijau dengan urban heat island wilayah Jabotabek. Disertasi. Sekolah Pascasarjana Institut Pertanian Bogor. (Bahan tidak terbit).
9. Giridaran, R., S. Ganesan and S.S.Y. Lau, 2004. Daytime urban heat island effect in high-rise and high-density residential developments in Hong Kong. *Journal of Energy Build*, 36: 525-534.
10. Intergovernmental Panel on Climate Change (IPCC), 2007, *Climate Change 2007: Impact, Adaptation and Vulnerability, Summary for Policy Makers*, 4th Assessment Report of the Working Group II, 13 April 2007.
11. Oke, T.R., 1987. Inadvertent modification of the city atmosphere and the prospect for planned urban climates, *proc. WMO symp. on meteor. As related to urban and regional land use planning*, Tech. Note 444, WMO, Geneva, pp: 150-175.
12. Iswanto, P.A., 2008. Urban heat island di Kota Pangkalpinang Tahun 2000 dan 2006. Skripsi. Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Indonesia. (Bahan tidak terbit).
13. Givoni, B., 1998. *Climate considerations in building and urban design*. Int. Thomson Publishing, Inc. USA, pp: 464.