Impact of the Urban Building on Air Temperature Variations along the 35th Street, Mandalay City

Moe Moe Hlaing[1], Mu Mu Aye[2]

ABSTRACT

Urban heat is very important for human health and local climate change. Urban heat varies from place to place due to spatial variations of urban land use, urban landscape, total population and etc. Mandalay City lies in Central Myanmar. Its urbanization is quickly developed with increasing population and urban morphology changes. This paper analyse the impact of the urban buildings on the air temperature variations along the 35th street which crossed the Mandalay urban area. The method of vehicle traverses (direct measurement) is used to measure the air temperature for the specific points along the 35th street. And the relationship between the housing density and temperature variations is analyzed by the method of Pearson's Product Moment Correlation Coefficient. The air temperature of the middle points was higher than the air temperature of the ends point of the street. The temperature difference between the downtown area and the urban fringes is 2.42º C which is very high. The correlation coefficient between the air temperature and the housing density along the 35th street is very high with the coefficient of determination (0.64). 64% of the variability in air temperature was determined by the housing density variable. Other factors that are influencing on air temperature have to be taken into account for the remaining 36 %. This paper argues that the air temperature is increasing to the urban center from the urban fringes. It is a very important fact and it can affect local people's health and local weather. In addition, its correlation with distribution of the housing is more significant than the other factors.

Key words: Urban heat, Air temperature, vehicle traverses, specific points, temperature variation.

INTRODUCTION

Mandalay City is the second largest city of Myanmar. Its urbanization is quickly developed with increasing population and urban morphology changes. With the urbanization Mandalay urban area has developed many modernized buildings and has higher density of the buildings with increased population. In an urbanized environment, energy is more likely to be found in the form of sensible heat, rather than in the latent heat, as a consequence of surface changes (Stewrt and Oke 2012). Building's materials are usually very good at insulating or holding in heat. As building density is related to population, housing appliance (air-conditioner, refrigeration) also adds the heat into the air above them. Thus building density is a very important fact in urban temperature variations. This research studies the air temperature variation along the 35th street across through the urban area and analyzes the relationship between the air temperature variation and building density.

Study Area

Mandalay City is located in the central dry zone of Myanmar. The 35th street crosses through the middle part of the Mandalay urban area from west to east. And its vicinal space has many various urban physical features and many roads cross this street with traffic points. The western end point is at north latitude 21º 58' 19.33" and east longitude 96 º 3' 23.97" and eastern end point is at north latitude 21.58' 1.2" and east longitude 96 º 7' 53.62". Its length is 4.8 miles (7.724 km).

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Aim and Objectives

- to examine the spatial variation of the air temperature along the 35th street across the urban area

- to analyze the relationship between air temperature and housing density

Research Question

1. How did the air temperature vary from place to place along the 35th street? Where is the hottest area along the street and Why?

2. What is the correlation between air temperature variation and the distribution of the houses?

Hypothesis

This paper argues that the air temperature is increasing to the urban center from the urban fringes. It can trend to urban heat island and it can affect on local people's health. In addition, the correlation between temperature variation and the distribution of the housing is more significant than the other factors.

Materials and Method

Materials were used by the temperature and humidity sensors and GPS (Garmin, GPSMAP 78 series). GPS is used to show the location of the points in the temperature measuring.

Among three types of urban heat, this research focuses on the canopy layer (Voogt 2013) as this air layer is where people are most impacted by temperature increased. The canopy layer is defined as a layer between earth surface and the top of the trees. The standard measurement was also defined between (1-2) meter above the ground.

The method of direct measurement called vehicle traverses (Stewart and Oke 2012) was used to measure the air temperature in the field. Measuring time is defined between 1:00 pm and 2:00 that time is at the highest point (amount) of air temperature during the day. In the measurement, the variable of the sensors was fixed to get the standard sensor measurement. But the variable of the sun ray striking during the one hour (1:00 - 2:00) was ignored. The frequency of the measurement was (30) times during January. The sample sites or points were selected according to the conditions of land use especially different residential densities, business areas and traffic places. The total points (fix points) were marked as nine points along the 35th street. Housing density is counted in one mile square centered by the respective points.

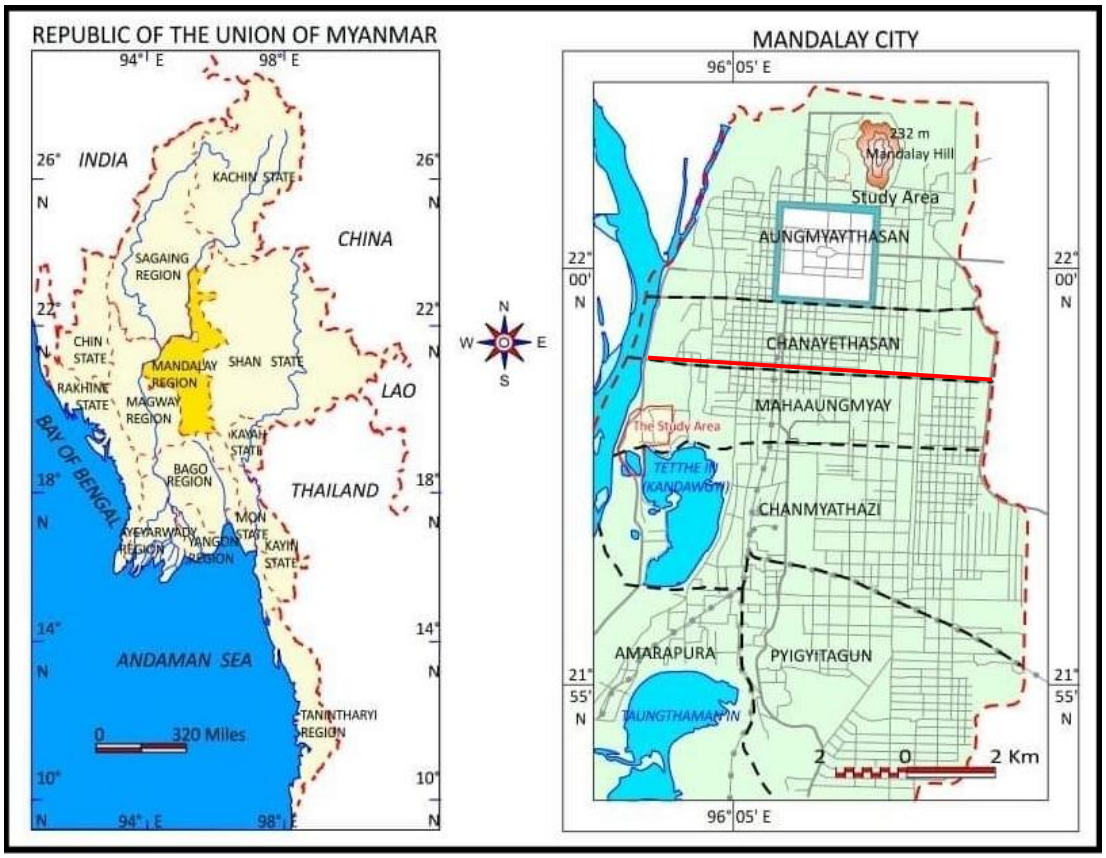
In addition, the gathered data was analyzed by means of line graphs and the scatter plot graph and then the relationship between the housing density and temperature variations is analyzed using Pearson's Product Moment Correlation Coefficient.

Geographical Bases

Mandalay City is located in Central Myanmar. Mandalay City is the second largest city in Myanmar and it is also a trading center of the Upper Myanmar. It is located between north latitudes 21º 52' 17" and 22º 01' 41" and between east longitudes 96º 02' 9" and 96º 08' 32". With the exception Mandalay Hill, this city lies in the level plain with an elevation of 220-230 feet above sea level. It is composed of six townships with the total area of 120 sq km and the

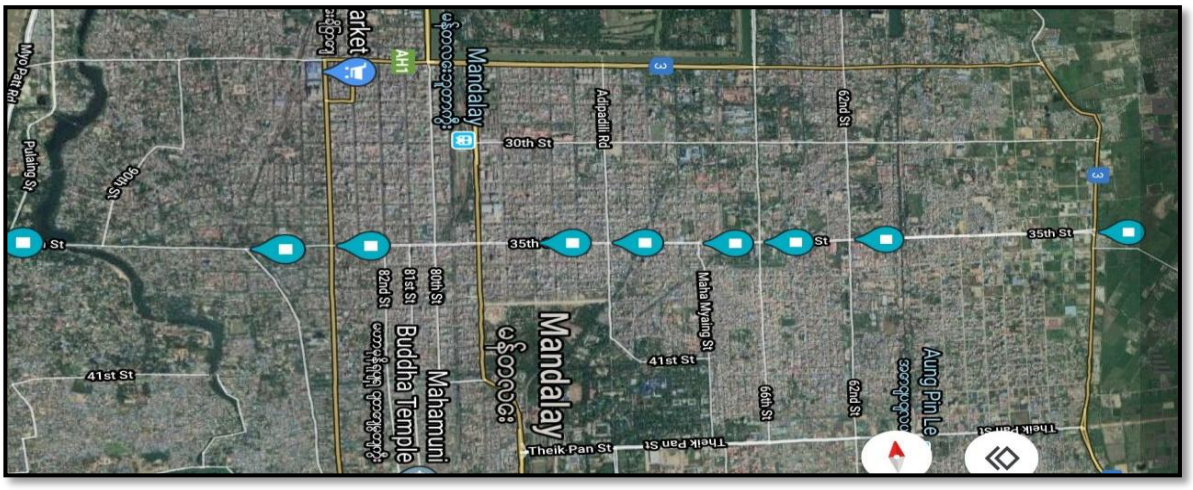
total population of 1,374,000 (estimate). The annual mean temperature is 28.22° C and the annual total rainfall is 425.90 mm. Mandalay City enjoys Tropical Steppe Climate (BSh). The 35th street across throws the Mandalay urban area from west to east entirely. The elevation of its eastern end is 220 ft above sea level and the eastern end is about 230 ft above sea level. And environment along the road side has many various urban physical features and many Road and streets across this street. The length of this street is 4.8 miles (7.724 km).

Map (1) Location of the Study area



Source: Department of Geography, Mandalay University

Map (2) Nine Sample Points in Survey Area along the 35th Street



Source: Google Map and Field survey

Result and Discussions

Spatial Air Temperature Variations along the 35th Street

The daily air temperatures have been measured during January, 2018 along the 35th road. In this measurement, the specific points are defined by urban landscape especially building landscape. According to the general building landscape, there are nine points. The specific points are used as fixed points.

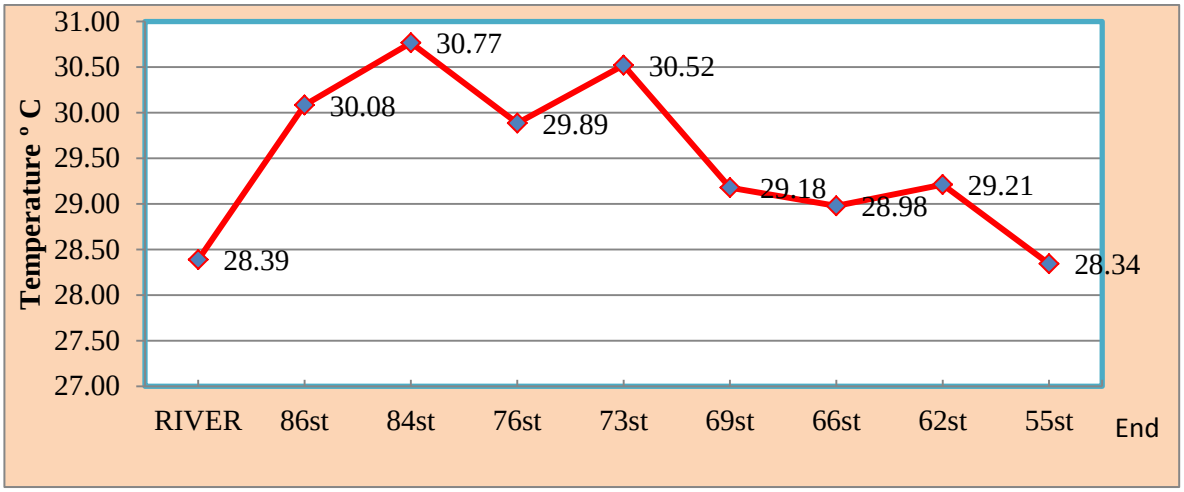
The first point is the western end of the 35th street and is also a place where meet 35th street and *Kannar* road. It is located at point meet latitude 21º 58' 19.33" and east longitude 96 º 3' 23.97". According to the field survey, at the first point, the average daily air temperature is 28.39° C. As this point is situated on the river bank and it has shady trees along the river bank, the air temperature of this point is lower than the other inner points. It is also the second lowest air temperature. And its vicinity space includes not only some houses but also Governmental Departments with the large compound and monastery compound. At this point, air temperature is affected by the water body, shady trees and less dense buildings. In its environment, the building density is 1285 per square mile.

Table (1) Air Temperature Variation along the 35th Street

Point No.	Point site	Distance W to E		Temperature (°C)	Housing Density (sq mile)	Remark
		meter	miles			
P-1	Western end	0	0	28.39	1285	Urban fringe
P-2	35th x 86th	1609.3	1.0	30.08	3510	
P-3	35th x 84th	482.8	0.3	30.76	3600	Downtown area
P-4	35th x 76th	1448.4	0.9	29.89	3020	Downtown area
P-5	35th x 73rd	482.8	0.3	30.52	2183	Downtown area
P-6	35th x 69th	643.7	0.4	29.18	387	
P-7	35th x 66th	482.8	0.3	28.98	612	
P-8	35th x 62nd	1931.1	1.0	29.21	142	Urban fringe
P-9	eastern end	649.63	0.2	28.34	122	Urban fringe

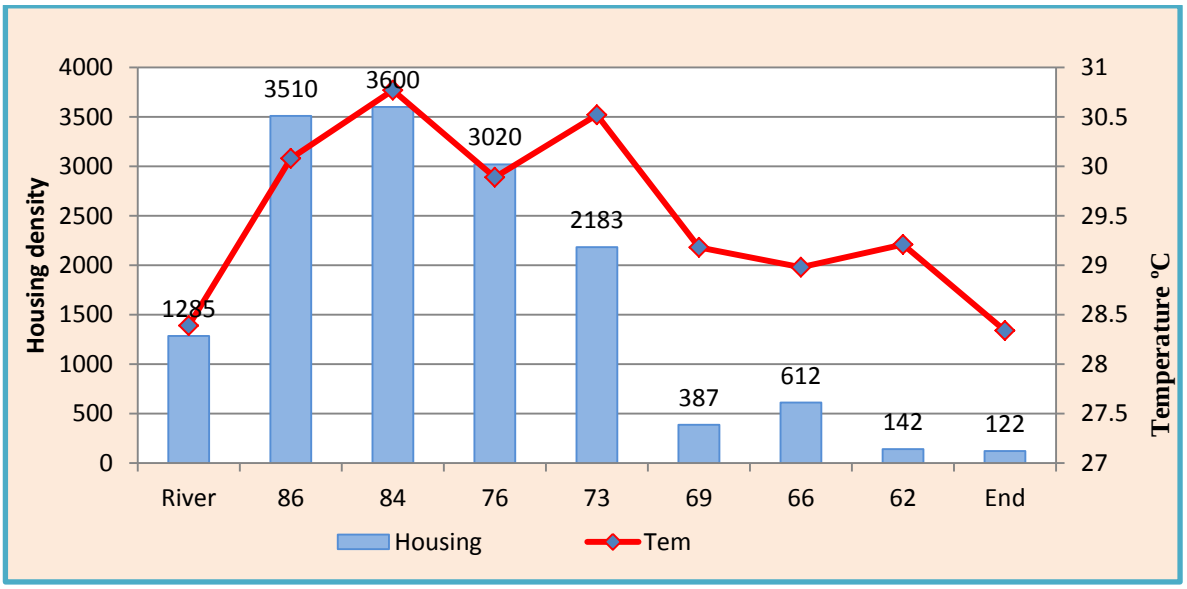
Source: Field Survey

Figure (1) Air Temperature Variations along the 35th Street



Source: Table (1)

Fig (2) Comparison of Temperature Variations and Housing Density along the 35th Street



Source: Table (1)

The second point is at a place where the 35th street and the 86th street meet. At this point, the average air temperature is 30.77º F. The air temperature of the second point sharply rises from the air temperature of the river bank point. From this point, the urban landscape condition is changed as central business district area. Really, the first point and second point is very close and the second point is only about one mile from second point. From this point, the housing density begins to rise toward the urban center. The housing density is 3510 per square mile.

The third point is at 35th street x 84th street. According to the field survey, the average daily air temperature is 30.76° C. This third point is very important point because this 84th road

is the main road for connecting upper Myanmar from Mandalay City. The house density is 3600 per square mile and it is the highest density area. In addition, the homes associate with store and shops. At this point, it is found that other factors also affected air temperature. As this point is a traffic point, many vehicles (cars and motorcycles) across this point during all time of the day. Many vehicles affect air temperature. During 30 seconds, heat of the air rise to 0.5 ºC immediately when traffic becomes busy at this place.

At 35th X 76th street point (point fourth), the heat slightly decreases to 29.89º C. The housing density is 3020 per square mile, thus it is a housing dense area. Although this point is included in the urban center, its surrounding area affects its air temperature. This is because the vicinity of this point is covered by the big trees and its neighboring space includes University of Distance Education campus.

The fifth point is (35th street x 73rd street) point. It's the air temperature is 30.52°C. The air temperature of this point is the second highest along the 35th street. The distribution of houses is relatively dense. The environment of this point is mainly covered with residential lands. The density of houses is 2183 houses per square mile. This residential land heats the air over it. But this is added by traffic. This point is a place two main roads meet. 73rd road is used by Mandalay University students and inter-migrant workers from Myothit (Mandalay urban sprawl) and it is usually traffic congestion area which is affected the motorcycles' engines exhaust fumes.

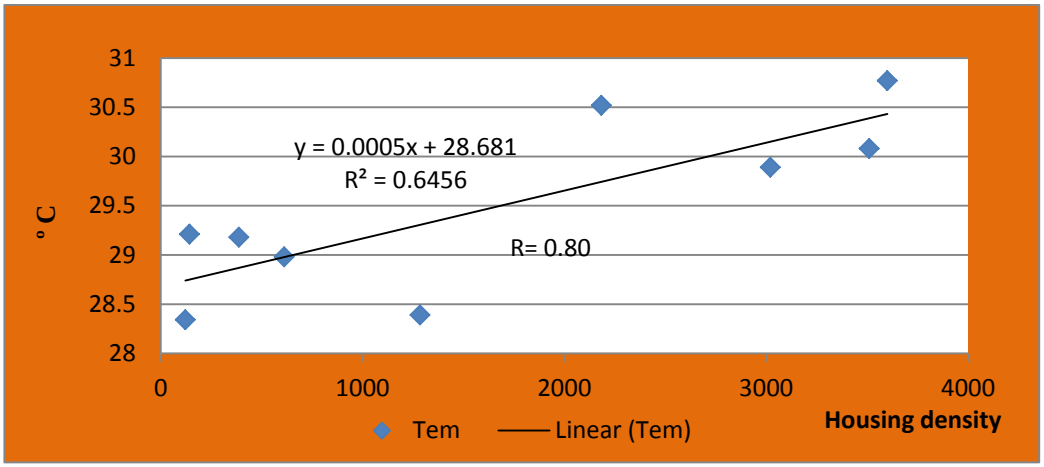
The sixth point is Century Mandalay Hall point at 35th street x 69th street. The air temperature is 29.18° C. To reach this place, the housing density is under 400 houses per square mile. The distribution of houses is considerably sparse due to the haciendas. From this place the air temperature is continuously decreasing toward the outer urban area. The environment of this point includes the grass space in Century Mandalay compound as urban green spaces. Because of condition, the air temperature is lower than the other point in the central area. Although these two points (fifth and sixth) are very close at about (3.2 Furlongs), the temperature difference is very high at about 1.35º C.

The next point is called seventh point (66th street). The air temperature of this point is 28.98° C. The houses density is 621 houses per square mile. The distribution of houses is sparse and they are associated with trees and urban plants. In addition, along its side, there are some urban green spaces in large compounds.

The next point is called 62nd street junction point. The air temperature of this point is 29.21° C. To reach this place (62nd street), the houses density is below 200 houses per square mile. The distribution of houses is sparse and they are associated with trees and urban plants. In addition, at its side, there are some urban green spaces in large compounds. Although the air temperature of this point is affected as traffic congestion, the housing density and green space affect on air temperature more above it.

The last point is placed near the urban fringe. In this place, although the distribution of house is scattered and there are some vacant land plots, its air temperature is slightly higher than the vicinity points. Near this point not only the urban trees are less but also there are also two fuel pump stations. The last point or the end of 35th street is the outer urban area. The temperature of this point is 28.34º C.

Fig (3) Relationship between the Air Temperature variations and Housing Density



Source: Table 1

Relationship between the Air Temperature Variations and Housing Density

Along the 35th road from west to east across the urban area, the density of the houses affected the air temperature on its environ due to the heat instrument in the houses as air-conditioner, refrigeration, cooking heat and human body heat etc also reflect on the air temperature. And the air temperature of space between 86th and 62nd street is more than other parts. The housing density of this space (between 86th street and 62nd street) is over 3000 per one mile square.

The correlation coefficient between air temperature and housing density along the 35th street is 0.80 (r) and the coefficient of determination (r^2) is 0.64. Thus the correlation between housing density and air temperatures is more significant. This means that 65% of the variability in air temperature can be determined by the housing density variable along the 35th street. Other factors influencing air temperature have to be taken into account for the remaining 36 %. In other words, 36 % of the variance in spatial air temperature variation along the 35th street have to be assessed by other urban physical factors such as pavement of roads and traffics congestions and total people, the kinds of housing materials, the darkness and brightness of roofs, the height and sizes of road side trees, green space, etc.

Conclusion

The 35th street passes through the middle part of the Mandalay urban area from west to east. Its vicinal space is used by the various urban land used. Its length is 4.8 miles (7.724 km) from the western end to the eastern end.

It passes through not only downtown area but also urban fringe areas. The air temperature of the two ends of this street is lower than the air temperature of the middle points. The temperature difference between the downtown area and the urban fringes is 2.42º C. And the air temperature is increasing immensely to the urban center from the urban fringes. It can trend to urban heat island and it can affect local people's health. In this condition, the distribution of the housing is more significant than the other factors.

This effect should be reduced by providing more shade with the trees as the urban planning including green spaces, house-plants, changing more reflective pavements using green roofs and the systematic roads construction with trees or green plants.

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