UNIVERSITI PUTRA MALAYSIA

LAND EVALUATION SYSTEM FOR ELAEIS GUINEENSIS JACQ. CULTIVATION IN PENINSULAR MALAYSIA

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LAND EVALUATION SYSTEM FOR *ELAEIS GUINEENSIS* JACQ. CULTIVATION IN PENINSULAR MALAYSIA

By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the Degree of Doctor of Philosophy

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Faculty: Forestry

The FAO Framework for Land Evaluation (FAO, 1976) was used for the development of a land evaluation system for oil palm cultivation in Peninsular Malaysia. The combined limitation and parametric approach was used as it contributed to a more meaningful interpretation of the results. Three basic land utilization types were identified in oil palm cultivation. Nine meteorological stations in the country were chosen for the study: Alor Star (Kedah), Ipoh (Perak), Subang (Selangor), Malacca (Malacca), Kluang (Johore), Senai (Johore), Kuantan (Pahang), Kuala Krai (Kelantan) and Tanah Merah (Kelantan). The results showed that when some amendments were made, the Papadakis climatic classification was found to be accurate in defining the climate of the country. Three climatic groups were identified to exist in the country and all the climatic groups are considered to be suitable for oil palm cultivation.

A system was developed for evaluating climate suitability for oil palm cultivation. Five rainfall regions were studied and it was found that the North-West was the least

favourable for oil palm cultivation. Three methods were compared to estimate crop evapotranspiration and the results showed that the method of Doorenbos and Pruitt (1977) provided a better estimation of crop evapotranspiration and crop-water requirement for oil palm. The results showed that the use of climate in land evaluation system for oil palm cultivation would enable a more accurate interpretation of the results for land evaluation.

Forty five soils were chosen to analyze the land evaluation systems. The system of evaluation by using land qualities was first developed. The system of Sys et al. (1991) was used in combination with climatic characteristics for the evaluation using land characteristics. The results showed that the evaluation using land qualities and land characteristics for land evaluation lead to similar conclusions with few exceptions. Comparing between the two systems, the system using land characteristics for land evaluation was prefered due to its simplicity and because the data required are often obtainable from soil survey reports. The method of using land qualities was complicated and required more time to arrive at about similar conclusion and the data required may not be easily obtainable from soil survey reports.

Geographic Information System (GIS) was used to map the oil palm suitability areas and the results were presented in the form of maps for easy interpretation together with data calculated by using combined limitation and parametric approach. A window based and user friendly Expert System Land Evaluation for Oil Palm Cultivation (ESLEOP) software was developed. The results showed that ESLEOP evaluate climate, land qualities and land characteristics faster that the conventional methods.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

SISTEM PERNILAIAN TANAH BAGI TANAMAN *ELAEIS GUINEENSIS* JACQ. DI SEMENANJUNG MALAYSIA

Oleh

ADZEMI BIN MAT ARSHAD

Ogos 1999

Pengerusi: Profesor Nik Muhamad Bin Nik Ab. Majid, Ph.D

Fakulti: Perhutanan

Rangkakerja FAO bagi Pernilaian Tanah (FAO, 1976) telah digunakan bagi membangunkan sistem pernilaian tanah bagi tanaman kelapa sawit di Semenanjung Malaysia. Gabungan limitasi dan pendekatan parametrik telah digunakan kerana ia memberikan sumbangan kearah pentafsiran keputusan yang lebih bermakna. Tiga jenis penggunaan tanah dikenal pasti bagi tanaman kelapa sawit. Sembilan stesyen kajicuaca negara ini telah dipilih untuk tujuan penyelidikan: Alor Star (Kedah), Ipoh (Perak), Subang (Selangor), Melaka (Melaka), Keluang (Johor), Senai (Johor), Kuantan (Pahang), Kuala Kerai (Kelantan) dan Tanah Merah (Kelantan). Keputusan menunjukkan bahawa apabila dibuat sedikit perubahan, pengkelasan iklim Papadakis didapati menunjukkan ketepatan dalam mendefinisikan iklim negara ini. Tiga kumpulan iklim dikenal pasti wujud di negara ini dan kesemua kumpulan iklim didapati sesuai bagi tanaman kelapa sawit.

Sistem pernilaian kesesuaian iklim bagi tanaman kelapa sawit telah dibangunkan. Lima wilayah hujan telah dikaji dan didapati wilayah Barat Laut sedikit kurang baik

bagi tanaman kelapa sawit. Tiga kaedah telah dibandingkan bagi menganggar evapotranspirasi tanaman dan keputusan menunjukkan bahawa kaedah Doorenbos dan Pruitt (1977) memberikan anggaran yang baik bagi evapotranspirasi tanaman dan keperluan air tanaman kelapa sawit. Keputusan menunjukkan penggunaan iklim dalam pernilaian tanah bagi tanaman kelapa sawit memberikan keputusan tafsiran yang tepat.

Empat puluh lima tanah telah dipilih bagi menganalisis sistem pernilaian tanah. Sistem pernilaian tanah menggunakan kualiti tanah telah dibangunkan. Sistem Sys et al. (1991) digunakan dengan kombinasi sifat iklim bagi pernilaian tanah dengan menggunakan sifat tanah. Keputusan menunjukkan pernilaian menggunakan kualiti tanah dan sifat tanah memberikan kesimpulan yang hampir sama dengan beberapa pengecualian. Perbandingan di antara dua sistem tersebut didapati sistem menggunakan sifat tanah lebih diutamakan disebabkan ia lebih ringkas dan data yang diperlukan boleh didapati dari laporan siasatan tanah. Kaedah menggunakan kualiti tanah didapati lebih rumit dan memerlukan lebih masa bagi mendapatkan kesimpulan yang hampir sama dan data yang diperlukan tidak boleh didapati terus dari laporan siasatan tanah.

Sistem Maklumat Geografi (SMG) telah digunakan bagi pemetaan kesesuaian kawasan kelapa sawit dan keputusan didapati dalam bentuk peta bagi memudahkan pentafsiran keputusan dengan data yang dikira dengan menggunakan gabungan limitasi dan pendekatan parametrik. Perisian Sistem Pakar Pernilaian Tanah bagi Tanaman Kelapa Sawit (SPPTKS) dibangunkan berdasarkan tetingkap dan mesra pengguna. Keputusan menunjukkan SPPTKS menilai kesesuaian iklim, kualiti tanah dan sifat tanah lebih cepat berbanding dengan kaedah lama.

CHAPTER 1

INTRODUCTION

There is a deep concern nowadays about land use strategy because land resources have become scarce. The fact that the increase in human population almost guarantees an increase in their activities, whether for agricultural or non agricultural purposes has become a great concern in society. In either agricultural or non agricultural sectors, planners are trying to meet the demand of an ever increasing population which means that land resources have to be systematically evaluated before being assigned for any particular land use. A decision, therefore has to be made to allocate a particular parcel of land for the most productive use, normally based on economics. Such decisions have to be formulated by taking into the recommendations based on some form of land appraisal or land evaluation to assess the potential of new land to be occupied in frontier extension where land reserve still exist and of intensifying the utilisation of already occupied land by applying new agricultural techniques and inputs to increase productivity.

The impetus to land development in this country was set in motion during the Malayan First Five Year Plan (1956 to 1960) with emphasis directed towards diversifying agriculture and opening of new land for agriculture, particularly in the undeveloped areas.

With the rapid increase in the opening of new land for agriculture and the need to diversify agriculture, there was a pressing need to some form of land allocation. The experience and the efforts of the Soil Survey Branch, Department of Agriculture in the

country led to the development of a soil suitability system published in 1966 by Leamy and Panton. The system was meant for general agricultural use although it was mainly set up on the basic experiences gained from the rubber and oil palm sectors. This system was revised, updated and subsequently renamed the Soil Crop Suitability Classification for Peninsular Malaysia (Wong, 1974, 1986). More changes have been proposed recently to made it more effective for current needs (Lim, 1993).

For oil palm, choice of land seems to have been limited by steep-sided hills in the interior, by mangrove or established padi on the coast and by inaccessibility in the remaining areas. The was little evidence that the planters preferred a particular land areas except that they avoided the more extensive peat deposits which were difficult to drain.

The different land evaluation systems in the country consider soil and landscape properties. As such the existing system of land evaluation for oil palm (Ng, 1968; Chiew, 1977) in Peninsular Malaysia is confined solely to the evaluation of soil and landscape.

Climate is often assumed to be the same or it is considered that differences due to climate are insignificant. Climate often defines ecological zones. As such the evaluation of climate forms a very important part in land evaluation. The relationship between climate and yield of oil palm is not well studied in this country. Research carried out in other countries have shown that climatic variations have resulted in a reduction of yields of oil palm (Hartley, 1988).

The Framework for Land Evaluation published by FAO in 1976 aimed towards a standardisation in land evaluation systems. Attempts have already been made to adapt this system of a land evaluation for specific land utilisation types including oil palm (Sys et al., 1993). Land characteristics have been used as diagnostic criteria. The FAO also recommended the use of land qualities for land evaluation and work on this field of land evaluation for oil palm in this country is new.

Oil palm is an important industry in Malaysian economy producing 7.8 million tons of crude palm oil and remained as the world's largest producer and exporter of palm oil in 1995. The oil palm industry constitutes one of the thirty-four land use categories in Malaysia and in 1995 it occupies 43% of the total agricultural land use in Malaysia (Kerajaan Malaysia, 1996). Since oil palm industry is important in agriculture sector it will be used in the land evaluation study.

Almost always land evaluation presents its results as maps but the use of Geographic Information System (GIS) for map analysis and presentation of land evaluation for oil palm cultivation in this country has not been documented.

With that in mind, this research will integrate all relevant climatic features, soil and landscape properties to evaluate the suitability of land for oil palm cultivation in Peninsular Malaysia.

Objective of the Study

The general objective of the study is to determine the environmental factors that affect oil palm cultivation towards providing a rational basis for national planning in oil palm cultivation.

The Specific Objectives of the Study are to:

1. Identify the land utilization types for oil palm cultivation
2. Examine the Papadakis system for classifying climate and its possible use to identify regional differences affecting oil palm cultivation and to estimate the crop-water requirement for oil palm using the method of Doorenbos and Pruitt (1977) and Penman-Monteith (Smith, 1991) the latter is compared with the method currently used in Peninsular Malaysia as recommended by Jabatan Parit dan Saliran (1977)
3. Develop a system of evaluating the suitability of climate for oil palm cultivation and to test its applicability using climatic data of selected meteorological stations
4. Characterise and classify the soils to be used for land evaluation purposes
5. Develop a system of land evaluation for oil palm cultivation by using land qualities and to compare with the system using land characteristics
6. Produce land suitability maps for oil palm cultivation in selected study areas using Geographic Information System (GIS)
7. Develop an expert system to ease in the calculation of the data for land evaluation purposes

CHAPTER II

LITERATURE REVIEW

Physiographic Situation of Peninsular Malaysia

Location

Peninsular Malaysia is located within the equatorial zone between latitudes 1^0 5' and 6^0 45'N and longitudes 99^0 and 104^0 20'E. South China Sea lies to the east while Straits of Malacca to the west of the peninsula. Peninsular Malaysia has an area of 13.2 million hectares. Its greatest length is about 735 km and the maximum width is about 320 km.

Physiology

The topography of most of the country is undulating and mountainous, dominated by valley slopes. The central mountain range runs nearly through the middle of the peninsular and rises up to a height of 2, 000 m. The highest peak, Gunong Tahan is 2, 188 m in elevation. Secondary mountain ranges fan out from this, mainly in the northern half of the country. These ranges consist of steep land with slopes exceeding 25^0 and constitute 40% of the total land surface. From these mountain systems, many rivers flow through hilly, rolling and undulating lowlands towards the flood plains, coastal flats and beach ridges. The intermediate lowlands lie mainly between 20 to 1, 160 m above sea level.

The undulating and rolling terrain occupies areas that are generally suitable for agriculture production. In Peninsular Malaysia, the criteria which divides the steep land which is unsuitable for agriculture is 20^0 slope limit. The 76 m contour line generally has slopes less than 20^0. Figure 1 and Figure 2 shows general physiography of Peninsular Malaysia and highlands in Peninsular Malaysia respectively. Now the government departments and agencies which are involved in research, planning and utilisation of land resources have agreed to adopt a slightly steeper slope of 25^0 as the lower limit of the steep land (DOA-MARDI, 1993).

The landforms of Peninsular Malaysia can be generalise into higher hills and mountains, limestone hills, low hills and flat lowlands. The high hills and mountains cover land of high altitudes at about 80 m above sea level and are usually steep slope (> 25^0). Below these mountain slopes is the land considered suitable for agricultural purposes that do not exceed 25^0. This break in slope occurs at different altitudes in different parts of Peninsular Malaysia. The low limestone hills are often very steep; they are isolated hills up to 400 m high. The area is dissected with typical elevation differences from valley to crest of 15 to 60 m. These hills have gentle to moderately steep slopes. The flat lowlands consist of coastal plains and flood plains. The coastal areas of the west coast are dominated by clay deposits of marine and riverine origin whilst the coastal areas of the east consists of beach ridges.

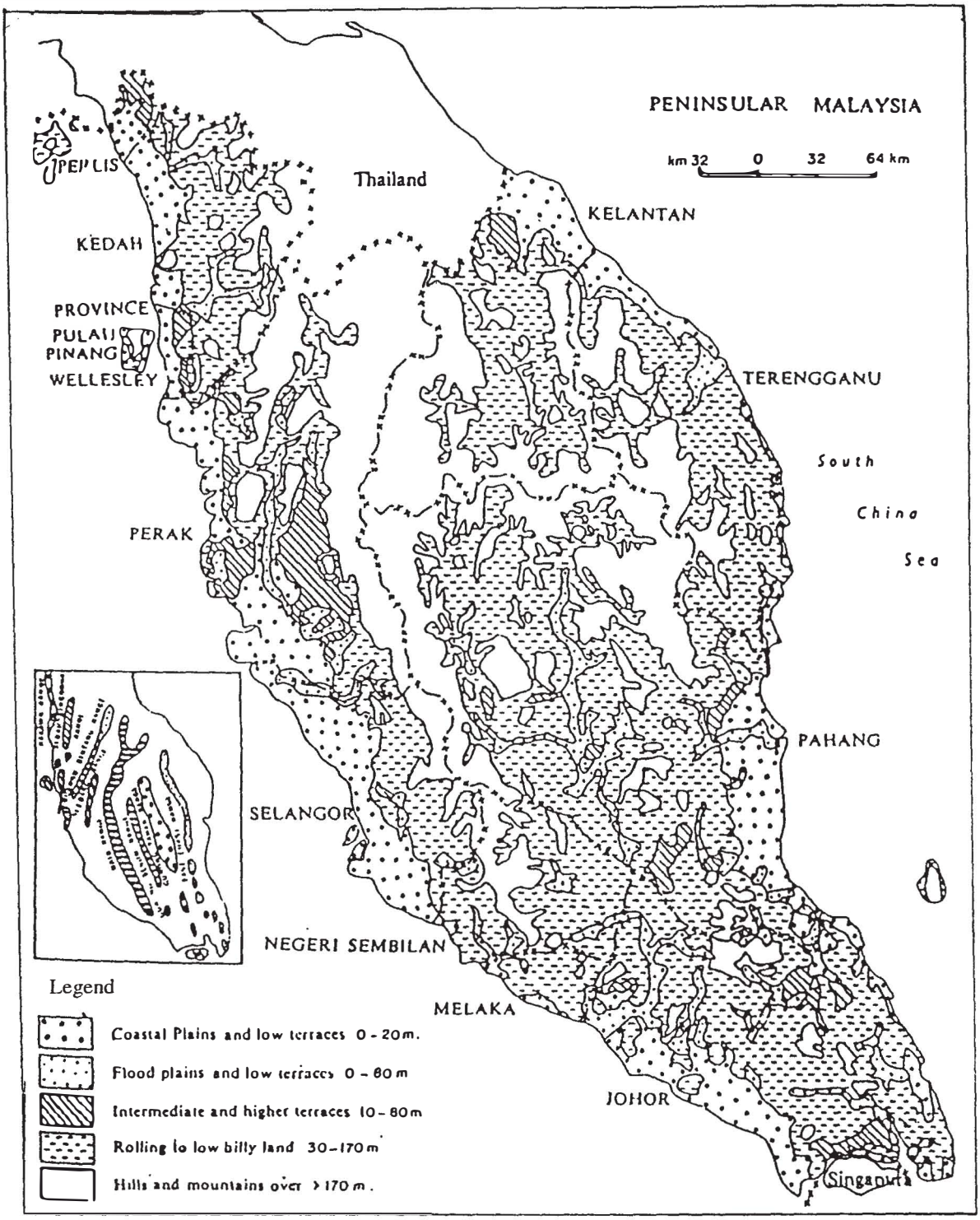

Figure 1: General Physiography of Peninsular Malaysia

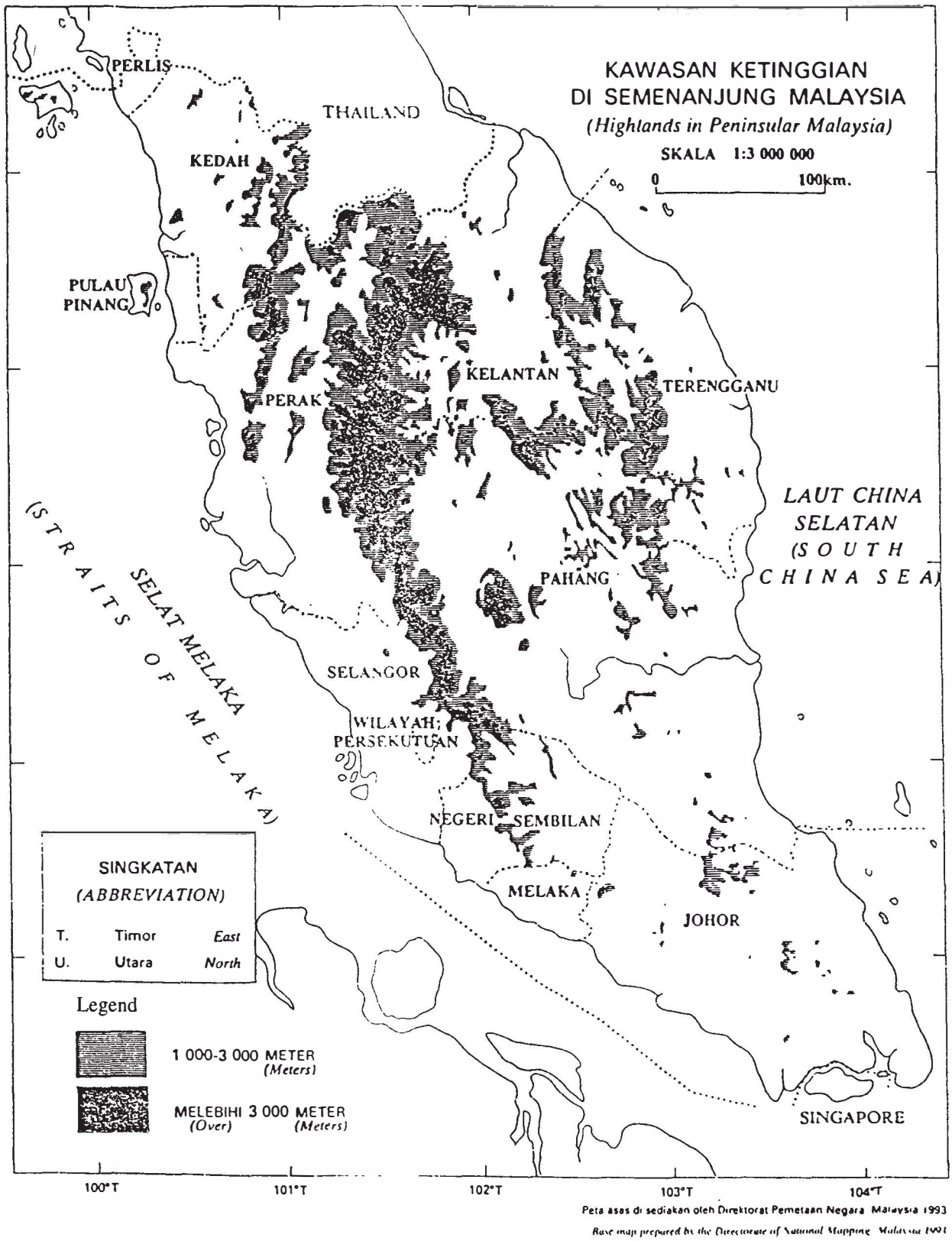

Figure 2: Highlands in Peninsular Malaysia