URBAN DEVELOPMENT AND CHANGING PATTERNS OF NIGHT TIME TEMPERATURES IN THE KUALA LUMPUR — PETALING JAYA AREA MALAYSIA

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Ringkasan

Makalah ini telah cuba menonjolkan beberapa ciri penting dalam perkembangan pembandaran di Kuala Lumpur — Petaling Jaya sejak tahun 1970an dan memeriksa cara bagaimana perkembangan ini telah mempengaruhi pola suhu pada waktu malam. Perbandingan pola suhu bagi tahun-tahun 1972, 1975 dan 1980 menunjukkan bahawa intensiti pulau haba telah bertambah disertai oleh pertambahan kawasan yang mempunyai suhu tinggi. Perbezaan suhu di antara pusat bandar dan kawasan Kebun Bunga telah menjadi berkurangan dan tidak sebegitu ketara seperti yang terdapat pada tahun 1972. Perubahan-perubahan ini adalah disebabkan oleh bertambahnya bilangan kenderaan berinjin di jalan-jalan raya di samping pertambahan kawasan perumahan dan jalan-jalan raya itu sendiri. Selain daripada mempengaruhi suhu dan keselesaan, permukaan-permukaan yang tidak telap air ini juga mempengaruhi haidrologi kawasan bandar. Larian air dari kawasan bandar adalah lebih tinggi daripada kawasan luar-bandar. Makalah ini seterusnya mencadangkan supaya selari dengan rancangan-rancangan perumahan dan jalanraya, rancangan-rancangan menanam pokok juga perlu dijalankan kerana ini akan mengurangkan larian air dan seterusnya kejadian banjir kilat di bandar.

Synopsis

The paper has attempted to highlight some salient features in the growth and development of urbanization in the Kuala Lumpur — Petaling Jaya since the early 1970s and examine the way in which such growth has affected night-time temperature patterns. Comparison of temperatures during 1972, 1975 and 1980 indicates that the intensity of the heat island had increased quite considerably followed by an increasingly larger areas having higher temperatures. The steep temperature gradient between the central city and the Lake Garden which was observed in 1972 had by 1980 disappeared. Such changes were attributed to the increased number of motor vehicles on the roads, the opening up of the many new housing estates and road building itself. Apart from affecting temperatures, paved surfaces also affect the hydrology of the area. Studies have shown that increased runoff from urban areas can be quite considerable. It is suggested that along with road construction and housing development programmes those of tree planting must also follow suit immediately. Such programmes will have the effect of decreasing runoff and hence flash floods.

Introduction

A number of man's impact on land has been shown to affect the climate directly or indirectly. Nowhere is this interaction between man and his environment more apparent than in the city especially when compared with sparsely settled areas (Landsberg, 1970). Observations indicate that the commercial centres are usually several degrees warmer than the surrounding countryside — a phenomenon known as the *heat island*. The intensity of this heat island varies from one city to another but in extreme cases, a rural-urban temperature contrast of 11°C (20°F) has been reported (Duckworth & Sandberg, 1954).

Like many large urban areas, Kuala Lumpur — Petaling Jaya has been shown to have a considerable impact upon its local climate. Such impacts with regard to wind, humidity, sunshine, radiation, temperatures and rainfall have been well-documented (Sham, 1973a & b, 1978, 1979a and 1980). The main aim of this brief note is not to repeat the previous studies, but rather to demonstrate the extent to which urban development since the early 1970s has modified the patterns of night-time temperatures in the Kuala Lumpur — Petaling Jaya area, and highlight the likely implications of such changes with regard to policy formulation in future environmental planning.

Urban Development During the 1970s

The 1970 decade has witnessed one of the most spectacular development within the Kelang Valley. During the period (1970-80), the population of the Valley grew from 1,710,000 to 2,600,000 at an average annual growth rate of 4.3% outstripping the original target by 216,000 and 0.9% respectively (Shankland Cox *et al*, 1973). Heavy pressures in terms of the concentration of applications for urban growth, renewal and conversion from agricultural to urban use were noted particularly within the boundaries of the Federal Territory and Petaling Jaya. In the Petaling District of which Petaling Jaya is a part, two major forces appeared to have operated contributing to its rapid growth. *First,* Petaling District shares an administrative boundary with the Federal Territory, thus attracting overspill to such major housing areas as Damansara Jaya, Damansara Utama, Taman Lee Yan Lian and SEA Park. *Second,* Petaling is in the district where the State Economic Development Corporation (PKNS) had concentrated its attention with the building of the new state capital (Shah Alam), the large residential areas of Subang — Sg. Way and industrial development at Petaling Selatan. The effect of allowing current pressures to continue unchecked would mean a delay (if not failure) in implementing a decentralized urban growth policy within the Kelang Valley Region. This would increase rural-urban migration to already congested areas of Kuala Lumpur and Petaling Jaya aggravating further the existing problem of squatters, housing, social services and the environment generally.

Of direct relevance to the study of the impact of urbanization on the atmospheric environment is the increase in motor vehicles. The Kelang Valley Review Report (Shankland Cox *et al*, 1979) estimated that there were 325,000 private cars and motor cycles in the Kelang Valley Region in 1980, which is 3½ times the number in 1970 and 50% more than the projection in the Kelang Valley Study of 1973. In the face of such development, several recommendations were submitted to the government intended to maximize the use of public transport, limit the number of road constructions, and restrain car trips to the central area through parking pricing policies and Area Road Pricing Schemes. Immediate improvements to bus services were proposed, as well as a Dispersal Scheme for traffic approaching the city centre from Federal Routes 1 and 2 (Figure 1).

Works on the Traffic Dispersal Scheme are currently in progress together with the construction of the new and improved sections of the Inner Ring Road, the various intersection improvements, the Central Area Circulation Plan, and various HOV priority schemes[1]. It is noted however that while works are in progress on all the road schemes, only one HOV priority scheme has been introduced a bus lane in Jalan Ipoh. The implementation of Area Road Pricing has been deferred indefinitely.

It term of road building investment, the Third Malaysia Plan (TMP) allocated expenditure on road projects within the Kuala Lumpur conurbation was estimated to be of the order of M$400 million. Of this total, less than 2% was for road works associated with public transport, i.e. busways, HOV priorities and HOV lanes. This massive investment in road building with virtually negligible amount being spent on restraint measures will mean that more people will be encouraged to use private cars resulting in a vicious circle (see the New Straits Times, 25.2.1981).

Urbanization and Night-time Temperatures

One obvious impact of urban growth on the atmospheric environment is the changing patterns of temperature particularly at night when the influence of the built environment is at its best[2].

[1] HOV (Heavy Occupancy Vehicles) are defined to include buses, taxis, and cars with four or more occupants.

[2] For more detailed discussion on urban climate, see Peterson (1974), Oke (1974) and Sham (1979a & 1980).

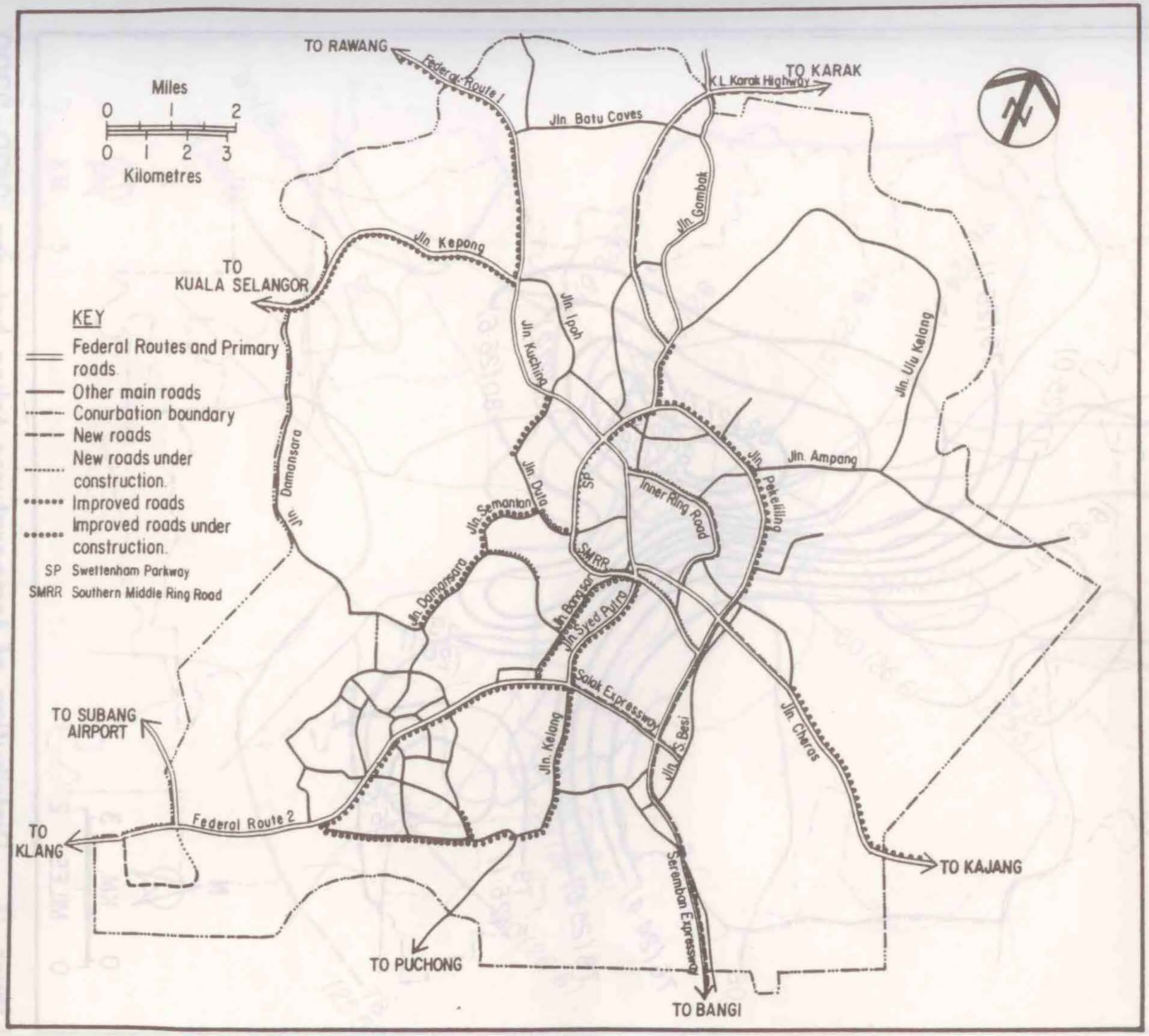

Figure 1: Kuala Lumpur Conurbation Road Construction 1973–80

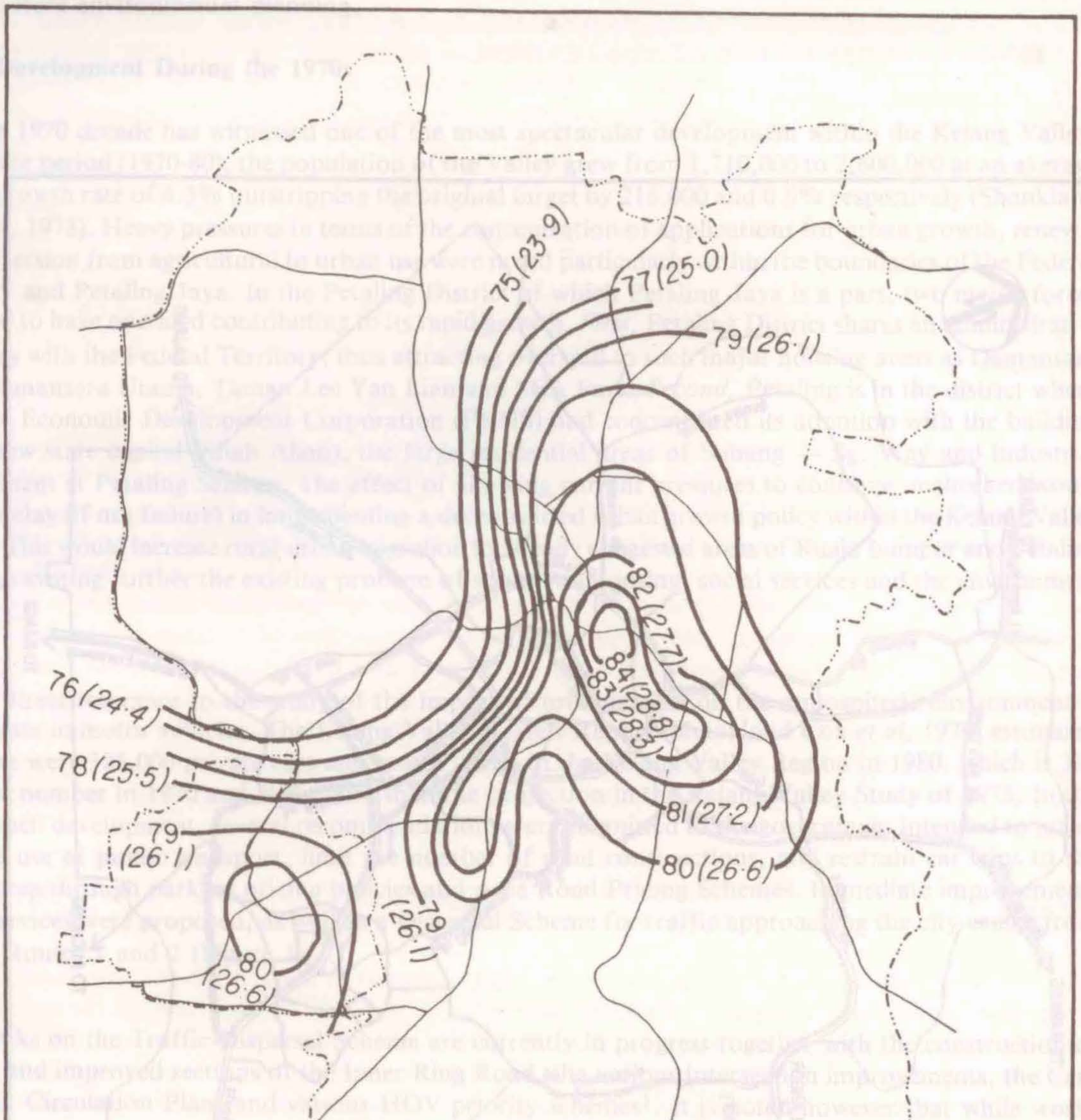

Figure 2 : Distribution of temperatures taken between 2100-2200 hours (L.T.) in Kuala Lumpur-Petaling Jaya, 11th. February, 1972 under calm and clear-sky conditions. Isotherms are numbered in °F with their equivalents in °C shown in brackets.

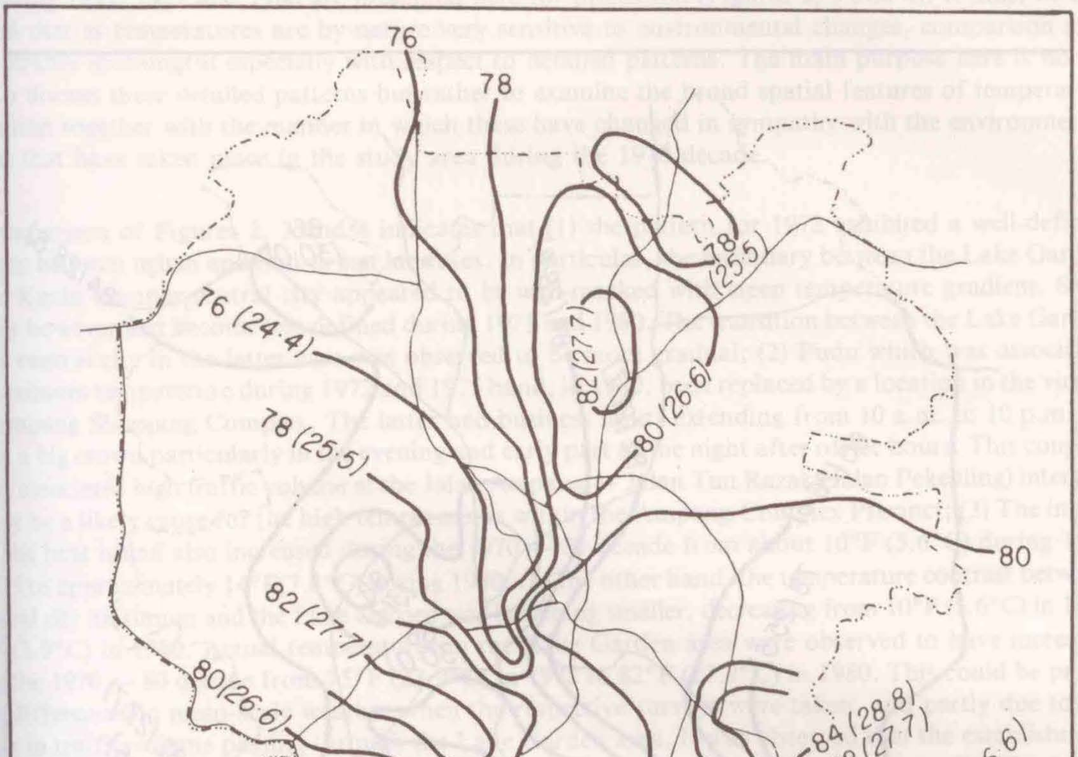

Figure 3 : Distribution of temperatures taken between 2100-2200 hours (L.T.) in Kuala Lumpur - Petaling Jaya, 3rd. December, 1975 under calm and clear-sky conditions. Isotherms are numbered in °F with their equivalents in °C shown in brackets.

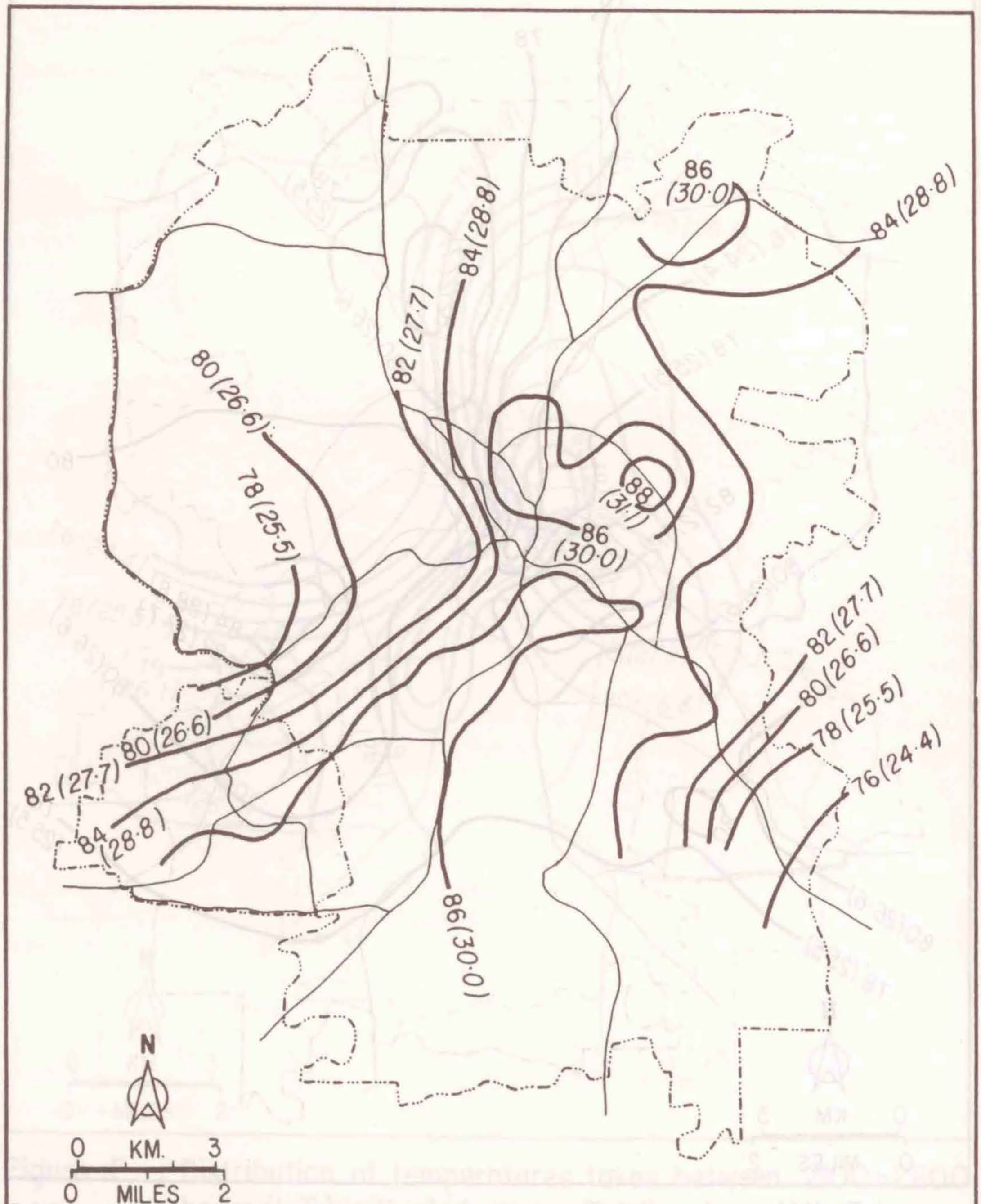

Figure 4 : Distribution of temperatures taken between 2100-2200 hours (L.T.) in Kuala Lumpur - Petaling Jaya, 15th. September, 1980 under calm and clear-sky conditions. Isotherms are numbered in °F with their equivalents in °C shown in brackets.

Through the 1970 decade several temperature surveys were carried out in the Kuala Lumpur — Petaling Jaya area using the traverse method. In each case, temperatures were measured using whirling hygrometers along pre-determined routes with the help of several senior geography students of the Universiti Kebangsaan Malaysia. A more detailed account of the survey procedures has been discussed elsewhere by the author (Sham, 1979, p. 212). Results of such surveys for three selected nights with very similar weather conditions during 1972, 1975 and 1980 are presented here for discussion (Figures 2, 3 and 4). It must be emphasized that as temperatures are by nature very sensitive to environmental changes, comparison may not be strictly meaningful especially with respect to detailed patterns. The main purpose here is not so much to discuss these detailed patterns but rather to examine the broad spatial features of temperature distribution together with the manner in which these have changed in sympathy with the environmental changes that have taken place in the study area during the 1970 decade.

Comparison of Figures 2, 3 and 4 indicates that (1) the pattern for 1972 exhibited a well-defined boundary between urban and non-urban landuses. In particular, the boundary between the Lake Garden and the Kuala Lumpur central city appeared to be well-marked with steep temperature gradient. Such a feature however had become less defined during 1975 and 1980. The transition between the Lake Garden and the central city in the latter case was observed to be more gradual; (2) Pudu which was associated with maximum temperature during 1972 and 1975 hand, in 1980, been replaced by a location in the vicinity of Ampang Shopping Complex. The latter had business hours extending from 10 a.m. to 10 p.m. attracting a big crowd particularly in the evening and early part of the night after office hours. This coupled with the associated high traffic volume at the Jalan Ampang — Jalan Tun Razak (Jalan Pekeliling) intersection may be a likely cause for the high temperatures within the Ampang Complex Precinct; (3) The intensity of the heat island also increased during the 1970 — 80 decade from about 10°F (5.6°C) during 1972 and 1975 to approximately 14°F(7.8°C) during 1980. On the other hand, the temperature contrast between the central city maximum and the Lake Garden was becoming smaller, decreasing from 10°F (5.6°C) in 1972 to 7°F (3.9°C) in 1980. Actual temperatures in the Lake Garden area were observed to have increased during the 1970 — 80 decade from 75°F (23.9°C) in 1972 to 82°F (27.7°C) in 1980. This could be partly due to differences in meso-scale weather when the respective surveys were taken, and partly due to the increase in traffic volume passing through the Lake Garden area. It was observed that the establishment of new housing estates such as Damansara Jaya, Damansara Utama, SEA Park and Taman Tun Dr. Ismail had transformed Jalan Damansara and Jalan Duta leading to the central city into a busy thoroughfare during 1975 - 80. As temperatures in the three studies quoted here were recorded along major roads, changes in trafic volume would inevitably had the effect of modifying the ambient air temperatures. The author is of the opinion that although differences in meso-scale weather condition could not be ruled out completely, the increase in traffic volumes appeared to be the more likely cause for the temperature increase observed during the 1980.

Similar patterns of temperature changes were also observed in the housing estates. A comparison of the more recent and older housing areas having different intensities of green cover in and around Kuala Lumpur — Petaling Jaya indicates that the latter can affect temperature distribution quite considerably particularly at night (Mariappa, 1980). The study showed that older housing areas with more established green areas and tree growth would have more moderate temperatures than the new residential areas. Temperature difference in certain cases could be in the order of 3-4°F(1.7 — 2.0°C) on a particular night

It was however observed that green areas in themselves had very limited effect in improving human comfort. Due to their high thermal conductivity and heat storage during daylight, brick houses tend to release much of the stored heat at night causing general discomfort to the people living inside. East-West building orientation and shades from relatively mature trees would be more effective in enhancing comfort in housing estates. Without properly planned tree planting programmes, new housing estates can become small heat islands in themselves causing a high degree of discomfort. Thus, as more housing estates are being developed without proper tree planting programmes, more high temperature areas will be created resulting in an increase in discomfort and energy use (in the form of air conditioning and fan) to counteract the heat and sweltriness.

Planning Implications

Climatically, one obvious consequence of increased urbanization is the creation of the heat island or islands. High environmental temperatures such as those found within the heat islands are deleterious to health and comfort; prolonged exposure can be instrumental to the incidence of strokes, heat diseas and pulmonary disorders (Schuman *et al,* 1964). In a study of death from heat illness and heat-aggravate illness in the United States, Ellis (1972) found that excessive heat could be more lethal than high leve of air pollution. He observed that infant (less than one year old) deaths from acute heat illness were ve much greater than for any other age group below 50 years. He attributed this to the less stable the moregulatory control in infants and the greater sweat loss in proportion to body weight than for adult Healthy older people are capable of adjusting to the stressful hot conditions, although as age increase the ability to adjust to limiting conditions appears to decrease.

Urban development particularly those of transport and housing in the Kuala Lumpur — Petalin Jaya area during the last 10 years has led to sporadic temperature increases in affected areas. This is bein further aggravated by the lack of tree planting programmes in the new housing areas and a rapid increas in the number of motor vehicles on the roads. Available green areas in the city appear to have slow given way to housing development and road constructions. Indeed even the catchment area to the ea of Kuala Lumpur central city has not been spared. Parts of it have to give way to housing developme projects to cater for the increasing demand for houses in the Kuala Lumpur — Petaling Jaya area (se the New Straits Times, 12.2.1979). The construction of the Southern Middle Ring Road for example ha taken up a significant portion of the Lake Garden area which is continually decreasing. This has the effe of further aggravating the already congested road connecting the city centre and Petaling Jaya via Jala Damansara.

The increasing rate of water proofing of the surfaces through housing development projects, roa construction and urban renewal programmes in the Kuala Lumpur — Petaling Jaya area during the las 10 years has another environmental consequence — that of hydrology. In its simplest form, the wate balance of any surface may be stated as follows:

$$P = E + r + f$$

where P is precipitation, E is evapotranspiration or condensation, r is net runoff, and f is net storag Quite apart from any effect cities may have upon precipitation and water quality, Leopold (1968) ha identified two main physical effects of urban landuse upon water balance. These are firstly, changes i total runoff and secondly, changes in peak flow characteristics both of which are dependent on the percen tage of impervious surfaces and the rate of water flow across the land. Although not all urban fabri are impervious (bricks and tiles for example are highly absorbent) by and large runoff from urban area are normally greater than those from similar rural areas (e.g. Reagen *et al,* 1971; Skelton, 1972; Thorpe 1973). Results of studies quoted for the different areas of course vary from one to another, but in genera they range from a 50% increase in mean annual flood discharge for a one square mile area which is 20% impervious and is 20% covered by storm sewerage to a 400% increase with 80% impervious and 80% coverage by storm sewerage. For unsewered areas, the difference between 0 and 100% impervious wi increase peak discharge in the order of 2½ times. As urbanization has the effect of intersifying the ex tremes of flow, this means that the recurrence interval in years of a given discharge is also sharply reduced[3] In other words, with increasing urbanization the frequency of occurrence of more severe floods is ex pected to be higher.

Summary and Conclusion

The paper has attempted to outline the growth of Kuala Lumpur — Petaling Jaya conurbation during the last 10 years and examine the way in which such growth has affected night-time temperature patterns. Comparison of temperatures during 1972, 1975 and 1980 indicates that the intensity of the hea

[3]Recurrence interval indicates the number of years that will elapse before a flood of a given magnitude recurs. The underlying premise is that the dry spells occurring during a period of time constitute a sample of an indefinitely large population in time. Thus, if in a period of 40 years of record the most severe flood recorded was of a certain magnitude, it is probable that the next 40 years will also contain a flood of equal severity. Recurrence interval can be calculated using the following formula

$$\text{Recurrence interval} = \frac{N + 1}{M}$$

where N is the number of years of record and M is the rank of the individual item in the array.

island had increased quite considerably followed by an increasingly larger areas having higher temperatures. The Lake Garden which was a heat sink during the 1972 survey was noted to have higher temperatures during the 1980; the steep temperature gradient between the Lake Garden and the central city which was observed in 1972 had by 1980 disappeared. Such changes were attributed to the increased number of motor vehicles on the roads and the opening up of the many new housing estates. Quite apart from the effects the new housing esates may have upon environmental temperatures, improved roads linking these housing estates and the central city are now having greater traffic volumes which subsequently affect temperatures and comfort.

Apart from affecting temperatures, paved surfaces also affect the hydrology of the area. Although the exact percentage of paved surfaces in the Kuala Lumpur — Petaling Jaya area is not known studies elsewhere have shown that in extreme cases increased runoff from urban areas can be quite considerable and hazardous. There does not appear to be any simple solution to the problem however. But an all-out effort for tree planting programmes and conservation of whatever green areas we have left must be given serious consideration. Such programmes will not only moderate environmental temperatures but also correct the overtly "runoff-skewed" water balance in the urban areas. It is suggested that along with road construction and housing development programmes those of tree planting must also follow suit immediately. Such programmes will have the effect of increased evapotranspiration (E) and net storage (f), the later through increased infiltration, and a corresponding decrease in runoff.

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References

Duckworth, F.S. & Sandberg, J.S. 1954. The effects of cities upon horizontal and vertical temperature gradients. *Bulletin American Meteorological Society,* v. 35. p. 198 - 207.

Ellis, F.P. 1972. Mortality from heat illness and heat aggravated illness in the United States. *Environmental Research,* v. 5, n. 1, p. 1 - 58.

Landsberg, H.E. 1970. Micrometeorological temperature differentiation through urbanization. *Urban Climates,* WMO Technical Note 108, p. 129 - 136.

Leopold, L.B. 1968. *Hydrology for Urban Landuse Planning — A Guidebook on the Hydrologic Effect of Urban Landuse,* Washington, D.C. Geological Survey Circular, 554

Mariappa, R. 1980. *Suatu Kajian Tentang Keselesaan di Beberapa Kawasan Perumahan di Kuala Lumpur — Petaling Jaya,* B.A. (Hons) thesis, Department of Geography, Universiti Kebangsaan Malaysia.

Oke, T.R. 1974. *Reviews of Urban Climatology, 1968 - 73.* WMO Technical Note No. 134, Geneva.

Peterson, J.T. 1969, *The Climate of Cities: A Survey of Recent Literature.* NAPCA Publication No. AP-59.

Reagon, R., Livermore, N.B. & Steans, J.C. 1971. *Environmental Impact of Urbanization on the Foothills and Mountainous Lands of California,* The State of California Resources Agency and Department of Conservation.

Schuman, S.H., Anderson, C.P. & Oliver, J.T. 1964. Epidemiology of successive heat waves in Michigan, 1962 and 1963. *Journal American Medical Association,* v. 189, p. 733 — 738.

Sham, S. 1973(a). The urban heat island: its concept and application to Kuala Lumpur. *Sains Malaysiana,* v.2, n. 1, p. 53 - 64.

_________.1973(b). Observations on the effect of city's form and function on temperature patterns: a case of Kuala Lumpur. *Journal Tropical Geograpy,* v.36, p. 60 - 65.

__.1978. Airflow in urban areas with special reference to Kuala Lumpur — Petaling Jaya, a tropical city. *Sains Malaysiana,* v. 7, n. 2, p. 215 - 222.

Sham, S. 1979(a). *Aspects of Air Pollution Climatology in a Tropical City: A Case of Kuala Lumpur — Petaling Jaya, Malaysia,* UKM Press.

__. 1979(b). Urban development and its implications on air quality in the Kelang Valley, Peninsular Malaysia. *Alam Sekitar,* v. 4, n. 1, p. 13 - 17.

_____.1980. *The Climate of Kuala Lumpur — Petaling Jaya Area Malaysia: A Study of the Impact of Urbanization on Local Climate Within the Humid Tropics.* Monograph No. 1, Department of Geography, UKM.

Shankland Cox Partnership 1973. *Kelang Valley Regional Planning and Development Study,* Vol. 1.

___________, Rekarancang Sdn. Bhd. & Perunding Bersatu Sdn. Bhd. 1979. *Kelang Valley Review,* Vol . 1.

Skelton, J. 1972. *Studies of Urban Runoff and Floods in Missouri,* US Geological Survey, Professiona Paper 800A.

The New Straits Times, 12.2.1979.

__________, 25.2.1981.

Thorpe, G.R. 1973. Forecasting runoff from storms moving over partially urbanized catchments. Paper in CIRIA *Symposium on Rainfall Runoff and Surface Water Drainage of Urban Catchments,* Bristo April, 1973.