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EVAPORATION IN PENINSULAR MALAYSIA

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Bahagian Parit dan Taliair
Kementerian Pertanian
Malaysia

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SUMMARY

The study reviews methods relevant to obtaining evaporation estimates for Peninsular Malaysia based on available climatic and evaporation pan data.

Open water evaporation estimates compare favourably with measured data obtained as part of an FAO study on evaporation from irrigated padifields.

Relationships between elevation and evaporation were derived and maps showing open water, forest and grassland evaporation for Peninsular Malaysia are presented. Point and spatial variability of evaporation are discussed.

INTRODUCTION

1.1 The Problem

With the rapid development of water resources in Malaysia there is a growing demand for information on the evaporation rates from open water (lakes and reservoirs) and other vegetative surfaces (forest, crops and grassland).

Often, when designing a water resources project, the engineer is faced with the problem posed by the lack of streamflow data. Social and economic pressure seldom, if ever, permit delaying project construction until such data has been collected and the engineer is usually forced to estimate the water resources using a water balance approach. Such techniques range from the simple water balance model to the more sophisticated, and supposedly more accurate, conceptual streamflow models (e.g. Stanford IV, Boughton). The accuracy to which such a model simulates catchment runoff is greatly influenced by the accuracy of the two major input parameters; precipitation and evaporation.

1.2 Study Objective

No attempt is made herein to discuss energy budget and mass transfer theory relevant to evaporation which is well presented in previous literature (Munn 1961, Hounam 1971). Instead the study reviews methods relevant to obtaining evaporation estimates for Peninsular Malaysia based on available climatic and evaporation pan data.

2. THE EVAPORATION PROCESS

Evaporation from natural surfaces is a physical process in which water is vaporised into the atmosphere. For land surfaces, the evaporation is controlled by complex interactions between climatic variables, the vegetation and the soil. One approach which simplifies the problem is to consider that evaporation involves three dynamic processes which occur simultaneously. These are:

(a) a flow of water from the soil, through the plant to the evaporating surface,

(b) a flow of heat by radiation, convection and conduction to the evaporating surface and its removal from the surface in the form of latent heat of vaporisation, and

(c) a flow of water vapour by turbulent and molecular diffusion from the evaporating surface into the atmosphere.

The rate by which water is transpired by the plant depends on soil moisture availability, the depth, density and water intake efficiency of the rooting system, and the foliage characteristics including leaf structure, density and behaviour of plant stomata. Evaporation of transpired water from the leaf surface requires a heat input of about 540 cals/gm to convert liquid to vapour, and a vapour pressure difference between the evaporating surface and the surrounding air.

The primary source of heat energy is in the form of short wave radiant energy from the sun; the amount reaching the earth's surface being dependant on latitude, season of the year, time of day and degree of cloudiness. Vapour transfer by diffusion processes are controlled primarily by the temperature and humidity differences between the evaporating surface and surrounding air, and the wind velocity of the air mass.

The most important difference between land and water surfaces is the availability of water at the evaporating surface. Heat flow to the surface controls the rate of evaporation only as long as there is a non-limiting supply of water. From a free water surface evaporation continues at a rate controlled primarily by climatic factors, and is called variously open water or free water evaporation. In the case of vegetated surfaces, there are often periods of soil moisture stress during which it becomes increasingly difficult for plant roots to extract water from the soil and the actual evaporation is less than the potential evapiration to be expected from the available energy input. Evaporation from a saturated bare soil takes place at about the same rate as for an open water surface, but decreases rapidly as the soil dries out near the surface and, once a desiccated surface layer is established, vapour transfer decreases to a very low rate controlled by temperature gradients within the soil profile.

3. METHODS FOR ASSESSING EVAPORATION

3.1 Pan evaporimeter

Within Peninsular Malaysia direct measurement of evaporation has been limited primarily to pan evaporimeter observations by the Malaysian Meteorological Service (MMS), the Drainage and Irrigation Department (DID), and the National Electricity Board (NEB).

In accordance with World Meteorological Organisation (WMO) recommended standards all departments now use the U.S. Class A land pan; a shallow (25.4 cm) galvanised iron pan of 120.6 cm (4 ft.) diameter. All DID pans are painted inside and outside with black bituminous paint, and there are about 45 stations (Fig. 1) with five or more years of records. Evaporation is also recorded at 15 MMS principal climatological stations throughout Malaysia. At these sites, the pans are painted with white enamel and records date from early 1974. Previous MMS observations were confined to three stations, namely; Malacca, Kota Bharu and Kuala Lumpur equipped with British Meteorological Organisation (BMO) pans.

Because of high intensity rainstorms typical of tropical climates, accurate pan evaporation records are difficult to achieve, especially during the monsoon months. During heavy rainfall, serious measurement errors result from the impact of raindrops splashing water from the pan. Overflow from the pan occurs when the rainfall exceeds about 70 mm. Occasionally errors result from incorrect reading of the raingauge or the evaporation pan to give abnormally high or low values. To obtain reasonable estimates of monthly pan evaporation, the DID has processed all daily data according to the following criteria. The observed data was neglected if:

(a) the rainfall exceeded 38.1 mm

(b) the observed evaporation was less than 1.25 mm, whether rainfall occurred or not

(c) the observed evaporation was greater than 7.65 mm if rainfall occurred, and

(d) the observed evaporation was greater than 11.45 mm if rainfall did not occur.

As observed previously by Tarble (1972) another major source of error results from observer integrity. One method to check observer reliability is to conduct a frequency analysis on observational data. If the record is reliable the frequency distribution approximates to a normal distribution. Such an analysis was conducted using daily data for each year of records, and those records, or periods of record, with poor frequency distributions were disregarded.

The most difficult errors to detect are those attributable to poor pan exposure and, or instrument maintenance. Deterioration and flaking of the paint, the growth of algae and accumulation of dust and other debris at the bottom of the pan all tend to change its heat transfer properties.

3.1.1 Pan Coefficient : Open Water

To estimate the rate of evaporation from a lake surface the recorded pan evaporation is multiplied by a pan coefficient.

Direct sunshine on the sides of the pan, and advective cooling by the air at night, cause the shallow layer of water in the pan to be heated and cooled more rapidly, with a resulting greater diurnal temperature variation than that for the water in a lake. Very few comparative experiments between reservoir or lake evaporation and pan evaporation have been reported. Probably the most notable are those conducted by the United States Geological Survey at Lake Hefner and Lake Mead in Arizona (Kohler, Nordenson and Fox:1955). Whilst the pan coefficient (lake to pan evaporation ratio) varied considerably from month to month, the average for the summer months was about 0.70. Rohwer (1934) obtained a similar result from studies on an 85ft. dia. reservoir near Fort Collins, Colorado. For the extremely arid climate of the central Mojave Desert in California, Blaney (1957) obtained a pan coefficient of only 0.60, but for the more humid, temperate climate near San Francisco, Rohwer (1934) reports 0.77 for his studies at East Part Reservoir, whilst Young (1947) quotes a similar figure for Lake Elsinore. For a seven year study near London, England, Lapworth (1965) reports pan coefficients of 0.71 and 0,80 for two separate class A pans observed during the experiment.

Various authors (Kuznecov 1955, Webb 1966) have shown that the pan coefficient is dependant on the ratio of the vapour pressure gradients over the pan and lake water surfaces. Lake evaporation (E_L) from pan evaporation Ep is given by:

$$E_L = K \left[\frac{e(L)-e(A)}{e(P)-e(A)}\right] Ep$$

where e(L), e(A) and e(P) are the vapour pressures corresponding to lake water, air, and pan water temperatures respectively and K is a constant. Konstantinov (1966) modified the equation further by introducing the ratio of the respective wind velocities. Based on this relationship it has argued (Hargreaves 1974) that for tropical climates, with little diurnal and annual variation in air temperature together with low wind velocities, then the vapour pressure gradient above the pan may approach that for an open water surface.

After considering information and argument presented for other tropical climates by Penman (1956) and Nordenson (1963), AUSTEC in their study of the Pahang River Basin, Malaysia adopted a pan coefficient of 0.90 for forest evaporation. For this study a coefficient of 0.90 was used to convert pan evaporation to open water evaporation.

3.1.2 Pan Coefficients: Vegetative Surfaces

Both stanhill (1962) and Smith (1964) agree that pan data can serve as the basis for satisfactory evaporation estimates from vegetative surfaces. Pruitt and Lourence (1968) from a three year lysimeter study showed that monthly ratios of evaporation from irrigated grass to pan evaporation varied from 0.72 to 1.04 with an overall average of 0.80. In a review of literature, from three separate experiments, Hargreaves (1974) concluded that the pan coefficient for grass ranges from 0.65 to 0.80. For this study a coefficient of 0.75 was adopted.

Water use by crops has been compared with pan evaporation in a number of countries. Stanhill (1962) showed that whilst for perennial grassland the relation between pan evaporation and grass evaporation remained linear throughout the year, the relationship for crops is non-linear; low during earlier and late stages of growth and high (pan coefficient approaching 1.0) immediately after irrigation when the crop is approaching maturity.

Because of practical difficulties, no lysimeter studies involving trees has ever been attempted. Based on the Penman formula (3.2) a pan coefficient of 0.80 was assumed. Thus, Table 1 shows the pan coefficients adopted for different surfaces in this study.

Table 1 : Pan Coefficients

Surface	Pan Coefficient
Open water	0.90
Forest	0.80
Grass	0.75

3.2 Penman's Method

The original Penman (1948) equation to estimate evaporation has been tested successfully over a range of climates (Hounam 1971).

The method, whilst sometimes described as semi-empirical, is based on logical physical argument developed from a combination of vapour transfer and energy balance approaches. By simultaneous solution of the relevant equations, Penman obviated the need to measure the surface temperature of the evaporating surface (difficult to achieve in the case of a free water surface and virtually impossible for vegetation) obtaining an estimate of evaporation using routine climatological data.

The generalised equation is:

$$E = \frac{\Delta H + \gamma Ea}{\Delta + \gamma}$$

where E is the evaporation, Δ is the slope of the standard vapour pressure/temperature curve at the bulk air temperature T_m, H is the net radiation flux received at the evaporating surface, γ is the psychrometric constant, and Ea is the vapour transfer term.

The net radiation flux (H) and the vapour transfer (Ea) are given by the equations.

$$H = \frac{R_A(a + b\frac{n}{N})(1-r) - \sigma T_m^4 (0.56 - 0.092\sqrt{e_d})(0.1 + 0.9\frac{n}{N})}{L}$$

and $Ea = 0.35 \ (1 + 0.526 \mu) \ (e_m - e_d)$

where R_A is the mean monthly extraterrestrial radiation, L the latent heat of vaporisation, n actual duration of bright sunshine, N maximum possible duration of bright sunshine, r the reflective coefficient of the surface (albedo), σ the Lummer and Pringsheim constant, e_m the saturation vapour pressure at mean air temperature, e_d the saturation vapour pressure for mean dew point temperature, and u is the wind velocity in m/sec at 2 metres above ground level. The empirical constants a and b convert sunshine hours to radiation, and are discussed further in 3.2.1.

In Peninsular Malaysia, there are 14 principal climatological stations, serviced by the Malaysian Meteorological Service, where observations include temperature, humidity, wind velocity and sunshine hours. Out of these 14 sites, there are 11 sites with more than 10 years of continuous records. Incoming short wave radiation records, dating from early 1974, are available for three sites only, namely Kuala Lumpur, Kota Bharu and Penang.

3.2.1 Sunshine Conversion Coefficients

Hounam (1971) has previously demonstrated the importance of accurately estimating or measuring the net radiation flux, especially with respect to tropical climates. Without actual radiation records, the radiation received by the water or vegetative surface (R_c) is estimated using the empirical equation:

$$R_c = R_A \left(a + b\frac{n}{N}\right) (1 - r)$$

where a, and b are empirical constants dependant on location.

By correlating the ratio of actual radiation (R_c) to extra-terrestrial radiation (R_A) against the ratio of actual sunshine hours (n) to maximum possible sunshine hours (N) using monthly data for 1974 observed at the three radiation recorder sites, the correlation equation for Peninsular Malayis was found to be

$$R_C = R_A \left(0.24 + 0.51\frac{n}{N}\right) (1 - r)$$

with a correlation coefficient (r) of 0.94

Comparable overseas values for a and b are given in Table 2.

Table 2: Empirical constant converting sunshine hours to radiation

Location	a	b	Author
Peninsular Malaysia	0.24	0.51	Scarf (1975)
Canberra, Australia	0.25	0.54	Prescott (cit. Weisner)
Rothamsted, England	0.18	0.55	Penman (cit. Weisner)
Gilat, Isreal	0.32	0.47	Stanhill (1961)
Virgina, USA	0.22	0.54	Kimball (cit. Weisner)

3.2.2 Albedo

The reflective coefficient (albedo) of the evaporating surface is a sensitive parameter in the radiation equation. For tropical climates, an albedo error of 0.01 gives rise to an error of 22 mm in the annual evaporation (approx. 1.5%). A literature review of albedo corresponding to various evaporative surfaces is included in Scarf (1975) and the values adopted for this study are summarised in Table 3.

Table 3 : Table of albedo values

Surface	Albedo
Open water	0.07
Grass	0.25
Deciduous forest	0.18
Coniferous forest	0.13
Crop	0.23
Urban	0.17

3.2.3 Wind Conversion

The aerodynamic term of the Penman equation was given originally as:

$$f(\mu) = 0.35(1.0 + 0.0098\mu)$$

where μ is the velocity in miles run per day at two metres above ground level. Penman (1956) modified the 1.0 to read 0.5, but the original form was later reinstated and has been used in this study.

In Malaysia wind velocity observation heights range from 12 to 18 metres above surface, and conversion to the standard 2 metres height was made using the logarithmic equation given by:

$$\mu_2 = \mu_h \left(\frac{\log 2}{\log h}\right)$$

where μ_h and μ_2 are wind velocities in m/sec at heights h and 2 metres respectively.

3.3 Hargreaves Method

Following a review of lysimeter studies by various authors (Pruitt, Lourence and Von Oettinger 1972, Pruitt and Lourence 1968, McGuinness and Bordine 1972, McIlroy and Angus 1964, Mustonen and McGuinness 1968) in addition to his own studies, Hargreaves (1974) developed the following equation to estimate evaporation from grassland.

$$ETG = 4.0 + 0.16\ T_m\ F\ \sqrt{100-RH}$$

The factor, F, is based on latitude and length of sunshine day, T_m is the mean monthly temperature in degrees Fahrenheit, RH is the mean monthly relative humidity in percent and ETG the evaporation in mm for the month. His regression equation has a high correlation coefficient (r = 0.96) and included tropical region data from the Congo and coastal Ecuador. Hargreaves argued that his equation had not been tested for altitudes in excess of 1000 metres, and reliability at such altitudes would probably decrease because of higher vapour pressure gradients and increase air turbulence. However, typical of tropical climates, Malaysia experiences low wind velocities and the exclusion of an aerodynamic term was not considered too serious.

3.3.1 Comparison with Penmans Method

To test the application of Hargreaves equation for Malaysian conditions, 188 monthly evaporation data obtained using this equation (ETG) were compared with corresponding grassland evaporation data obtained using the Penman method (Ep). Monthly data from 14 principal climate stations were analysed, and gave a regression equation

$$ETG = 0.94\ Ep + 6.3$$

with a correlation coefficient of 0.87. Principle outliers in the regression included data from Mersing and Kuala Trengganu which, on average, experience slightly greater wind velocities than other stations in Peninsular Malaysia.

From the regression equation, there is no significant difference between estimating evaporation from grass using the Hargreaves and Penman methods.

3.3.2 Regression equations for mean monthly temperature and humidity

Besides the 14 principal climatological stations in Peninsular Malaysia, there are 68 secondary climatological stations. Observations at these stations include rainfall, air temperature at 0700 and 1300 hours, and relative humidity at 1300 hours. To satisfy data input requirements to the Hargreaves equation, regression equations converting (a) air temperature at 0700 and 1300 hours to mean air temperature and (b) humidity at 1300 hours to mean relative humidity were derived using principal climate station data. The respective regression equations and correlation coefficients obtained were:

$$T_m = 0.98 \frac{(T_7 + T_{13})}{2} + 0.63 \qquad (r = 0.995)$$

$$RH = 0.43\ (RH_{13}) + 55.2 \qquad (r = 0.84)$$

Whilst the correlation for relative humidity is not as good as that for temperature, errors in the relative humidity term in the Hargreaves equation are less sensitive than errors in temperature.

Using these regression equations, the mean monthly temperature and relative humidity were determined for the record period at all 68 secondary climatological stations, and the grassland evaporation calculated using the Hargreaves equation.

3.3.3 Conversion coefficients for other surfaces

To obtain an estimate for monthly evaporations from open water (ETW) and forest (ETF) from the Hargreaves grassland estimate (ETG) the following conversion equations were used:

$$ETW = 1.256\ ETG + 1.1$$

$$ETF = 1.1\ ETG + 0.3$$

Where ETW, ETF and ETG are in mm. The equations were derived from the relative differences given by the Penman analyses at the 14 principal climatological stations.

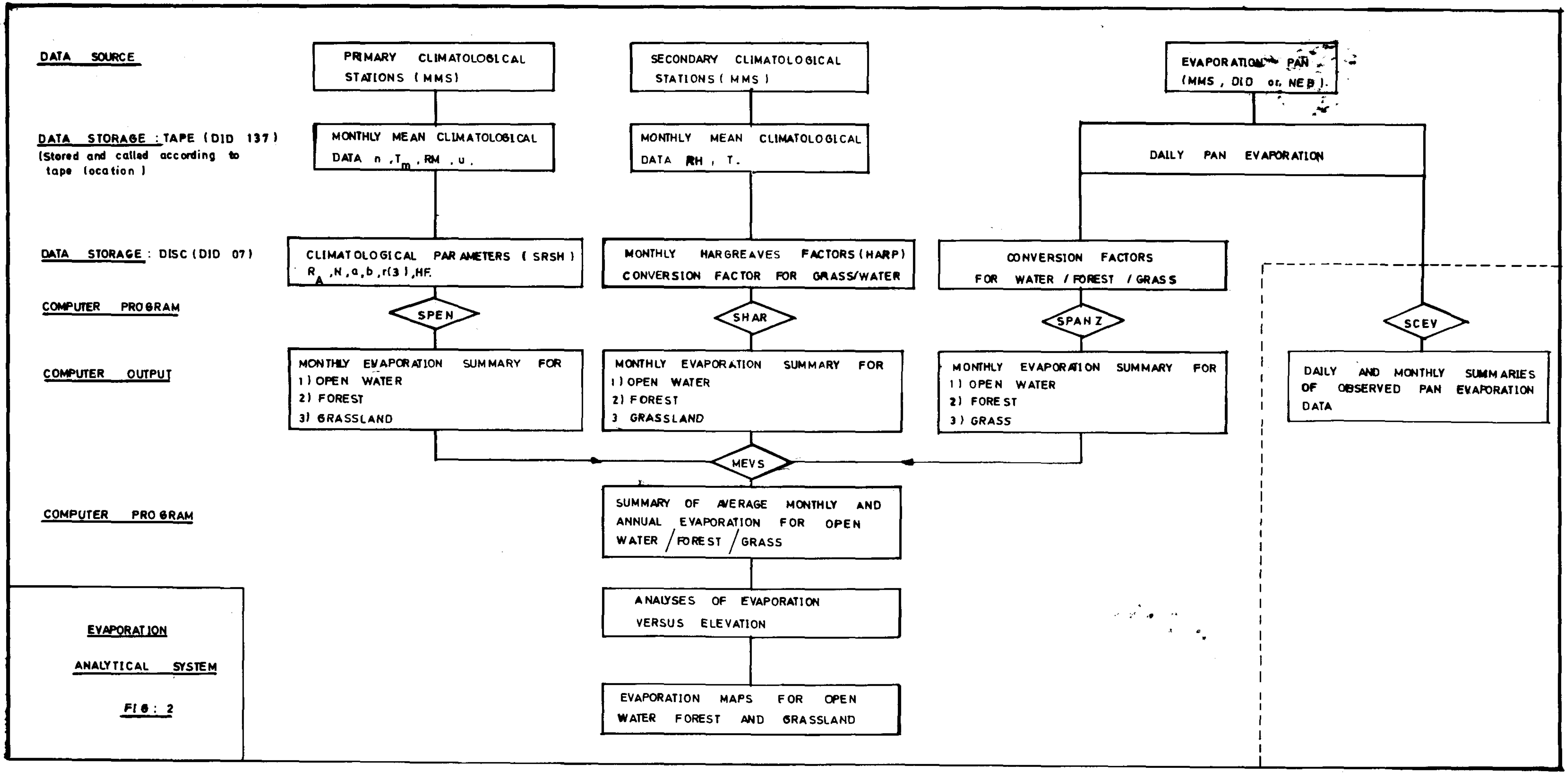
4. DATA PROCESSING AND ANALYSES

4.1 Analytical system

Data was processed as outlined in Fig. 2, using a NOVA 1220 computer. Results for average monthly and annual evaporation (Program MEVS) for open water, forest and grassland are included in Appendices 1, 2 and 3 respectively. Printouts from programs SPEN, SHAR, SPANZ or SCEV for individual stations are available on request.

4.2 Point variability of evaporation in Peninsular Malaysia

All stations exhibit a similar evaporation pattern throughout the year, with a maximum occuring in March, and a minimum during the monsoon months of November and December. The range of monthly evaporation seldom exceeds ± 20% of the average, reflecting the small temperature range associated with tropical climates.



EVAPORATION

ANALYTICAL SYSTEM

FIG: 2

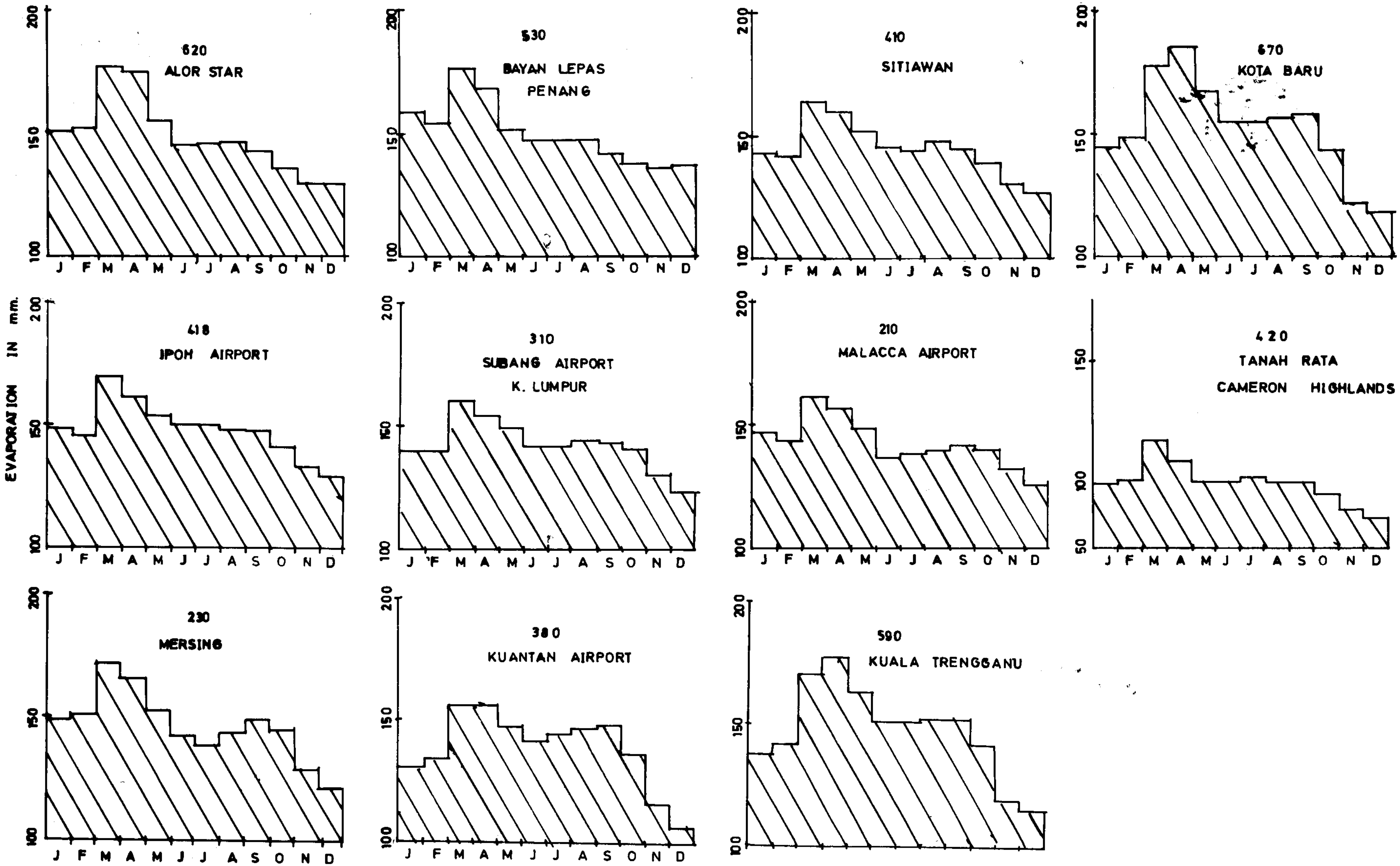


FIG. 3 AVERAGE MONTHLY OPEN WATER EVAPORATION FOR PRINCIPAL CLIMATOLOGICAL STATIONS

Inspection of data from stations with ten or more years of records shows that the months November through February exhibit the greatest variability from year to year. The variability is associated with the onset of the northeast monsoon bringing heavy rainfall, increased humidity and cloudiness.

The east coast stations have a greater variation in monthly totals throughout the year resulting from a more definite seasonalised climate pattern; a monsoon season from November to January, and a dry season from February to May. In Kota Bharu during the dry season, the sky is clear, air temperatures are high, and little or no rainfall may occur for prolonged periods up to two months duration. During the monsoon period, sunshine hours are low, mean humidity is high and rainfall events occur frequently. To demonstrate differences in monthly variability, average monthly evaporation for the 14 principal climatological stations are shown in Fig. 3.

4.3 Comparison with observed open water evaporation

Van de Goor and Zijlstra (1968) reported on an FAO study to determine the evaporation rates from rice in Peninsular Malaysia. Of relevance to this study are the experiments conducted at Bumbong Lima (Province Wellesley) and Jitra (Kedah). By accurately recording the inflow of rainfall and irrigation water to, and the outflow from a bunded padi field they were able to determine the evaporation from rice using a simple water balance approach. At Bumbong Lima the experimental area included 4.2 ha. and at Jitra, 34 ha.

Both study areas were equipped with two lysimeters (3 x 3 x 3 ft.) installed in the padi field away from the surrounding bunds and with the rim approximately 74 mm above the water level in the flooded field. Evaporation from the surrounding padi as determined by the water balance approach compared favourably with that recorded by the lysimeters.

In the early stages of crop growth the consumptive water use results almost wholly from open water evaporation. From the results shown in Table 4, there is very good agreement between measured evaporation from the young rice crop, and estimated open water evaporation calculated using the Penman procedure and climate data from the nearest climatological station. At maturity, the rice crop evaporates about 15% more than the open water estimate.

Table 4

Location: Bumbong Lima **Climatological Station:** Bayan Lepas (Penang)

Month	Year	Evaporation mm		Comments on crop growth
		Lysimeter	Penman open water	
March	1962	171	169	Transplanting and presaturation
April		165	170	
May		183	162	
Jun		173	150	Crop ripening
Sept.		144	146	Presaturation and transplanting
Oct.		151	137	
Nov.		151	144	
Dec.		159	141	Crop ripening

Location: Jitra **Climatological Station:** Kepala Batas (Alor Star)

Month	Year	Lysimeter	Penman open water	Comments on crop growth
Jun	1962	157	155	Transplanting and Presaturation
July		153	143	
Aug.		158	147	
Sept.		139	150	
Oct.		164	136	Crop ripening
Nov.		160	142	Crop ripening

5. EVAPORATION MAPPING

5.1 Elevation and Evaporation

Mean air temperature decreases with increasing height above mean sea level, and there is a direct relationship between evaporation and elevation.

For Peninsular Malaysia two distinct relationships are apparent (Fig. 4); one representing the northwestern coastal range extending north from central Perak towards Baling, and the other representing the central mountain chain extending from just north of Malacca to the Thailand border.

The differences are attributable primarily to differences in mean relative humidity, the humidity in the northwestern coastal range being consistently greater than for the central range. For example, relative humidity at Cameron Highlands (1470m.) averages about 87 percent, whilst for Maxwell's Hill (1036m.) and Penang Hill (732m) average humidities are about 95 and 93 percent respectively. Corresponding mean temperature for these stations are 17.8, 20.3 and 22.1°C.

Some additional information for defining the central range relationship was provided by National Electricity Board (NEB) Class A evaporation pan data observed at Habu Power Station (1080m) and Tanah Rata (1470m) averaging 1290 and 1200 mm respectively. Subsequent conversion to open water evaporation using the pan coefficient (0.90) defined in 3.1.1 gave 1160 and 1080 mm respectively.

The climate record for Kuala Tahan is very short (18 months) and the reliability of the plotted average is questionable.

Graphed also in Fig. 4 for comparison are relationships derived previously by Goh (1974) based on the Thornthwaite and Mather (1951) procedure, and AUSTEC (1974) based on evaporation pan data. For the latter no distinction was made between NEB pans (galvanised) and DID pans (painted black).

5.2 Mapping average annual evaporation

From the data presented in Appendices 1, 2 and 3, average annual evaporation maps from open water, forest and grassland in Peninsular Malaysia were prepared (Figs. 5, 6 and 7)

It is stressed that the data and maps for forest and grassland represent the potential evaporation; that is, the evaporation that would occur if soil water were continuously available. Whilst the annual rainfall throughout Peninsular Malaysia generally exceeds 2000 mm, much of this occurs during the monsoon season(s), and in some areas it is not uncommon to receive little or no rainfall for periods up to two months. During such periods a soil moisture deficit may occur whereby insufficient water is available for plant transpiration and growth, and the actual evaporation is less than the potential rate.

5.3 Spatial variability of evaporation in Peninsular Malaysia

For those parts of Peninsular Malaysia more than 300 m above mean sea level, evaporation was mapped according to the evaporation-elevation relationships

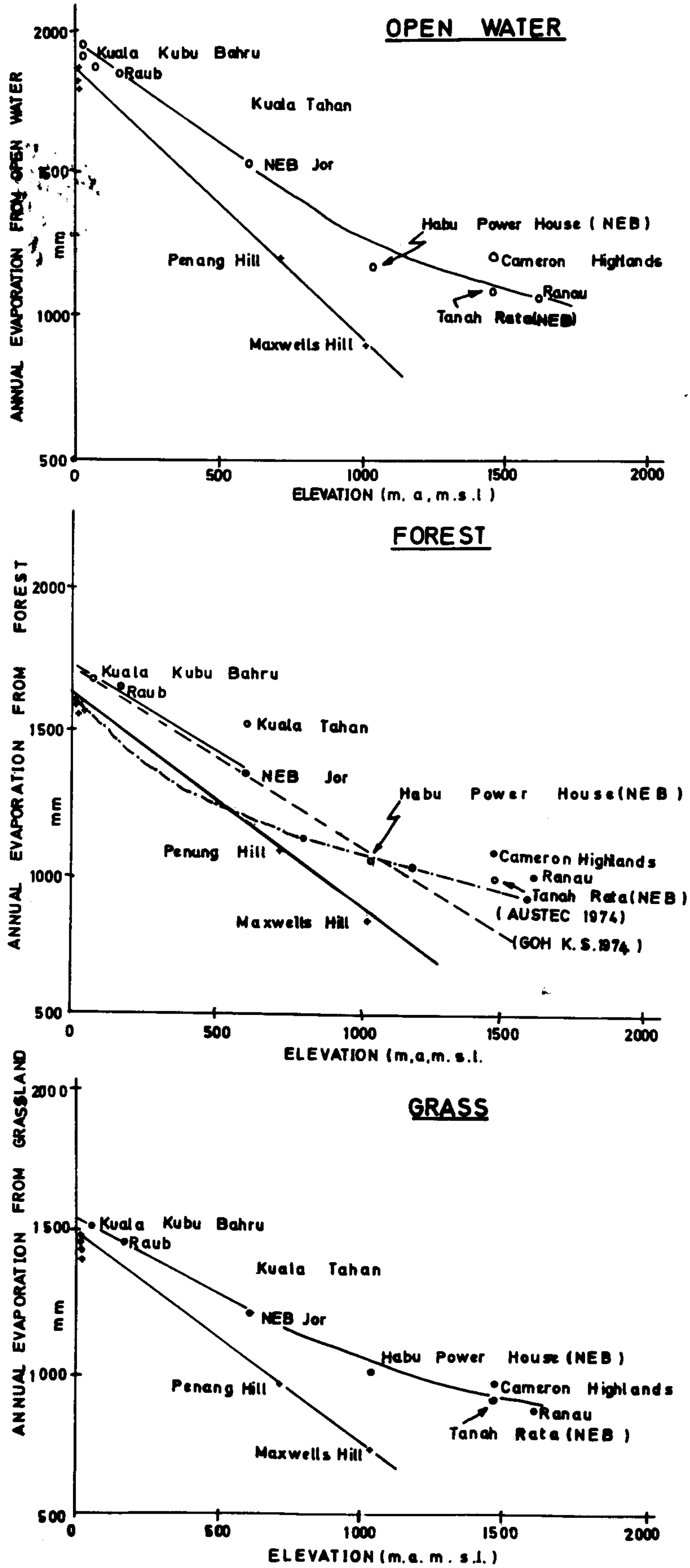


FIG. 4 : EVAPORATION - ELEVATION RELATIONSHIPS FOR PENINSULAR MALAYSIA

derived in 5.1. Because of the lack of climate and evaporation observation sites for these regions, the variability is little more than a reflection of altitude variation and has a corresponding lower reliability.

For the better instrumented coastal regions reliability of the plotted evaporation isolines is greatly improved. In general, maximum evaporation occurs along the foothills of the mountain blocks and decreases towards the coast. Whilst a similar conclusion was reached by AUSTEC (1974), Nieuwolt (1965) concluded the opposite, reasoning that for inland regions convection during the heat of the day increases cloudiness and reduces radiation. Comparing mean hourly sunshine for the coastal station Sitiawan and Ipoh about 65 km. inland would appear to confirm Nieuwolt's reasoning. However for the earlier part of the day (0900 – 1300 hours) the average sunshine for the inland site far exceeds that for the coastal site, tending to balance daily differences in net radiation.

Humidity is highest on the coast, maintained by the mass movement of moisture-laden sea air by onshore winds. Inland away from the major source of moisture, humidities are lower. To demonstrate, Table 5 shows the mean temperature and relative humidity for 1974 for some stations near Kuala Lumpur. There is a reduction in mean

Table 5 – Mean temperature and humidity for 1974 for some selected stations

Site Name	Site No.	Mean Temperature °C	Mean humidity %
One Fathom Bank	258	26.8	89
Tanjong Karang	325	25.9	86
Klang High School	306	26.4	83
Subang Airport	310	26.2	84
Kepong	312	26.6	83
Kajang	300	26.4	82
Kuala Kubu Bharu	322	26.8	82

relative humidity from One Fathom Bank; a lighthouse about 25 km out from the coast, to Kuala Kubu Bharu about 40 km inland.

Mean relative humidity, in general, increases from north to south with Alor Star, Subang (Kuala Lumpur) and Senai (Johor Bahru) recording means of 81, 84 and 86 percent respectively. All three stations are similar with respect to distance from the coast.

The diurnal relative humidity varies inversely with air temperature. During the day the humidity fluctuates between 55 and 75 percent and at night rises to above 95 percent. Inland stations have greater diurnal variation compared to coastal stations.

A similar conclusion is reached with respect to diurnal temperature variation. Mean air temperature at Ipoh for the period 1200 to 1500 hours daily, average 0.9° C higher than that recorded at Sitiawan on the coast. This, together with a lower mean relative humidity, does much to explain the higher evaporation recorded at Ipoh, and other inland stations.

Surface winds throughout Peninsular Malaysia are generally light and tend to be stronger along the east coast. Average wind velocity ranges between 2.6m/sec, recorded at Mersing, and 0.7m/sec. recorded at Temerloh. There is little increase in wind velocity with increasing altitude as evidenced by an average of 1.2 m/sec. recorded for Cameron Highlands (1470 m).

The lower evaporation recorded for Johor Bahru results from a high relative humidity and lower wind velocity, sunshine hours and midday temperatures. The climate at Mersing is similar to that for Johor Bahru and Kuantan and the increased evaporation recorded at Mersing is attributable primarily to a higher average wind velocity.

5.4 Conclusions:–

This study has afforded a better understanding of the time and spatial variability of evaporation throughout Peninsular Malaysia. The data presented herein will provide a better estimate of the evaporation component for conceptual streamflow modelling leading to an improved assessment of the surface water resources for Peninsular Malaysia.

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PREVIOUSLY PUBLISHED

1. Surface Water Resources Map (Provisional) of Peninsular Malaysia 1974

2. Hydrological Regions of Peninsular Malaysia 1975

3. Sg. Tekam Experimental Basin Annual Report No. 1 1975

4. Notes on Some Hydrological Effects of Land Use Changes in Peninsular Malaysia 1975

HYDROLOGY BRANCH JPT MALAYSIA

OPEN WATER EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0614	KANGAR	PS	6 26	100 12	3	H	11	144	153	180	161	153	137	142	147	141	138	128	132	1756
6401308	JPT, KANGAR	PS	6 27	100 11	3	AP	14	160	176	200	174	143	123	126	128	121	119	112	123	1705
6397311	PG. MATSIRAT, P. LANGKAWI	KD	6 21	99 44	5	AP	13	181	182	196	159	134	124	127	126	124	118	127	151	1749
0602	PULAU LANGKAWI	KD	6 19	99 51	4	H	2	158	165	174	170	153	140	139	149	140	140	129	149	1806
6204323	PETAK UJIAN. JITRA	KD	6 16	100 25	5	AP	10	166	185	200	170	150	130	134	138	136	129	118	131	1787
6203324	TELAGA BATU	KD	6 15	100 22	4	AP	8	167	175	193	167	148	127	141	139	129	128	123	143	1780
0619	PEDU DAM	KD	6 14	100 46	59	H	7	148	155	179	174	159	150	154	157	146	143	131	130	1826
6207332	PEDU DAM	KD	6 14	100 46	59	AP	6	196	199	214	172	146	124	139	140	129	126	120	142	1847
0620	ALOR STAR, K. BATAS AIRPORT	KD	6 12	100 25	5	P	11	151	152	177	175	155	145	146	147	143	136	130	130	1787
0635	GAJAH MATI	KD	6 10	100 33	15	H	7	154	159	189	168	169	154	160	164	150	148	135	141	1891
6105337	GAJAH MATI	KD	6 10	100 32	15	AP	8	161	179	197	171	143	119	133	133	123	121	141	129	1723
0638	MUDA DAM	KD	6 7	100 51	110	H	7	141	147	176	162	166	143	146	144	133	121	122	117	1718
6108301	MUDA DAM	KD	6 7	100 51	110	AP	7	186	191	207	173	145	134	146	145	134	124	106	143	1834
0553	SALA KANAN	KD	5 58	100 24	15	H	7	144	146	171	154	140	131	140	140	131	127	121	121	1666
0549	BATU SEKETUL	KD	5 58	100 48	76	H	4	149	152	179	169	150	142	161	142	144	143	122	124	1777
5903351	KUALA SALA	KD	5 58	100 22	3	AP	10	178	173	185	155	140	129	136	141	129	120	123	136	1745
5904352	SIMPANG TIGA, SG. RIMAU	KD	5 55	100 26	3	AP	8	162	171	186	168	155	136	156	149	141	134	127	134	1819
0548	CHAROK PADANG	KD	5 48	100 43	31	H	7	155	160	187	183	182	171	176	178	169	167	152	151	2031
0545	BALING	KD	5 41	100 55	54	H	11	163	161	194	177	179	169	173	180	167	165	149	151	2028
0543	SUNGAI PATANI	KD	5 39	100 30	8	H	11	156	159	185	172	172	163	169	173	161	157	140	142	1949
0540	KULIM	KD	5 23	100 33	32	H	11	151	153	174	159	158	153	158	161	151	148	135	135	1836
0542	BUMBONG LIMA	PW	5 32	100 28	4	H	2	138	133	159	151	154	141	150	154	136	138	121	132	1707
5504332	BUMBONG LIMA	PW	5 33	100 26	4	AP	8	171	181	189	154	152	131	147	140	137	136	125	139	1802
0537	BUTTERWORTH	PW	5 28	100 23	2	H	6	148	147	168	156	152	145	154	157	140	142	129	134	1772
0538	BUKIT MERTAJAM	PW	5 22	100 28	14	H	11	154	155	182	166	165	161	165	162	159	155	140	143	1907
0533	PENANG HILL	PG	5 25	100 16	732	H	11	112	109	127	108	104	100	102	102	95	97	88	94	1238
0532	PENANG TOWN	PG	5 25	100 19	5	H	11	158	161	182	168	159	154	157	159	147	146	139	144	1874
0530	PENANG, BAYAN LEPAS AIRPORT	PG	5 18	100 16	3	P	11	158	154	176	168	151	147	147	147	142	138	136	137	1801
0520	PARIT BUNTAR	PK	5 8	100 30	3	H	11	141	138	156	152	158	149	156	160	159	154	142	141	1806
0505	LENGGONG	PK	5 6	100 58	101	H	11	161	163	190	169	170	157	166	171	166	163	146	144	1966
5006321	JPT, BUKIT MERAH	PK	5 2	100 39	3	AP	10	161	158	169	154	154	157	161	161	141	147	135	141	1839
0503	BAGAN SERAI	PK	5 1	100 32	3	H	11	141	143	159	151	157	155	155	161	154	151	140	135	1802
0445	MAXWELLS HILL	PK	4 52	100 48	1036	H	11	70	78	83	79	82	81	85	89	84	81	70	71	953
0446	TAIPING	PK	4 52	100 44	18	H	11	149	148	166	150	154	157	160	163	154	156	134	137	1828
0447	KUALA KANGSAR	PK	4 46	100 56	39	H	11	161	160	185	175	171	166	168	174	164	161	148	149	1982
0419	TANJUNG RAMBUTAN	PK	4 40	101 10	70	H	11	164	162	191	178	179	168	177	182	172	172	157	155	2057
0418	IPOH AIRPORT	PK	4 34	101 6	39	P	11	148	146	170	162	154	150	150	149	148	141	133	129	1780
0417	BATU GAJAH	PK	4 28	101 2	34	H	7	153	154	174	167	166	159	163	171	167	160	146	143	1923
0416	PARIT	PK	4 26	100 54	19	H	4	150	147	177	161	158	146	151	155	154	158	138	138	1833
0460	N.E.B. JOR	PK	4 22	101 20	604	H	2	131	130	149	129	118	123	134	134	129	125	111	112	1525
0414	KAMPAR	PK	4 18	101 9	37	H	11	151	148	173	162	163	158	164	173	167	167	147	144	1917
0410	SITIAWAN	PK	4 13	100 4	7	P	11	142	141	164	159	151	145	144	147	144	138	129	126	1730
0413	TAPAH	PK	4 12	101 16	35	H	7	155	151	179	170	164	160	168	169	168	163	147	146	1940

STATE CODE: PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN.

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

OPEN WATER EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0402	TELOK ANSON	PK	4 2	101 1	3	H	11	157	149	177	161	162	157	161	170	166	165	146	141	1912
3710306	BAGAN TERAP	SR	3 44	101 5	3	AP	11	143	148	166	150	145	132	138	145	141	143	129	124	1704
0340	TANJUNG MALIM	SR	3 41	101 31	43	H	7	147	146	174	162	162	157	163	164	165	160	149	142	1891
3609313	SUNGEI BESAR	SR	3 40	100 59	3	AP	11	145	148	166	156	153	151	153	157	142	147	135	130	1783
0322	KUALA KUBU BARU	SR	3 34	101 39	61	H	11	156	146	172	165	162	164	161	167	162	163	149	150	1907
3516322	KUALA KUBU BARU	SR	3 34	101 40	90	AP	13	183	163	162	132	142	136	133	130	131	125	125	146	1708
0325	TANJUNG KARANG	SR	3 30	101 12	2	H	7	133	133	153	142	141	136	138	148	143	142	128	124	1661
0312	KEPONG	SR	3 14	101 38	67	H	11	149	150	170	159	152	143	145	151	146	150	135	136	1786
0311	BUKIT NANAS	SR	3 9	101 42	30	H	2	162	163	183	151	160	162	163	188	166	179	149	157	1983
3117370	JPT, AMPANG, KUALA LUMPUR	SR	3 9	101 45	46	AP	10	150	154	172	160	156	141	146	147	135	139	132	132	1764
0310	SUBANG INT. AIRPORT K.L.	SR	3 7	101 33	16	P	11	139	139	160	154	149	141	142	144	143	140	130	124	1705
0306	KLANG HIGH SCHOOL	SR	3 3	101 27	10	H	11	150	148	170	155	155	146	150	161	150	153	142	137	1817
0300	KAJANG	SR	3 0	101 47	40	H	11	160	155	181	166	164	152	159	165	157	161	152	150	1922
0258	ONE FATHOM BANK LIGHTHOUSE	SR	2 53	100 59	21	H	7	98	106	132	127	114	116	128	130	108	122	110	114	1405
0248	JELEBU, KUALA KELAWANG	NS	2 57	102 4	137	H	11	150	144	166	160	160	151	154	161	159	163	148	148	1865
0246	AYER HITAM, BAHAU	NS	2 56	102 24	55	H	2	152	139	179	161	172	158	163	175	168	166	147	150	1930
0244	KUALA PILAH	NS	2 44	102 15	107	H	11	153	152	170	161	161	154	149	162	162	161	142	141	1868
0241	SEREMBAN	NS	2 43	101 56	64	H	11	159	157	180	166	165	152	154	160	159	161	151	147	1911
0240	PORT DICKSON	NS	2 32	101 48	9	H	11	150	146	167	159	153	146	151	155	156	157	144	148	1832
0219	TAMPIN	NS	2 28	102 14	61	H	11	153	152	173	156	152	140	144	150	154	156	142	138	1810
0210	MALACCA AIRPORT	MA	2 16	102 15	7	P	11	147	144	162	157	147	137	138	140	142	141	132	126	1713
0205	MERLIMAU ENGLISH SCHOOL	MA	2 9	102 26	3	H	11	148	145	164	149	138	133	140	143	144	146	140	141	1731
0216	SEGAMAT	JH	2 30	102 49	29	H	11	149	151	176	168	155	148	152	161	160	165	149	140	1874
0206	TANGKAK	JH	2 16	102 32	30	H	7	155	157	176	160	146	139	145	153	155	163	147	147	1843
2125342	KESANG TASEK	JH	2 9	102 32	5	AP	13	139	132	146	138	139	128	131	135	133	131	124	122	1598
0204	MUAR	JH	2 3	102 34	6	H	11	153	146	166	150	144	135	151	154	154	151	145	140	1789
0143	AYER HITAM	JH	1 56	103 11	37	H	6	144	147	172	160	154	144	153	143	147	166	149	143	1822
0140	SUNGAI SUDAH	JH	1 54	102 43	2	H	6	149	144	167	153	152	144	147	149	149	155	144	143	1796
1829378	BATU PAHAT	JH	1 51	102 56	4	AP	9	138	140	148	144	144	135	146	139	129	139	120	131	1653
0134	LAYANG LAYANG	JH	1 49	103 28	30	H	2	140	131	154	141	143	130	145	149	141	154	139	132	1699
0130	PARIT BOTAK	JH	1 43	103 5	5	H	6	156	139	164	148	145	136	144	148	139	154	141	141	1755
0115	PONTIAN KECIL	JH	1 29	103 23	5	H	11	137	131	147	135	136	129	138	133	138	138	128	125	1615
0117	JOHOR BHARU	JH	1 28	103 45	15	H	11	142	130	148	137	135	124	132	138	136	145	135	133	1635
1437316	JPT, JOHOR BHARU	JH	1 29	103 45	30	AP	14	128	126	139	120	123	112	121	119	121	126	112	108	1455
0118	KONG KONG	JH	1 36	103 49	38	H	6	138	134	157	140	137	129	137	136	137	149	133	122	1649
0120	KOTA TINGGI	JH	1 44	103 54	9	H	11	149	147	166	154	155	142	144	149	152	157	144	141	1800
0230	MERSING	JH	2 27	103 50	45	P	11	149	151	172	166	153	143	139	144	149	145	129	121	1761
2636370	ENDAU	JH	2 39	103 37	4	AP	13	125	133	162	150	141	126	133	131	132	125	108	107	1573
2734383	PAYA SEPAYANG	PH	2 44	103 28	6	AP	14	112	121	139	142	141	128	134	136	134	131	114	109	1541
0378	PEKAN	PH	3 29	103 24	4	H	2	129	119	153	144	151	132	151	150	138	143	130	118	1658
3533302	PAHANG TUA	PH	3 34	103 21	5	AP	14	132	130	157	151	156	149	144	151	145	139	120	118	1692
0360	KAMPONG AWAH	PH	3 35	102 30	30	H	7	137	146	172	165	166	153	160	166	160	160	146	142	1873
0320	BENTONG	PH	3 31	101 55	97	H	11	145	144	169	168	173	161	163	172	169	165	155	146	1930

STATE CODE: PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN
JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN;

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

OPEN WATER EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0335	RAUB	PH	3 47	101 51	158	H	7	143	142	169	164	163	154	161	165	163	163	145	128	1860
3818354	RAUB	PH	3 48	101 51	185	AP	8	129	130	151	144	137	137	145	135	125	128	114	122	1597
0420	CAMERON HIGHLANDS T. RATA	PH	4 28	101 23	1471	P	10	101	102	118	110	102	102	104	101	101	97	90	87	1215
0461	KUALA TAHAN	PH	4 23	102 24	610	H	2	139	110	169	156	161	145	148	158	152	149	131	130	1748
0363	SUNGAI TEKAM	PH	3 50	102 34	76	H	2	154	137	168	170	167	156	165	168	165	158	137	144	1889
0380	KUANTAN AIRPORT	PH	3 47	103 13	15	P	11	130	134	156	156	147	141	144	146	147	136	116	106	1659
0381	BUKIT GOH	PH	3 52	103 16	15	H	7	130	137	161	149	156	145	157	157	153	159	133	120	1757
0382	SUNGAI LEMBING	PH	3 55	103 2	70	H	11	137	136	164	164	166	155	162	166	163	161	140	129	1843
0464	SUNGAI BAGING	PH	4 4	103 23	4	H	7	126	128	154	146	155	141	142	152	144	149	119	113	1669
0465	KEMAMAN	TR	4 14	103 27	3	H	11	129	128	150	149	153	140	148	154	148	148	125	119	1691
0476	DUNGUN	TR	4 46	103 25	3	H	8	126	119	158	147	150	141	142	147	144	146	121	117	1658
4734379	DUNGUN	TR	4 46	103 25	6	AP	10	150	152	182	172	161	138	144	154	143	140	116	126	1778
0482	JERANGAU	TR	4 59	103 9	30	H	11	118	119	140	149	152	144	146	151	147	141	110	101	1618
0590	KUALA TRENGGANU	TR	5 20	103 8	35	P	11	137	142	170	177	163	150	150	151	151	141	119	115	1766
5725306	KG. RAJA BESUT	TR	5 48	102 34	4	AP	6	116	136	148	164	153	143	139	142	139	127	107	106	1620
5823301	TIGA DAERAH	KN	5 52	102 19	20	AP	13	121	131	161	173	155	134	138	144	139	129	112	108	1645
0665	KOTA BHARU AGR. STATION	KN	6 3	102 17	5	H	7	128	130	163	161	168	154	162	159	153	143	119	106	1746
6021361	PASIR MAS PUMPHOUSE	KN	6 3	102 10	10	AP	8	123	141	161	159	159	135	133	132	134	128	112	98	1615
0670	KOTA BHARU P. CHEPA AIRPORT	KN	6 10	102 17	5	P	11	144	148	177	185	167	155	155	157	158	143	122	119	1830

STATE CODE: PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN; JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN.

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

FOREST EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0614	KANGAR	PS	6 26	100 12	3	H	11	126	133	157	141	133	119	124	128	123	120	111	115	1530
6401308	JPT, KANGAR	PS	6 27	100 11	3	AP	14	143	157	178	155	127	109	112	114	108	106	100	109	1518
6397311	PG. MATSIRAT, P. LANGKAWI	KD	6 21	99 44	5	AP	13	161	162	174	141	119	111	113	112	110	105	113	134	1555
0602	PULAU LANGKAWI	KD	6 19	99 51	4	H	2	137	144	152	148	133	121	121	130	122	121	112	130	1571
6204323	PETAK UJIAN, JITRA	KD	6 16	100 25	5	AP	11	148	164	178	151	133	116	119	123	120	115	105	116	1588
6203324	TELAGA BATU	KD	6 15	100 22	4	AP	8	148	156	171	149	131	113	126	124	114	113	109	127	1581
0619	PEDU DAM	KD	6 14	100 46	59	H	7	129	135	157	151	139	131	134	137	127	124	114	114	1592
6207332	PEDU DAM	KD	6 14	100 46	59	AP	7	175	176	190	153	130	111	123	124	115	112	107	126	1642
0620	ALOR STAR, K. BATAS AIRPORT	KD	6 12	100 25	5	P	11	130	132	153	152	135	126	128	129	125	118	113	113	1554
0635	GAJAH MATI	KD	6 10	100 33	15	H	7	134	139	165	147	147	134	140	143	131	129	118	123	1650
6105337	GAJAH MATI	KD	6 10	100 32	15	AP	8	143	159	175	152	127	106	118	118	109	108	102	115	1532
0638	MUDA DAM	KD	6 7	100 51	110	H	7	123	128	154	141	145	124	127	125	115	105	106	102	1495
6108301	MUDA DAM	KD	6 7	100 51	110	AP	7	165	170	184	154	129	119	129	128	119	111	94	727	1629
0553	SALA KANAN	KD	5 58	100 24	15	H	7	126	127	149	134	121	114	122	122	114	110	105	106	1450
0549	BATU SEKETUL	KD	5 58	100 48	76	H	4	130	132	156	147	131	123	140	124	125	125	106	108	1547
5903351	KUALA SALA	KD	5 58	100 22	3	AP	10	158	154	164	138	125	115	121	125	115	107	109	121	1552
5904352	SIMPANG TIGA, SG. RIMAU	KD	5 55	100 26	3	AP	8	144	151	165	149	138	121	138	132	125	120	113	119	1615
0548	CHAROK PADANG	KD	5 48	100 43	31	H	7	134	140	163	160	159	149	154	155	148	146	133	132	1773
0545	BALING	KD	5 41	100 55	54	H	11	142	141	169	154	156	147	151	157	146	144	129	131	1767
0543	SUNGAI PATANI	KD	5 39	100 30	8	H	11	136	139	161	150	150	142	147	151	141	137	122	123	1699
0540	KULIM	KD	5 23	100 33	32	H	11	131	133	152	138	138	133	138	140	131	129	117	118	1598
0542	BUMBONG LIMA	PW	5 32	100 28	4	H	2	120	116	139	131	134	123	131	134	119	120	106	115	1488
5504332	BUMBONG LIMA	PW	5 33	100 26	4	AP	8	151	161	168	137	135	116	130	124	122	121	112	124	1601
0537	BUTTERWORTH	PW	5 28	100 23	2	H	6	129	128	146	136	132	127	134	137	122	124	112	117	1544
0538	BUKIT MERTAJAM	PW	5 22	100 28	14	H	11	134	135	159	145	144	141	144	141	139	135	122	125	1664
0533	PENANG HILL	PG	5 25	100 16	732	H	11	97	95	110	94	91	87	89	88	82	84	77	82	1076
0532	PENANG TOWN	PG	5 25	100 19	5	H	11	138	141	159	147	139	134	137	138	128	127	121	125	1634
0530	PENANG , BAYAN LEPAS AIRPORT	PG	5 18	100 16	3	P	11	137	134	153	146	132	129	128	128	124	120	119	120	1570
0520	PARIT BUNTAR	PK	5 8	100 30	3	H	11	123	120	136	133	138	130	136	139	139	134	124	123	1575
0505	LENGGONG	PK	5 6	100 58	101	H	11	141	142	166	148	148	137	145	149	145	142	127	125	1715
5006321	JPT, BUKIT MERAH	PK	5 2	100 39	3	AP	10	143	140	150	137	137	139	143	143	125	131	120	125	1633
0503	BAGAN SERAI	PK	5 1	100 32	3	H	11	123	124	139	132	137	135	135	141	135	131	122	118	1572
0445	MAXWELLS HILL	PK	4 52	100 48	1036	H	11	61	68	73	69	71	70	74	78	73	71	61	61	830
0446	TAIPING	PK	4 52	100 44	18	H	11	130	129	145	130	135	137	140	142	134	136	117	119	1594
0447	KUALA KANGSAR	PK	4 46	100 56	39	H	11	140	140	162	152	149	145	147	152	143	141	129	129	1729
0419	TANJUNG RAMBUTAN	PK	4 40	101 10	70	H	11	143	141	167	155	156	147	154	159	150	150	137	135	1794
0418	IPOH AIRPORT	PK	4 34	101 6	39	P	11	129	128	148	142	134	131	131	131	130	123	116	112	1555
0417	BATU GAJAH	PK	4 28	101 2	34	H	7	134	134	152	146	145	138	142	149	146	140	127	125	1678
0416	PARIT	PK	4 26	100 54	19	H	4	131	128	154	140	138	128	132	135	134	137	120	120	1597
0460	N.E.B. JOR	PK	4 22	101 20	604	H	2	114	113	130	113	103	107	117	117	113	109	97	97	1330
0414	KAMPAR	PK	4 18	101 9	37	H	11	131	129	151	142	142	138	143	150	146	146	128	126	1672
0410	SITIAWAN	PK	4 13	100 4	7	P	11	123	123	142	139	132	127	126	128	126	120	113	110	1509
0413	TAPAH	PK	4 12	101 16	35	H	7	136	131	156	148	143	139	146	148	147	142	128	128	1692

STATE CODE: PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG-PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN; JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

FOREST EVAPORATION

SITE NO	SITE NAME	ST	LAT		LONG		ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0402	TELOK ANSON	PK	4	2	101	1	3	H	11	137	130	154	141	141	137	140	148	144	144	127	123	1666
3710306	BAGAN TERAP	SR	3	44	101	5	3	AP	12	128	131	147	133	129	118	123	128	126	127	115	110	1515
0340	TANJUNG MALIM	SR	3	41	101	31	43	H	7	128	127	152	141	141	137	142	143	144	140	130	124	1649
3609313	SUNGEI BESAR	SR	3	40	100	59	3	AP	11	129	131	148	139	136	134	136	140	126	130	120	116	1585
0322	KUALA KUBU BARU	SR	3	34	101	39	61	H	11	136	127	150	144	141	135	140	146	142	142	129	131	1663
3516322	KUALA KUBU BARU	SR	3	34	101	40	90	AP	13	163	145	143	118	126	121	118	116	117	111	111	130	1519
0325	TANJUNG KARANG	SR	3	30	101	12	2	H	7	116	116	133	124	123	118	120	129	125	124	112	108	1448
0312	KEPONG	SR	3	14	101	38	67	H	11	130	130	148	138	133	125	126	131	127	131	118	118	1555
0311	BUKIT NANAS	SR	3	9	101	42	30	H	2	141	143	160	132	139	141	142	164	145	156	129	137	1729
3117370	JPT, AMPANG, KUALA LUMPUR	SR	3	9	101	45	46	AP	10	133	137	153	142	139	125	130	131	120	124	117	118	1569
0310	SUBANG INT. AIRPORT	SR	3	7	101	33	16	P	11	121	121	139	134	130	123	123	125	125	122	114	109	1486
0306	KLANG HIGH SCHOOL	SR	3	3	101	27	10	H	11	131	129	148	136	135	127	131	141	131	133	123	119	1584
0300	KAJANG	SR	3	0	101	47	40	H	11	140	135	158	145	143	133	138	144	137	140	133	131	1677
0258	ONE FATHOM BANK LIGHTHOUSE	SR	2	53	100	59	21	H	7	85	92	115	110	99	101	111	113	94	106	96	99	1221
0248	JELEBU, KUALA KELAWANG	NS	2	57	102	4	137	H	11	130	126	145	140	139	131	134	140	139	142	129	130	1625
0246	AYER HITAM, BAHAU	NS	2	56	102	24	55	H	2	132	121	157	140	150	137	142	153	147	145	128	130	1682
0244	KUALA PILAH	NS	2	44	102	15	107	H	11	133	132	148	140	141	134	129	142	142	140	124	122	1627
0241	SEREMBAN	NS	2	43	101	56	64	H	11	139	136	157	145	144	133	134	140	139	141	132	129	1669
0240	PORT DICKSON	NS	2	32	101	48	9	H	11	131	127	146	138	133	127	132	135	136	137	125	129	1596
0219	TAMPIN	NS	2	28	102	14	61	H	11	133	132	151	136	132	122	126	131	134	136	124	120	1577
0210	MALACCA AIRPORT	MA	2	16	102	15	7	P	11	128	126	141	137	128	119	119	122	124	123	115	111	1493
0205	MERLIMAU ENGLISH SCHOOL	MA	2	9	102	26	3	H	11	129	126	143	130	120	116	122	124	126	127	122	123	1508
0216	SEGAMAT	JH	2	30	102	49	29	H	11	130	132	164	147	135	129	132	141	140	144	129	122	1635
0206	TANGKAK	JH	2	16	102	32	30	H	7	135	137	154	140	127	121	126	133	135	142	128	128	1606
2125342	KESANG TASEK	JH	2	9	102	32	5	AP	13	124	117	130	123	124	114	116	120	118	116	110	108	1420
0204	MUAR	JH	2	3	102	34	6	H	11	133	128	145	131	125	118	132	134	134	132	126	122	1560
0143	AYER HITAM	JH	1	56	103	11	37	H	6	126	128	150	139	135	125	134	125	128	144	131	125	1590
0140	SUNGAI SUDAH	JH	1	54	102	43	2	H	6	129	125	146	133	132	125	128	130	130	135	126	124	1563
1829378	BATU PAHAT	JH	1	51	102	56	4	AP	9	122	124	131	127	128	120	129	124	115	123	107	116	1466
0134	LAYANG LAYANG	JH	1	49	103	28	30	H	2	122	115	135	122	124	114	126	130	123	134	121	114	1480
0130	PARIT BOTAK	JH	1	43	103	5	5	H	6	136	121	143	129	127	119	125	129	121	134	122	123	1529
0115	PONTIAN KECIL	JH	1	29	103	23	5	H	11	119	114	128	117	119	112	120	116	120	120	111	109	1405
0117	JOHOR BHARU	JH	1	28	103	45	15	H	11	124	113	129	120	118	108	114	120	119	126	118	116	1425
1437316	JPT, JOHOR BHARU	JH	1	29	103	45	30	AP	14	114	112	124	106	109	100	107	106	108	112	99	96	1293
0118	KONG KONG	JH	1	36	103	49	38	H	6	120	116	137	121	119	113	120	119	119	130	116	106	1436
0120	KOTA TINGGI	JH	1	44	103	54	9	H	11	130	128	145	134	135	124	126	130	132	136	126	122	1568
0230	MERSING	JH	2	27	103	50	45	P	11	132	133	151	145	134	125	121	125	130	127	113	107	1543
2636370	ENDAU	JH	2	39	103	37	4	AP	14	111	118	144	133	126	112	118	116	117	111	96	95	1397
2734383	PAYA SEPAYANG	PH	2	44	103	28	6	AP	14	100	107	123	126	125	114	119	121	119	116	101	97	1368
0378	PEKAN	PH	3	29	103	24	4	H	2	113	104	133	126	131	114	132	131	120	124	113	103	1444
3533302	PAHANG TUA	PH	3	34	103	21	5	AP	14	117	115	140	134	138	132	128	134	129	123	107	105	1502
0360	KAMPONG AWAH	PH	3	35	102	30	30	H	7	120	127	150	144	144	133	139	144	140	139	127	124	1631
0320	BENTONG	PH	3	31	101	55	97	H	11	126	125	147	146	151	140	142	150	148	144	135	127	1681

STATE CODE PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN; JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

FOREST EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0335	RAUB	PH	3 47	101 51	158	H	7	124	123	147	143	142	135	140	144	142	142	126	112	1620
3818354	RAUB	PH	3 48	101 51	185	AP	8	114	116	134	128	122	122	129	120	111	113	101	108	1418
0420	CAMERON HIGHLANDS T. RATA	PH	4 28	101 23	1471	P	10	87	88	102	95	88	88	89	87	87	84	78	75	1048
0461	KUALA TAHAN	PH	4 23	102 24	610	H	2	121	96	148	136	140	126	129	138	133	130	114	114	1525
0363	SUNGAI TEKAM	PH	3 50	102 34	76	H	2	135	119	147	148	146	136	143	147	143	138	119	126	1647
0380	KUANTAN AIRPORT	PH	3 47	103 13	15	P	11	113	116	136	136	128	123	126	127	128	118	101	93	1445
0381	BUKIT GOH	PH	3 52	103 16	15	H	7	114	119	141	130	136	127	137	137	133	138	116	104	1532
0382	SUNGAI LEMBING	PH	3 55	103 2	70	H	11	120	118	144	144	145	135	141	145	142	140	122	112	1608
0464	SUNGAI BAGING	PH	4 4	103 23	4	H	7	110	112	134	128	135	123	125	133	125	130	104	99	1458
0465	KEMAMAN	TR	4 14	103 27	3	H	11	112	111	131	130	134	122	129	134	129	129	109	104	1474
0476	DUNGUN	TR	4 46	103 25	3	H	8	110	103	138	127	131	123	124	128	125	127	105	102	1443
4734379	DUNGUN	TR	4 46	103 25	6	AP	10	134	135	162	153	143	122	128	137	127	125	103	112	1581
0482	JERANGAU	TR	4 59	103 9	30	H	11	102	104	122	130	132	126	127	131	128	123	96	88	1409
0590	KUALA TRENGGANU	TR	5 20	103 8	35	P	11	119	123	148	153	142	131	131	132	132	123	104	100	1538
5725306	KG. RAJA BESUT	TR	5 48	102 34	4	AP	6	103	121	132	146	136	127	123	126	123	113	94	94	1438
5823301	TIGA DAERAH	KN	5 52	102 19	20	AP	13	108	116	143	154	138	119	122	128	124	115	100	96	1463
0665	KOTA BHARU AGR. STATION	KN	6 3	102 17	5	H	7	112	113	141	140	147	134	142	138	134	124	103	93	1521
6021361	PASIR MAS PUMPHOUSE	KN	6 3	102 10	10	AP	8	110	125	143	141	141	120	118	118	119	114	99	87	1435
0670	KOTA BHARU P. CHEPA AIRPORT	KN	6 10	102 17	5	P	11	125	129	154	160	146	135	135	136	138	125	106	144	1593

STATE CODE: PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN;
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METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

GRASS EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0614	KANGAR	PS	6 26	100 12	3	H	11	114	121	143	128	121	108	112	116	111	109	101	104	1388
6401308	JPT, KANGAR	PS	6 27	100 11	3	AP	14	134	147	167	145	119	102	105	107	101	99	93	102	1421
6397311	PG. MATSIRAT, P. LANGKAWI	KD	6 21	99 44	5	AP	13	151	152	164	132	111	104	106	105	104	98	106	126	1459
0602	PULAU LANGKAWI	KD	6 19	99 51	4	H	2	125	130	138	134	121	110	110	118	111	110	102	118	1427
6204323	PETAK UJIAN, JITRA	KD	6 16	100 25	5	AP	11	139	154	167	142	125	108	112	115	113	108	99	109	1491
6203324	TELAGA BATU	KD	6 15	100 22	4	AP	8	139	146	161	139	123	106	118	116	107	106	103	119	1483
0619	PEDU DAM	KD	6 14	100 46	59	H	7	117	123	142	137	126	118	122	124	115	113	103	103	1443
6207332	PEDU DAM	KD	6 14	100 46	59	AP	7	164	166	178	143	122	104	116	117	108	105	100	118	1541
0620	ALOR STAR, K. BATAS AIRPORT	KD	6 12	100 25	5	P	11	117	119	138	137	122	115	116	117	114	107	102	102	1406
0635	GAJAH MATI	KD	6 10	100 33	15	H	7	122	126	149	133	133	122	127	129	119	117	107	112	1496
6105337	GAJAH MATI	KD	6 10	100 32	15	AP	8	134	149	164	142	119	100	111	111	103	101	96	108	1438
0638	MUDA DAM	KD	6 7	100 51	110	H	7	111	116	139	128	131	113	115	114	105	95	96	92	1355
6108301	MUDA DAM	KD	6 7	100 51	110	AP	7	155	159	173	144	121	112	121	121	112	104	88	119	1529
0553	SALA KANAN	KD	5 58	100 24	15	H	7	114	115	136	121	110	103	111	111	103	100	95	96	1315
0549	BATU SEKETUL	KD	5 58	100 48	76	H	4	118	120	142	134	119	112	127	112	114	113	96	98	1405
5903351	KUALA SALA	KD	5 58	100 22	3	AP	10	149	144	164	129	117	108	113	118	108	101	102	141	1457
5904352	SIMPANG TIGA, SG. RIMAU	KD	5 55	100 26	3	AP	8	135	142	155	140	129	113	130	124	118	112	106	112	1516
0548	CHAROK PADANG	KD	5 48	100 43	31	H	7	122	127	148	145	144	135	139	141	134	132	120	120	1607
0545	BALING	KD	5 41	100 55	54	H	11	129	128	153	140	142	134	137	142	132	131	117	119	1604
0543	SUNGAI PATANI	KD	5 39	100 30	8	H	11	123	126	146	136	136	129	134	137	128	124	111	112	1542
0540	KULIM	KD	5 23	100 33	32	H	11	119	121	138	125	125	121	125	127	119	117	106	107	1450
0542	BUMBONG LIMA	PW	5 32	100 28	4	H	2	109	105	126	119	122	111	119	122	107	109	96	104	1349
5504332	BUMBONG LIMA	PW	5 33	100 26	4	AP	8	142	151	158	129	127	109	122	116	114	113	105	116	1502
0537	BUTTERWORTH	PW	5 28	100 23	2	H	6	117	116	133	124	120	115	122	124	110	112	102	106	1401
0538	BUKIT MERTAJAM	PW	5 22	100 28	14	H	11	122	122	144	131	131	128	130	128	126	122	111	113	1508
0533	PENANG HILL	PG	5 25	100 16	732	H	11	88	86	100	86	82	79	81	80	74	76	69	74	975
0532	PENANG TOWN	PG	5 25	100 19	5	H	11	125	127	144	133	126	122	124	125	115	115	109	114	1480
0530	PENANG, BAYAN LEPAS AIRPORT	PG	5 18	100 16	3	P	11	124	121	139	133	120	117	117	117	113	109	108	109	1427
0520	PARIT BUNTAR	PK	5 8	100 30	3	H	11	111	109	124	120	125	118	123	126	126	122	112	111	1427
0505	LENGGONG	PK	5 6	100 58	101	H	11	127	129	151	134	134	124	131	136	131	129	116	113	1555
5006321	JPT, BUKIT MERAH	PK	5 2	100 39	3	AP	10	134	131	141	128	129	131	134	134	117	122	113	117	1531
0503	BAGAN SERAI	PK	5 1	100 32	3	H	11	111	113	126	119	124	123	122	127	122	119	110	107	1423
0445	MAXWELLS HILL	PK	4 52	100 48	1036	H	11	55	61	66	62	64	64	67	70	66	64	55	56	750
0446	TAIPING	PK	4 52	100 44	18	H	11	118	117	131	118	122	124	127	129	121	124	106	108	1445
0447	KUALA KANGSAR	PK	4 46	100 56	39	H	11	127	127	147	138	135	132	133	138	130	128	117	117	1569
0419	TANJUNG RAMBUTAN	PK	4 40	101 10	70	H	11	130	128	151	141	142	133	140	144	136	136	124	122	1627
0418	IPOH AIRPORT	PK	4 34	101 6	39	P	11	117	115	135	129	122	119	119	119	118	112	105	102	1412
0417	BATU GAJAH	PK	4 28	101 2	34	H	7	121	122	138	133	131	125	129	135	132	127	115	113	1521
0416	PARIT	PK	4 26	100 54	19	H	4	119	116	140	127	125	116	119	122	122	125	109	109	1449
0460	N.E.B. JOR	PK	4 22	101 20	604	H	2	103	103	118	102	93	97	106	106	102	99	88	88	1205
0414	KAMPAR	PK	4 18	101 9	37	H	11	119	117	137	128	129	125	130	137	132	132	116	114	1516
0410	SITIAWAN	PK	4 13	100 4	7	P	11	112	111	129	126	119	115	114	116	115	109	102	100	1368
0413	TAPAH	PK	4 12	101 16	35	H	7	123	119	142	134	130	126	133	134	133	129	116	116	1535

STATE CODE: PS–PERLIS: KE–KEDAH; TW–PROVINCE WELLESLEY PG–PENANG; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN;
JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

GRASS EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0402	TELOK ANSON	PK	4 2	101 1	3	H	11	124	118	140	128	128	124	127	135	131	130	115	111	1511
3710306	BAGAN TERAP	SR	3 44	101 5	3	AP	12	120	123	138	125	121	111	116	121	118	119	108	104	1424
0340	TANJUNG MALIM	SR	3 41	101 31	43	H	7	116	115	138	128	128	124	129	130	131	127	118	112	1496
3609313	SUNGEI BESAR	SR	3 40	100 59	3	AP	11	121	123	139	130	128	126	127	131	118	122	113	109	1487
0322	KUALA KUBU BARU	SR	3 34	101 39	61	H	11	123	115	136	131	128	122	127	132	128	129	117	119	1507
3516322	KUALA KUBU BARU	SR	3 34	101 40	90	AP	13	153	136	135	110	118	114	111	108	110	104	104	122	1425
0325	TANJUNG KARANG	SR	3 30	101 12	2	H	7	105	105	121	113	112	107	109	117	113	112	101	98	1313
0312	KEPONG	SR	3 14	101 38	67	H	11	118	118	134	125	121	133	114	119	115	119	107	107	1410
0311	BUKIT NANAS	SR	3 9	101 42	30	H	2	128	129	145	120	126	128	129	149	132	141	117	124	1568
3117370	JPT, AMPANG, KUALA LUMPUR	SR	3 9	101 45	46	AP	10	125	128	143	133	130	117	122	123	112	116	110	110	1469
0310	SUBANG INT. AIRPORT K.L.	SR	3 7	101 33	16	P	11	109	109	126	121	117	111	112	113	113	111	103	98	1343
0306	KLANG HIGH SCHOOL	SR	3 3	101 27	10	H	11	119	117	134	123	122	115	118	128	119	121	112	108	1436
0300	KAJANG	SR	3 0	101 47	40	H	11	126	122	144	131	130	120	125	131	124	127	120	119	1519
0258	ONE FATHOM BANK LIGHTHOUSE	SR	2 53	100 59	21	H	7	77	84	104	100	90	91	101	102	85	96	87	90	1107
0248	JELEBU, KUALA KELAWANG	NS	2 57	102 4	137	H	11	118	114	131	127	126	119	122	127	126	129	117	118	1474
0246	AYER HITAM, BAHAU	NS	2 56	102 24	55	H	2	120	110	142	127	136	125	129	139	133	132	116	118	1527
0244	KUALA PILAH	NS	2 44	102 15	107	H	11	120	120	135	127	127	121	117	128	128	127	113	111	1474
0241	SEREMBAN	NS	2 43	101 56	64	H	11	126	124	143	132	131	120	122	127	126	128	119	117	1515
0240	PORT DICKSON	NS	2 32	101 48	9	H	11	119	115	132	125	121	115	119	123	124	124	113	117	1447
0219	TAMPIN	NS	2 28	102 14	61	H	11	121	120	137	123	120	111	114	118	122	124	112	109	1431
0210	MALACCA AIRPORT	MA	2 16	102 15	7	P	11	116	114	128	124	116	108	108	110	112	112	104	100	1352
0205	MERLIMAU ENGLISH SCHOOL	MA	2 9	102 26	3	H	11	117	115	130	118	109	105	110	113	114	115	111	111	1368
0216	SEGAMAT	JH	2 30	102 49	29	H	11	118	120	139	133	123	117	120	128	127	130	117	111	1483
0206	TANGKAK	JH	2 16	102 32	30	H	7	123	124	140	127	115	110	114	121	122	129	116	116	1457
2125342	KESANG TASEK	JH	2 9	102 32	5	AP	13	116	110	122	115	116	107	109	112	111	109	103	101	1331
0204	MUAR	JH	2 3	102 34	6	H	11	121	116	132	119	114	107	119	122	122	119	114	110	1415
0143	AYER HITAM	JH	1 56	103 11	37	H	6	114	116	136	126	122	114	121	113	116	131	118	113	1440
0140	SUNGAI SUDAH	JH	1 54	102 43	2	H	6	117	114	132	121	120	114	116	118	118	123	114	113	1420
1829378	BATU PAHAT	JH	1 51	102 56	4	AP	9	115	117	123	120	120	112	121	116	108	116	100	109	1377
0134	LAYANG LAYANG	JH	1 49	103 28	30	H	2	111	104	122	111	113	103	114	118	111	121	110	104	1342
0130	PARIT BOTAK	JH	1 43	103 5	5	H	6	123	110	130	117	115	108	114	117	109	122	111	112	1388
0115	PONTIAN KECIL	JH	1 29	103 23	5	H	11	108	103	116	106	108	102	109	105	109	109	101	99	1275
0117	JOHOR BHARU	JH	1 28	103 45	15	H	11	112	103	117	108	107	98	104	109	108	114	107	105	1292
1437316	JPT, JOHOR BHARU	JH	1 29	103 45	30	AP	14	107	105	116	100	102	94	101	100	101	105	93	90	1214
0118	KONG KONG	JH	1 36	103 49	38	H	6	109	105	124	110	108	102	108	108	108	118	105	96	1301
0120	KOTA TINGGI	JH	1 44	103 54	9	H	11	118	116	131	122	123	112	114	118	120	124	114	111	1423
0230	MERSING	JH	2 27	103 50	45	P	11	121	121	137	131	121	113	110	114	118	115	103	97	1401
2636370	ENDAU	JH	2 39	103 37	4	AP	14	104	111	135	125	118	105	111	109	110	105	90	90	1313
2734383	PAYA SEPAYANG	PH	2 44	103 28	6	AP	14	94	101	116	118	117	107	112	114	112	109	95	91	1286
0378	PEKAN	PH	3 29	103 24	4	H	2	102	94	121	114	119	104	120	119	109	113	102	93	1310
3533302	PAHANG TUA	PH	3 34	103 21	5	AP	14	110	108	131	126	130	124	120	126	121	116	100	99	1411
0360	KAMPONG AWAH	PH	3 35	102 30	30	H	7	108	115	136	130	131	120	126	131	127	126	115	112	1477
0320	BENTONG	PH	3 31	101 55	97	H	11	114	114	134	133	137	127	129	136	134	131	122	115	1526

STATE CODE: PS–PERLIS; KD–KEDAH. PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN;
JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN.

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

HYDROLOGY BRANCH JPT MALAYSIA

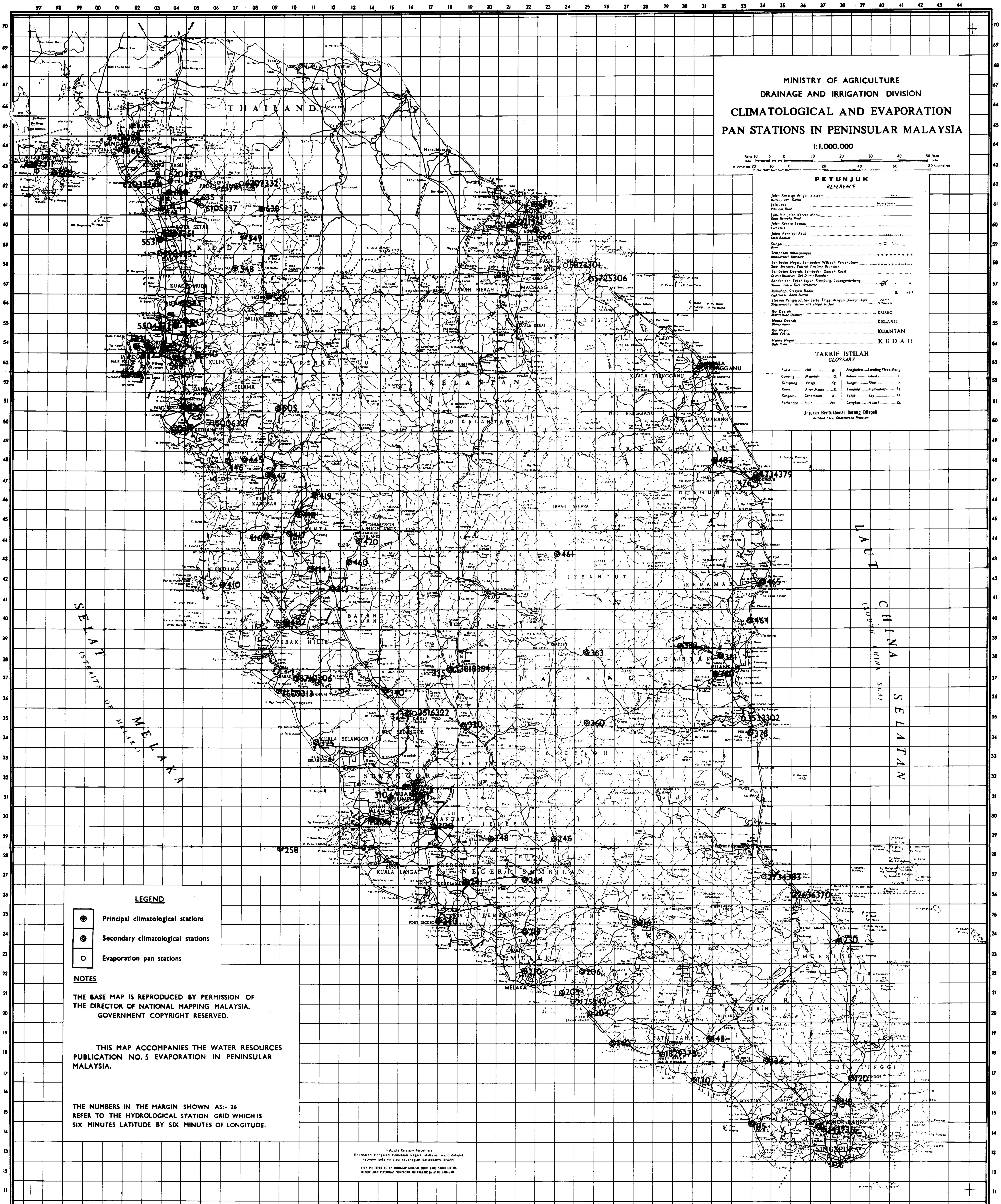
GRASS EVAPORATION

SITE NO	SITE NAME	ST	LAT	LONG	ELEV	MD	NY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0335	RAUB	PH	3 47	101 51	158	H	7	113	112	133	130	129	122	127	131	129	129	115	101	1471
3818354	RAUB	PH	3 48	101 51	185	AP	8	107	109	126	120	114	114	121	113	104	106	95	101	1330
0420	CAMERON HIGHLANDS T. RATA	PH	4 28	101 23	1471	P	10	78	79	92	86	79	79	80	78	79	76	71	68	945
0461	KUALA TAHAN	PH	4 23	102 24	610	H	2	110	87	134	123	127	114	117	125	120	118	103	103	1381
0363	SUNGAI TEKAM	PH	3 50	102 34	76	H	2	122	108	133	134	132	123	130	133	130	125	108	114	1492
0380	KUANTAN AIRPORT	PH	3 47	103 13	15	P	11	102	105	123	123	116	111	114	115	116	107	92	84	1308
0381	BUKIT GOH	PH	3 52	103 16	15	H	7	103	108	128	118	124	115	124	125	121	126	105	94	1391
0382	SUNGAI LEMBING	PH	3 55	103 2	70	H	11	108	107	130	130	131	122	128	132	129	127	111	101	1456
0464	SUNGAI BAGING	PH	4 4	103 23	4	H	7	100	101	122	116	122	111	113	120	114	118	94	89	1320
0465	KEMAMAN	TR	4 14	103 27	3	H	11	102	101	119	118	121	111	117	121	117	117	99	94	1337
0476	DUNGUN	TR	4 46	103 25	3	H	8	99	94	125	116	118	111	112	116	114	115	96	93	1309
4734379	DUNGUN	TR	4 46	103 25	6	AP	10	125	127	152	143	135	115	121	128	119	117	97	105	1484
0482	JERANGAU	TR	4 59	103 9	30	H	11	93	94	111	118	120	114	115	119	116	111	87	80	1278
0590	KUALA TRENGGANU	TR	5 20	103 8	35	P	11	108	111	133	138	128	119	118	119	120	111	95	92	1392
5725306	KG. RAJA BESUT	TR	5 48	102 34	4	AP	6	97	113	124	137	128	119	116	118	116	106	89	89	1352
5823301	TIGA DAERAH	KN	5 52	102 19	20	AP	13	101	109	135	145	130	112	115	120	116	108	94	90	1375
0665	KOTA BHARU AGR. STATION	KN	6 3	102 17	5	H	7	101	103	128	127	133	122	128	125	121	113	94	84	1379
6021361	PASIR MAS PUMPHOUSE	KN	6 3	102 10	10	AP	8	103	117	134	132	113	132	111	110	112	107	93	82	1346
0670	KOTA BHARU P. CHEPA AIRPORT	KN	6 10	102 17	5	P	11	114	116	139	145	132	123	122	124	125	114	97	95	1446

STATE CODE: PS–PERLIS; KD–KEDAH; PW–PROVINCE WELLESLEY; PG–PENANG; PK–PERAK; SR–SELANGOR; MA–MELAKA; NS–NEGERI SEMBILAN; JH–JOHOR; PH–PAHANG; TR–TRENGGANU; KN–KELANTAN

METHOD CODE: P–PENMAN; H–HARGREAVES; AP–CLASS A EVAPORATION PAN

FIG. 1


MINISTRY OF AGRICULTURE
DRAINAGE AND IRRIGATION DIVISION
CLIMATOLOGICAL AND EVAPORATION PAN STATIONS IN PENINSULAR MALAYSIA
1:1,000,000
PETUNJUK
REFERENCE
TAKRIF ISTILAH
GLOSSARY
LEGEND
Principal climatological stations
Secondary climatological stations
Evaporation pan stations
NOTES
THE BASE MAP IS REPRODUCED BY PERMISSION OF THE DIRECTOR OF NATIONAL MAPPING MALAYSIA. GOVERNMENT COPYRIGHT RESERVED.
THIS MAP ACCOMPANIES THE WATER RESOURCES PUBLICATION NO. 5 EVAPORATION IN PENINSULAR MALAYSIA.
THE NUMBERS IN THE MARGIN SHOWN AS:- 26 REFER TO THE HYDROLOGICAL STATION GRID WHICH IS SIX MINUTES LATITUDE BY SIX MINUTES OF LONGITUDE.
THAILAND
SELAT MELAKA
(STRAITS OF MALAKA)
LAUT CHINA SELATAN
(SOUTH CHINA SEA)
STATION GRID NUMBER - FIRST DIGIT PAIR
STATION GRID NUMBER - SECOND DIGIT PAIR

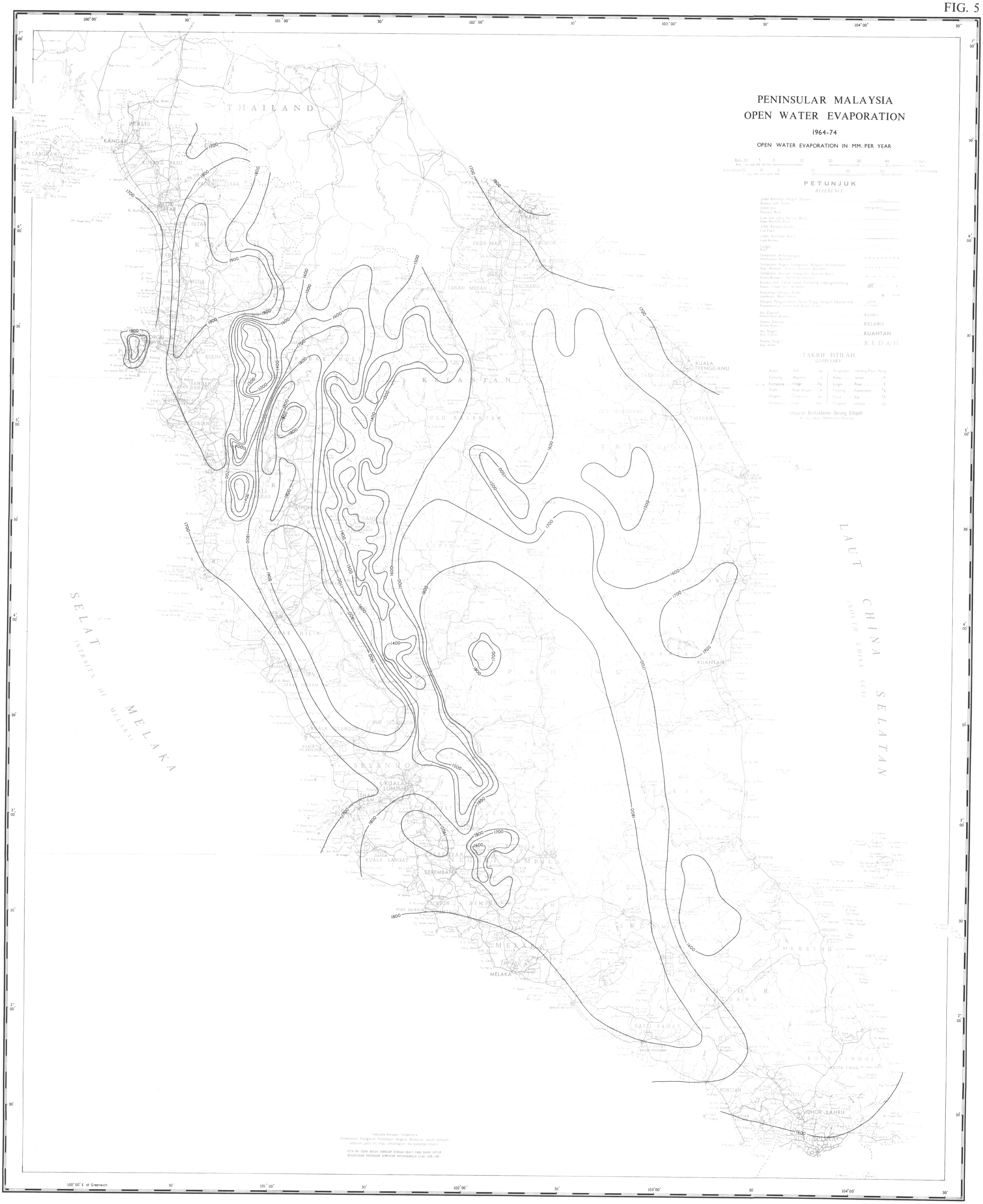


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FIG. 6

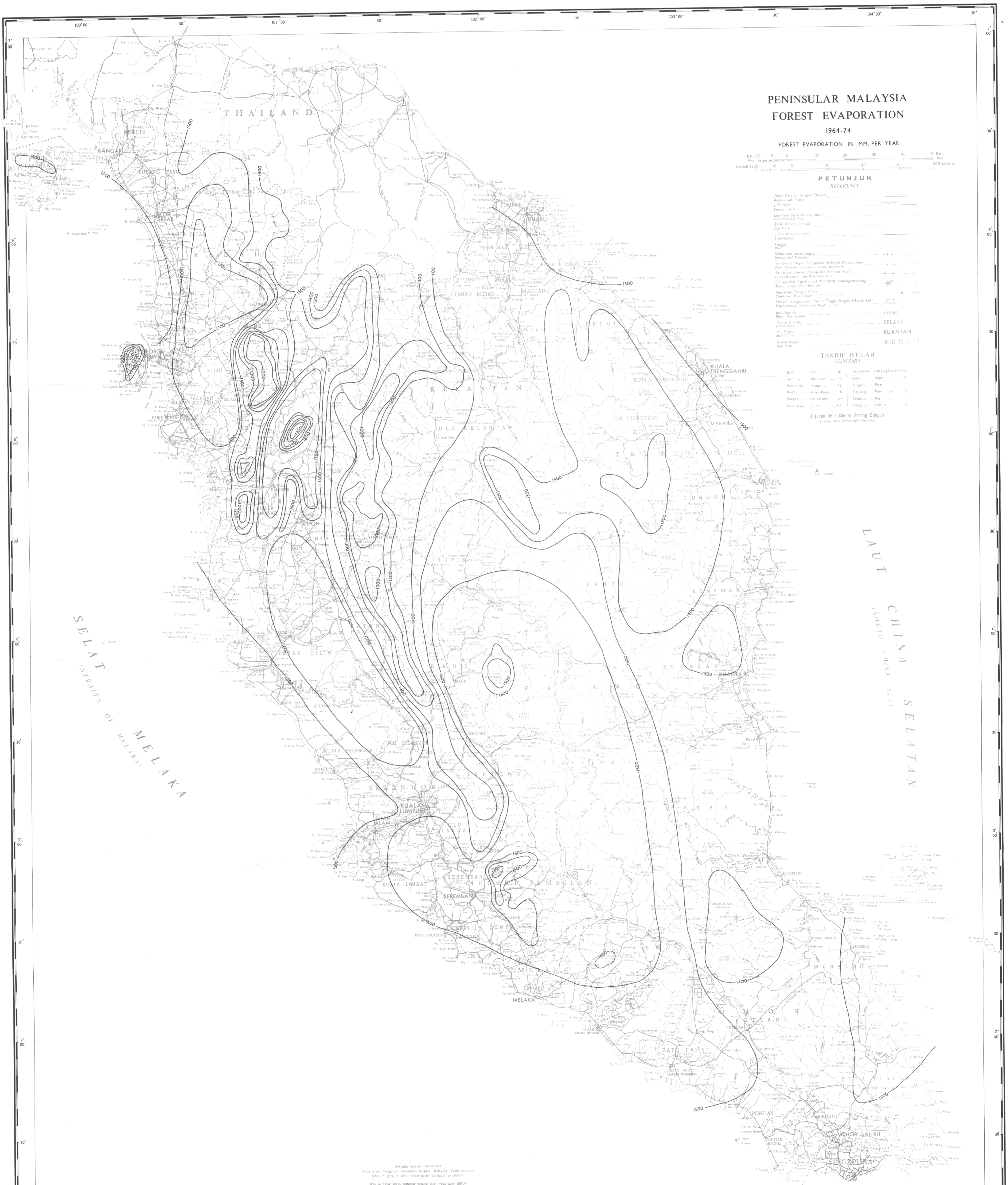
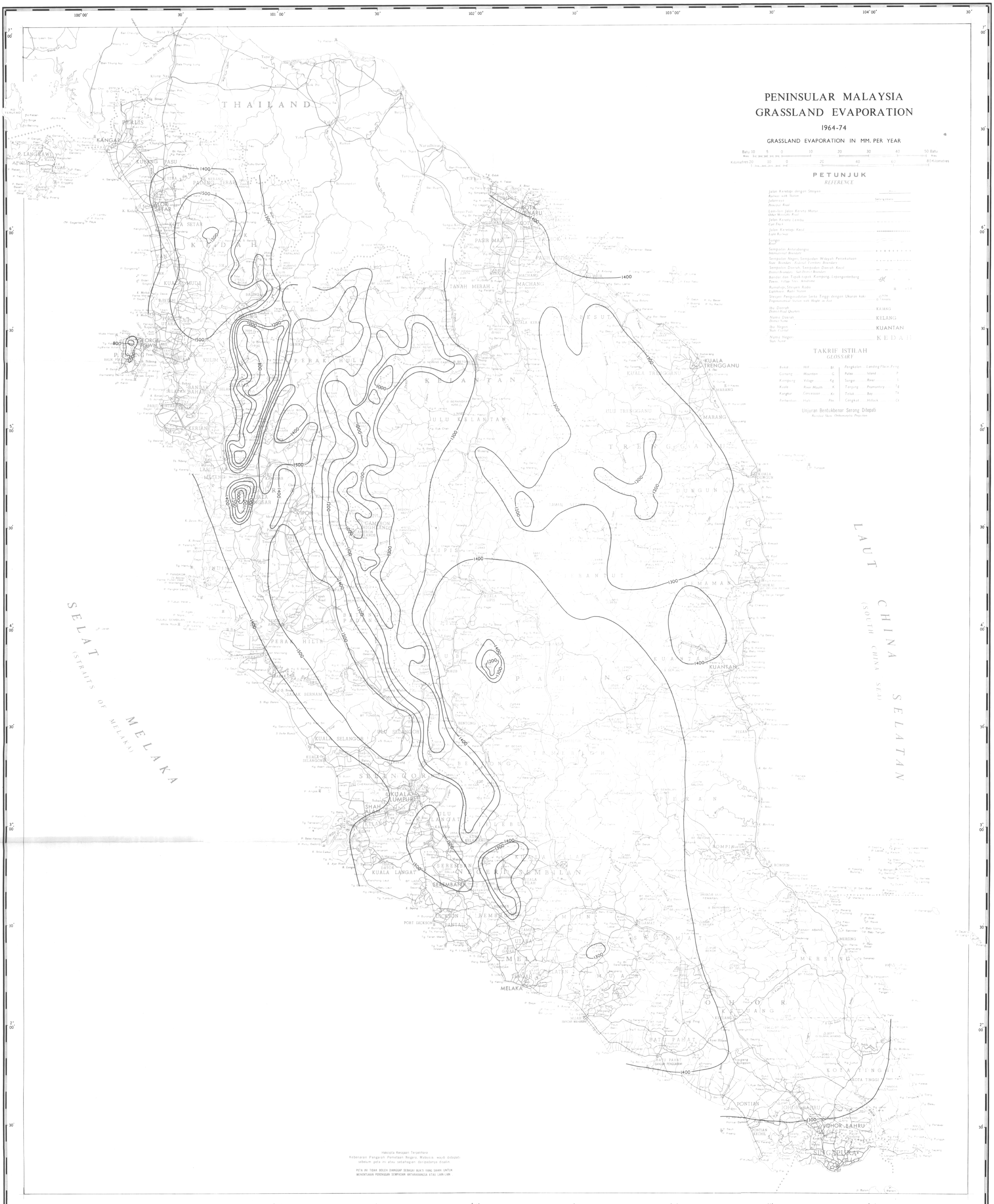

PENINSULAR MALAYSIA
FOREST EVAPORATION
1964-74
FOREST EVAPORATION IN MM. PER YEAR
PETUNJUK
REFERENCE
TAKRIF ISTILAH
GLOSSARY
THAILAND
SELAT MELAKA
(STRAITS OF MELAKA)
LAUT CHINA SELATAN
(SOUTH CHINA SEA)
KELANTAN
TRENGGANU
PAHANG
SELANGOR
KUALA LUMPUR
MELAKA
JOHOR
KUANTAN
KUALA TRENGGANU
KOTA BHARU
SINGAPURA

FIG. 7



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