5.2.2 Vehicle Trip Generation and Attraction

Trip generation is defined as the number of trips generated by each traffic zone per unit of time, and the trip attraction is defined as those attracted to each traffic zone per unit of time in the study area.

The total number of trips produced as estimated in the previous section is used as a control for estimating the total trip generation and attraction by state. The total trip demand in terms of number of passengers and tons are then converted into vehicle trips using the appropriate conversion factors.

The procedure for forecasting future vehicle traffic generation and attraction is illustrated in Figure 5.3. The trip generation and attraction models to be used for the forecasting are calibrated based on 1991 present traffic demand together with the socio-economic indicators obtained from traffic surveys. The calibrated trip generation and attraction models are given in Table 5.2. The average vehicle occupancy conversion factors are taken as 1.8 and 28.0 for car and bus respectively, while the load factor for lorry is 1.7.

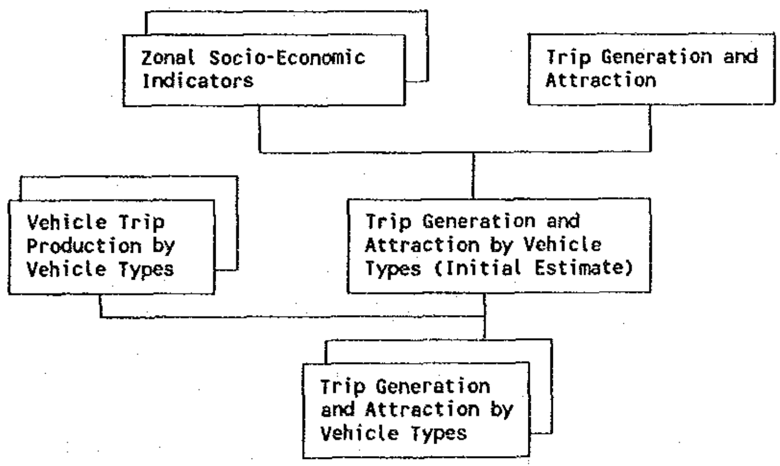


Figure 5.3: Procedure for Forecasting Vehicle Trip Generation and Attraction in P.Malaysia to Year 2010

Table 5.2: Trip Generation and Attraction Models, Peninsular Malaysia

Type of Vehicle	Generation and Attraction	Formula
Car	Generation Attraction	Gi = 20,882 + 932.178ZEMP Aj = 20,811 + 933.341ZEMP
Bus	Generation Attraction	Gi = -1,085 + 28.724ZEMP Aj = -1,048 + 28.953ZEMP
Lorry	Generation Attraction	Gi = 2,681 + 20.382ZEMP Aj = 2,516 + 20.420ZEMP

Note: ZEMP: Employment by Zone

Using these trip generation and attraction models for P.Malaysia and the future socio-economic indicators, the future trip generation and attraction by state are forecasted and the results are shown in Figure 5.4.

5.2.3 Vehicle OD Distribution

Trip distribution model is used to distribute the total trip generation and attraction forecasted above to produce a trip OD matrix in the study area. For this "Do-Nothing" scenario analysis, the "Present Pattern Distribution Model" is used. This Present Pattern Distribution Model is given as:

$$X_{ij}^{2010} = \frac{X_{ij}^{1991} \bullet F_{Gi} \bullet F_{Aj} \bullet L_{Gi}^{1991} + L_{Aj}^{1991}}{2}$$

where,

$$F_{Gi} = G_i^{2010}/G_i^{1991}$$

$$F_{Aj} = A_j^{2010}/A_j^{1991}$$

$$L_{Gi}^{1991} = \frac{G_i^{1991}}{\Sigma\, x_{ij}^{1991} \bullet F_{Aj}^{1991}}$$

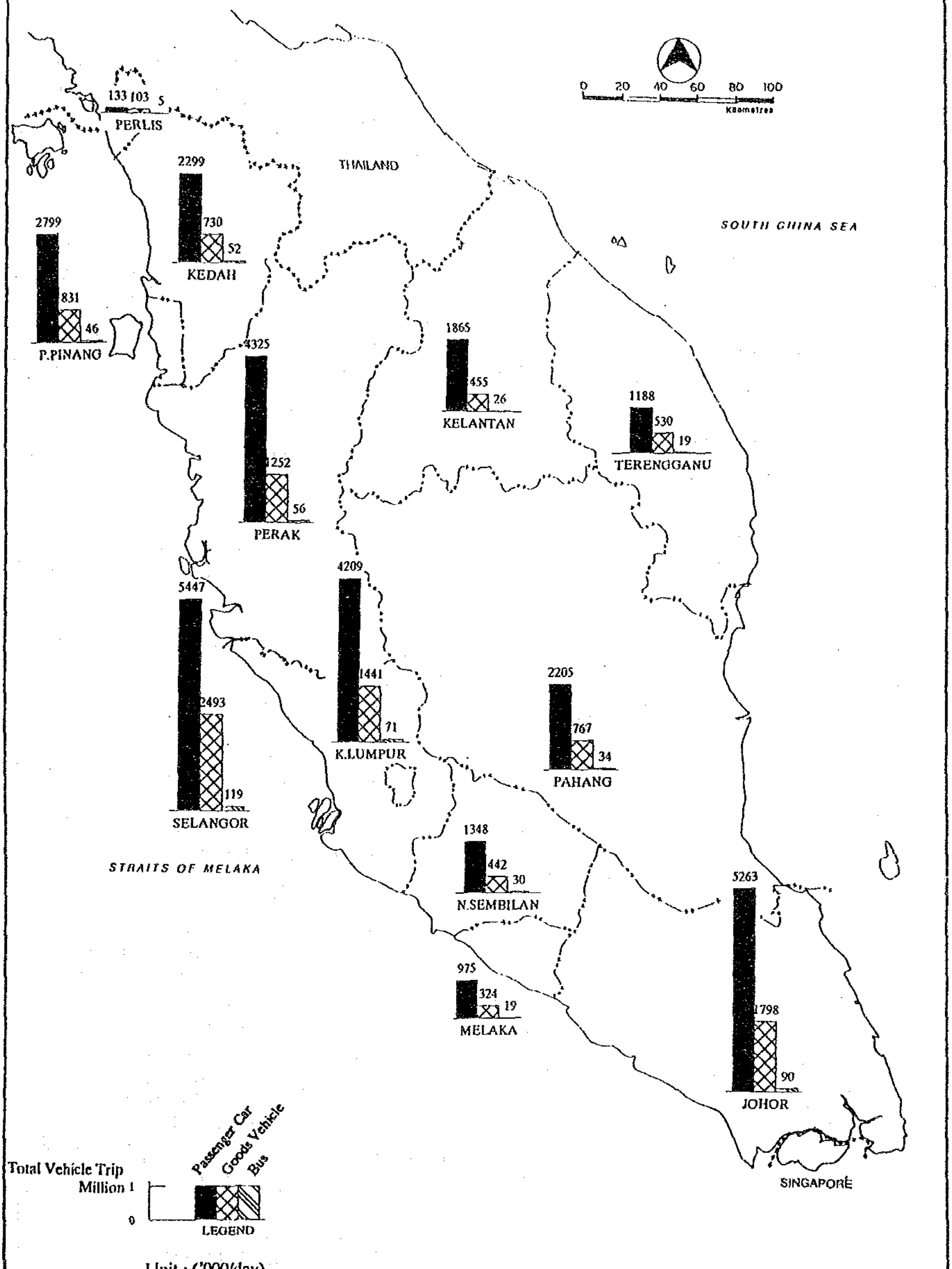
$$L_{Aj}^{1991} = \frac{A_j^{1991}}{\Sigma\, x_{ij}^{1991} \bullet F_{Gi}^{1991}}$$

X_{ij} = Trips from zone i to zone j

G_i = Trip generation from zone i

A_j = Trip attraction to zone j

The results of this trip distribution are expressed in vehicle trip desire lines between states as shown in Figure 5.5.



Unit : ('000/day)

Figure 5.4 : Trip Generation and Attraction for Peninsular Malaysia to Year 2010 under "Do-Nothing" Scenario

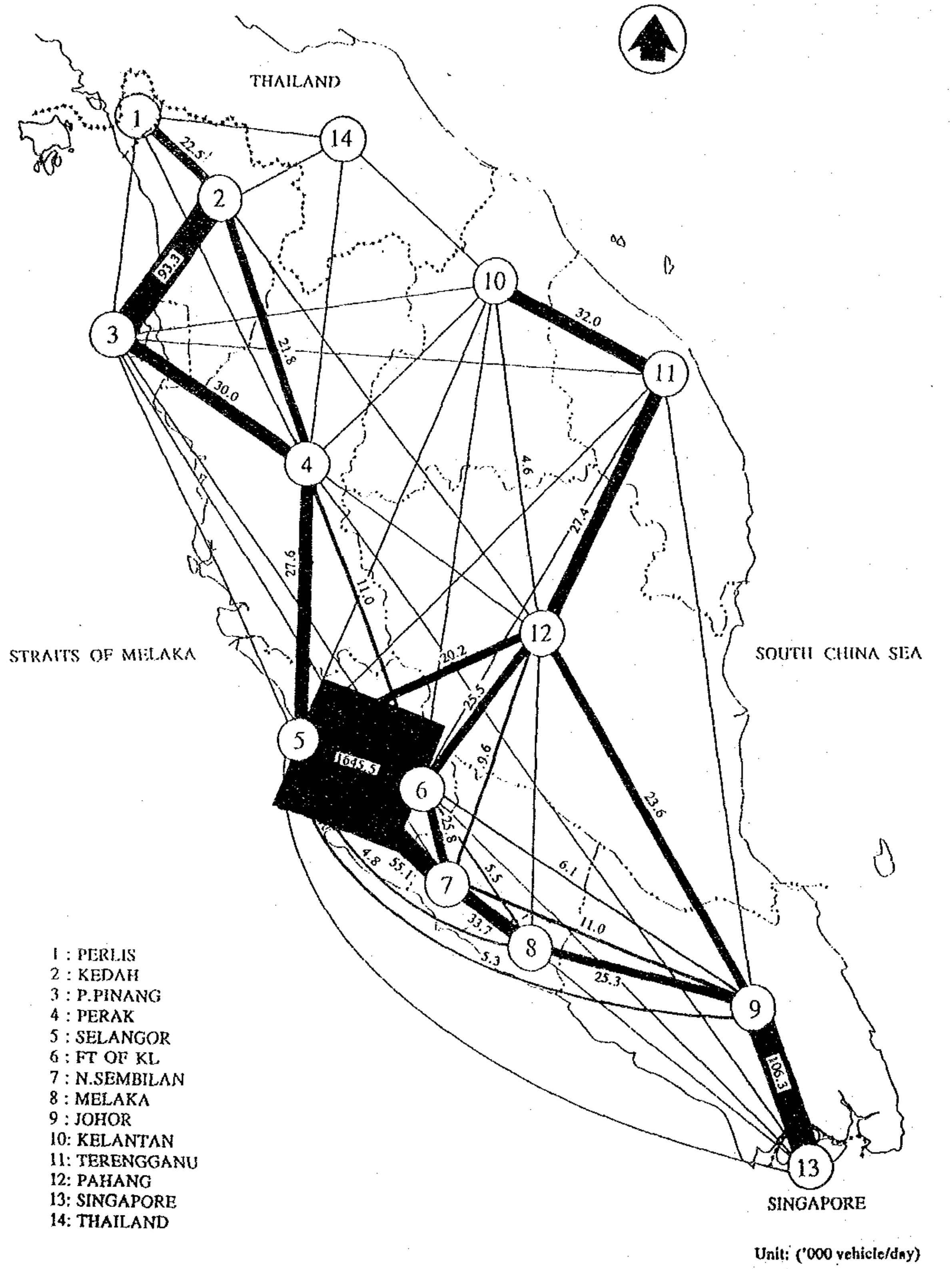


Figure 5.5 : Vehicle Trip Distribution Pattern for Peninsular Malaysia to Year 2010 under "Do-Nothing" Scenario

5.3 Macro Level Traffic Demand Forecasting For Peninsular Malaysia To Year 2010 Under The "Do-Something" Scenario

Compared to the "Do-Nothing" scenario discussed in section 5.2,the "Do-Something" scenario in this section considers the following two basic assumptions:-

1. Transport policies will be implemented by the Government to specifically change the shares of transport modes in the country. The railway system will be improved by introducing double tracking and more efficient operation to meet the expected demand and assuming that a percentage of road transport demand will be diverted to the rail transport.

2. Trip distribution pattern of road transport will differ from the present situation as accessibility of various regions will be improved with the proposed future road network.

5.3.1 Share of Transport Modes

Road transport accounts for nearly 95% share of the total transport in Malaysia. Road and rail transport together carry almost all the surface traffic demand. Air and water transport (i.e sea transport) have very negligible share as they face some limitations and constraints such as points of origin or destination and high cost of operation.

The analysis of future mode share for surface traffic demand therefore will consider road and rail transport systems only. The issue on transportation in Peninsular Malaysia is to enhance the public transport system especially rail transport for medium to long distance inter-state travel.

If the existing railway system is improved, to what extent will the passenger traffic be shifted from road transport to rail transport? To predict this traffic volume, diversion curves may be used. Diversion curves can indicate the share of the demand on rail mode with improved travel time ratio or travel cost difference. Existing data on these two travel modes however indicate that there is little or no significant relationship to construct such a diversion curve.

The alternative approach therefore will be the 'Capacity Restraint Method', ie. the use of railway operational capacity to predict future railway traffic demand. This approach assumes that with better service level for rail while those of other modes remain the same or decline, rail traffic demand in future will grow until it reaches the limiting capacity.

As there is no concrete railway development plan in the country at present, the estimation of future rail transport capacity is based on the following assumptions:

1. The existing rail network will be maintained, and no new line will be added in the near future,

2. Improvement works such as double tracking with re-alignment and introducing speedy coaches will be implemented to increase frequency of trains and level of services, especially along the west coast from Penang to Johor Bahru.

Using these assumptions, approximately 40 trains can operate on a single track line and 100 to 130 trains for double track lines. The diversion from road to rail transport in future is estimated to be 20% from bus, 10% from car and 5% from lorry.

The future rail traffic passenger and freight traffic demand on the existing KTM rail network in P.Malaysia, given in Figures 5.6 and 5.7, show substantial increases in total demand in future.

Under the "Do-nothing" scenario, rail will handle only 3% to 6% of the total land transport demand along the rail corridors whereas under the "Do-Something" scenario, it is expected to handle about 10% of total land transport demand along the applicable corridors. Table 5.3 shows the future traffic demand by modes in 2010 after allowing for increase in share of rail transport in P.Malaysia.

The fact remains that even with such allowance for growth of rail transport share in future, the impact is limited to only the present rail corridors. With this limited rail network and infrastructure, the impact of rail transport increases in future on the overall national transport system remains low.

The overall mode share of road transport still remains very high at 99.6% for passenger and 98.5% for freight under the 'Do-something' scenario in 2010 shown in Table 5.3. Rail transport share has increased only slightly from 0.1% to 0.3% for passenger although in real terms, rail transport will increase 7 times for passenger by 2010 from 1991 and 4 times by volume for freight.

Table 5.3: Traffic Demand by Transport Mode in Peninsular Malaysia, in 1991 and 2010

	Mode	1991 (Composition Rate)	2010 (Composition Rate)		Annual Growth Rate (%) 1991-2010	
			Do-Nothing	Do-Something	Do-Nothing	Do-Something
Passenger Traffic ('000 Pass./Year)	Road	4,861,852(99.8%)	12,989,814(99.8%)	12,958,452(99.6%)	5.31	5.30
	Rail	6,564(0.1%)	13,905(0.1%)	45,267(0.3%)	4.03	10.70
	Air	2,845(0.1%)	13,028(0.1%)	13,028(0.1%)	8.34	8.34
	Total	4,871,261(100%)	13,016,747(100%)	13,016,747(100%)	5.31	5.31
Freight Traffic ('000 tonne/year)	Road	630,534(98.5%)	2,359,003(98.6%)	2,355,613(98.5%)	7.19	7.18
	Rail	4,258(0.7%)	12,812(0.5%)	16,202(0.7%)	5.97	7.29
	Air	15 (0.0%)	58 (0.0%)	58(0.0%)	7.38	7.38
	Water	5,031(0.8%)	20,592(0.9%)	20,592(0.9%)	7.70	7.70
	Total	639,838(100%)	2,392,465(100%)	2,392,465(100%)	7.19	7.19

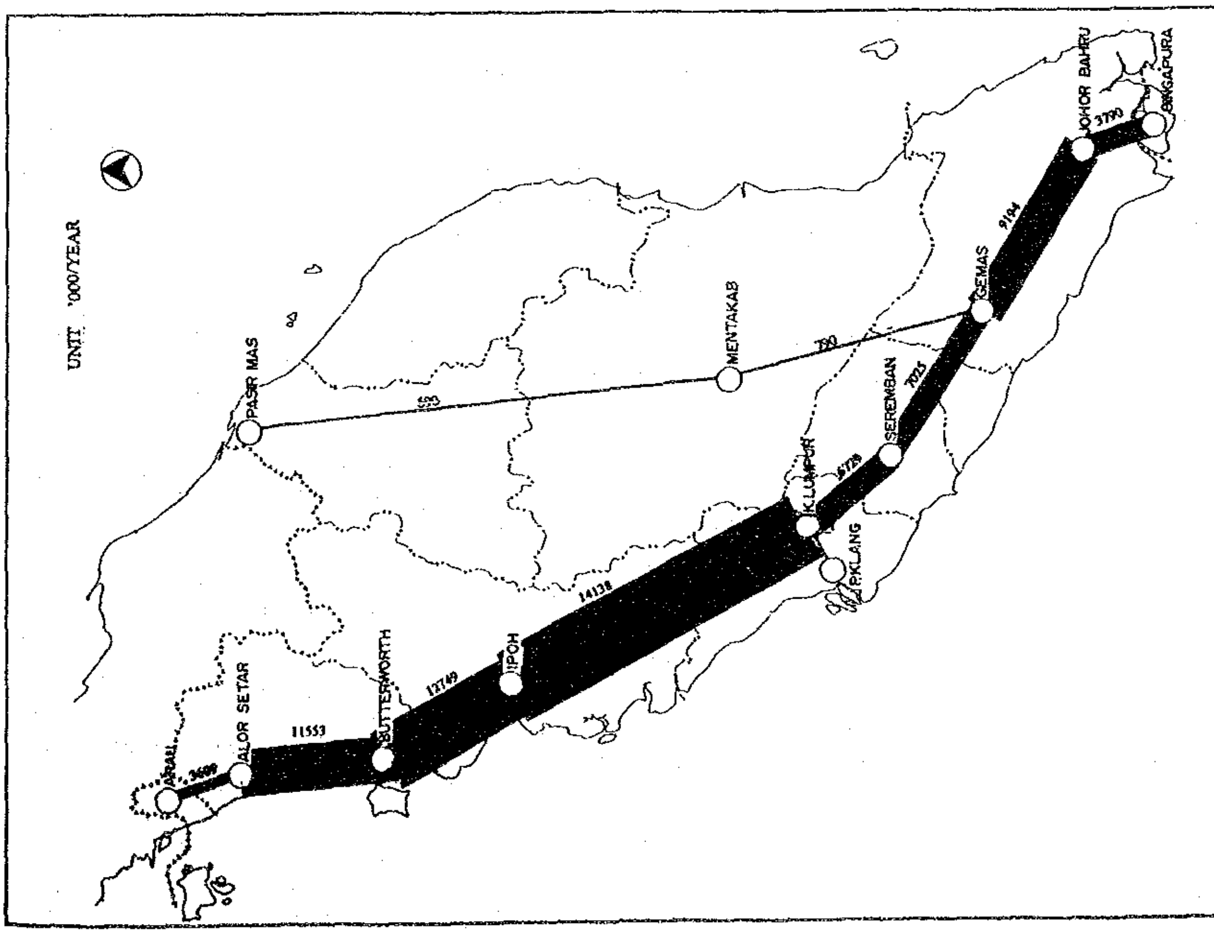


Figure 5.6: Future Rail Passenger Traffic Demand in P.Malaysia in 2010

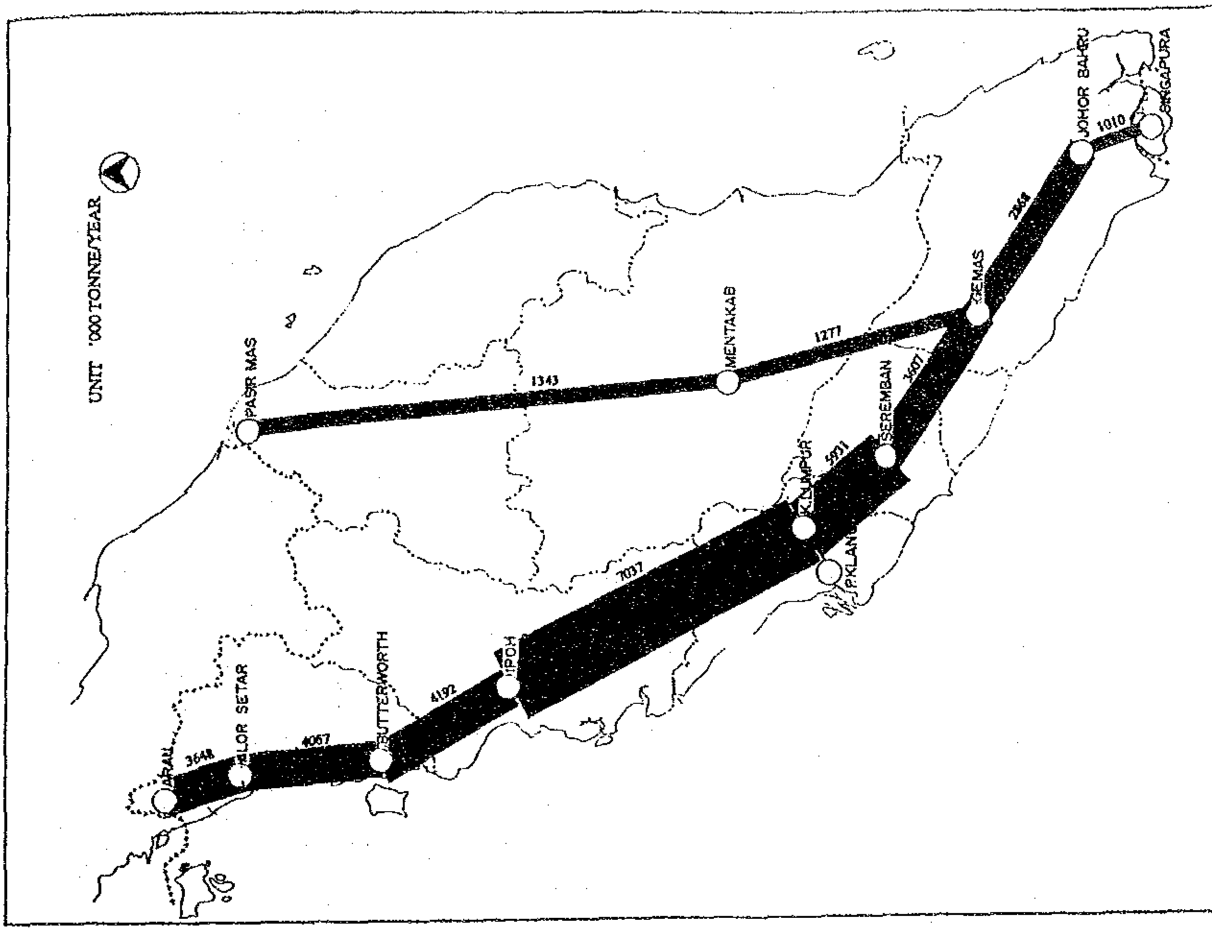


Figure 5.7: Future Rail Freight Traffic Demand in P.Malaysia in 2010

Both passenger and freight traffic demand will increase rapidly to the year 2010 with sustained high economic growth of the country corresponding to the targets of Vision 2020 in making Malaysia a fully developed and industrialized nation. The total traffic demand for passenger traffic in 2010 is predicted to be 13,016 million trips/year. The total freight traffic demand in 2010 will be 2,392 million tons/year.

5.3.2 Vehicle Trip Distribution Under the "Do-Something" Scenario

Vehicle trip distribution under the "Do-Something" scenario has to consider the improvements on the existing highway network system. Once the highway network is improved, long distance travel will be made easier, faster and more comfortable. This would encourage more people to travel resulting in an overall increase in average trip length. The Gravity Model is best suited to distribute trip under the "Do-Something" scenario as it takes into account such changes in future travel characteristics.

In the Gravity Model, the number of trips between two zones is directly related to activities in the two zones, and inversely related to the impedance between the zones measured as a function of distance or travel time. This feature of the Gravity model enables the prediction of traffic demand between zones in response to improvement in accessibility (travel time) between zones.

Basically there are three forms of gravity models, namely the standard Gravity Model, the BPR (Bureau of Public Road, USA) Model and the Voorhees Model. The BPR method is selected because it is not only practical but also able to explain the existing distribution pattern. The formula of the BPR Gravity model is given below.

$$X_{ij} = G_i \frac{A_j\, f(T_{ij})\, K_{ij}}{\sum_{j=1}^{n} A_j\, f(T_{ij})\, K_{ij}}$$

Where

X_{ij}	=	number of trips generation in i zone and attracted to zone j
G_i	=	trips generated from zone i
A_j	=	trips attracted to zone j
$f(T_{ij})$	=	friction factor for interchange i j ($= t_{ij}^{-\alpha}$)
K_{ij}	=	a specific zone to zone adjustment factor
i	=	origin zone
j	=	destination zone
n	=	number of zones in the study area
t_{ij}	=	travel time between i and j
α	=	parameter

Using this Gravity Model, future vehicle trips are distributed between states in Peninsular Malaysia under the "Do-Something" scenario and these are expressed as desire lines as shown in Figure 5.8.

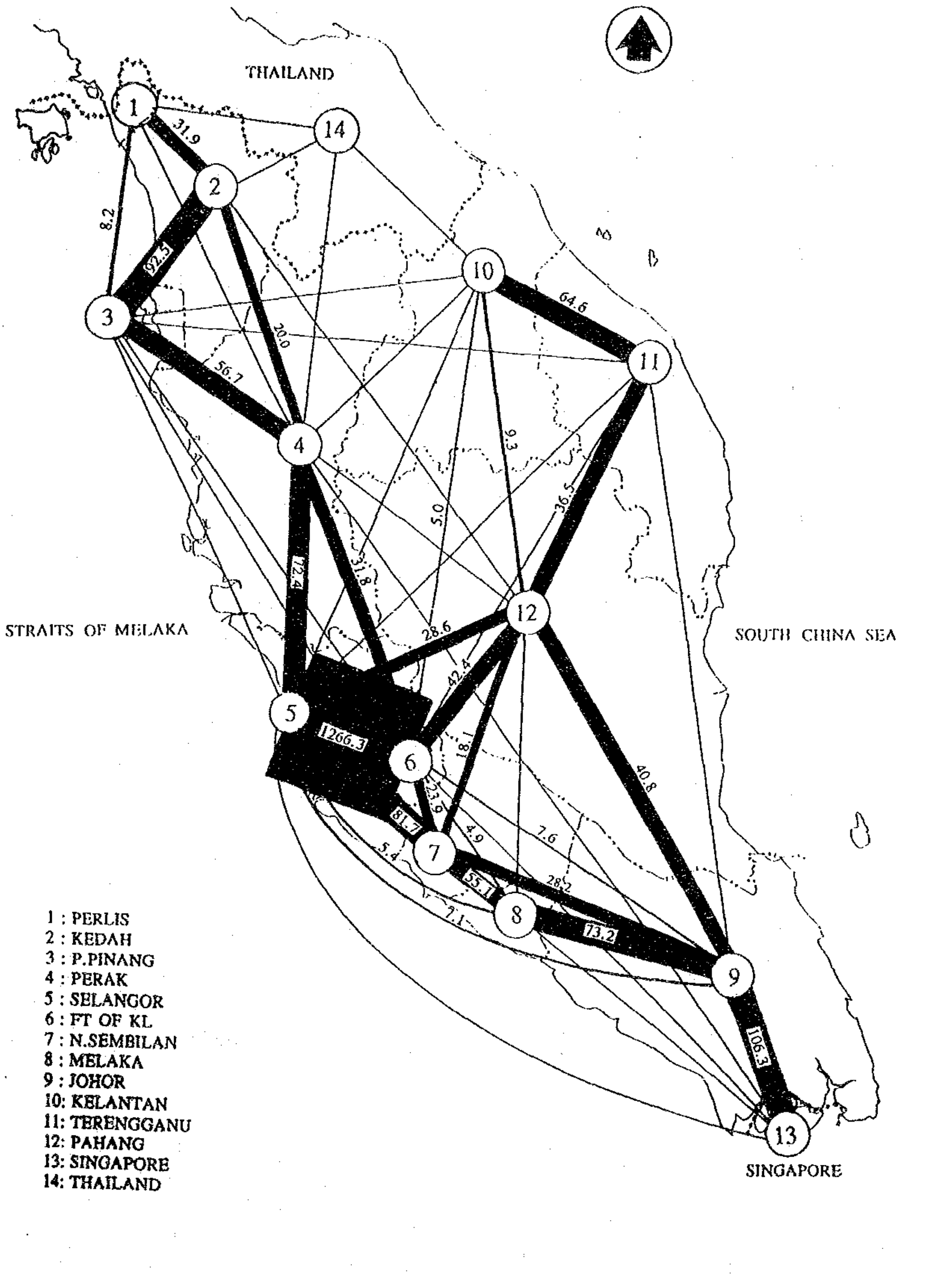


Figure 5.8: Future Vehicle Trip Distribution Pattern in P.Malaysia, 2010 under the "Do-Something" Scenario

Figure 5.9 compares the corridor vehicle traffic demands under the "Do-Nothing" scenario and "Do-Something" scenario in 2010. Traffic demands for all the corridors are predicted to increase sharply from the existing traffic demands. In the west coast of Peninsular Malaysia for instance, the average demands between states are predicted to be about 120,000 to 140,000 vehicles per day (VPD) except for the Northern region. This is about 3.5 to 7.5 times higher than the existing volume. The growth rates of traffic demand along the Selangor-Perak and Johor-Melaka corridors are expected to be very high because of the rapid expansion of Kuala Lumpur and Johor metropolitan areas.

Traffic demand between the west and east coasts are also expected to increase in future. To enhance the industrialization program in the east coast states, it is vital to improve accessibility between west and east coasts. It is envisaged that linkages between west and east will experience high growth in travel demand with the highest along the KL-Kuantan corridor.

Under the "Do-Something" scenario, there is a more balanced distribution of travel demand on the corridors compared to the pattern in the "Do-Nothing" scenario.

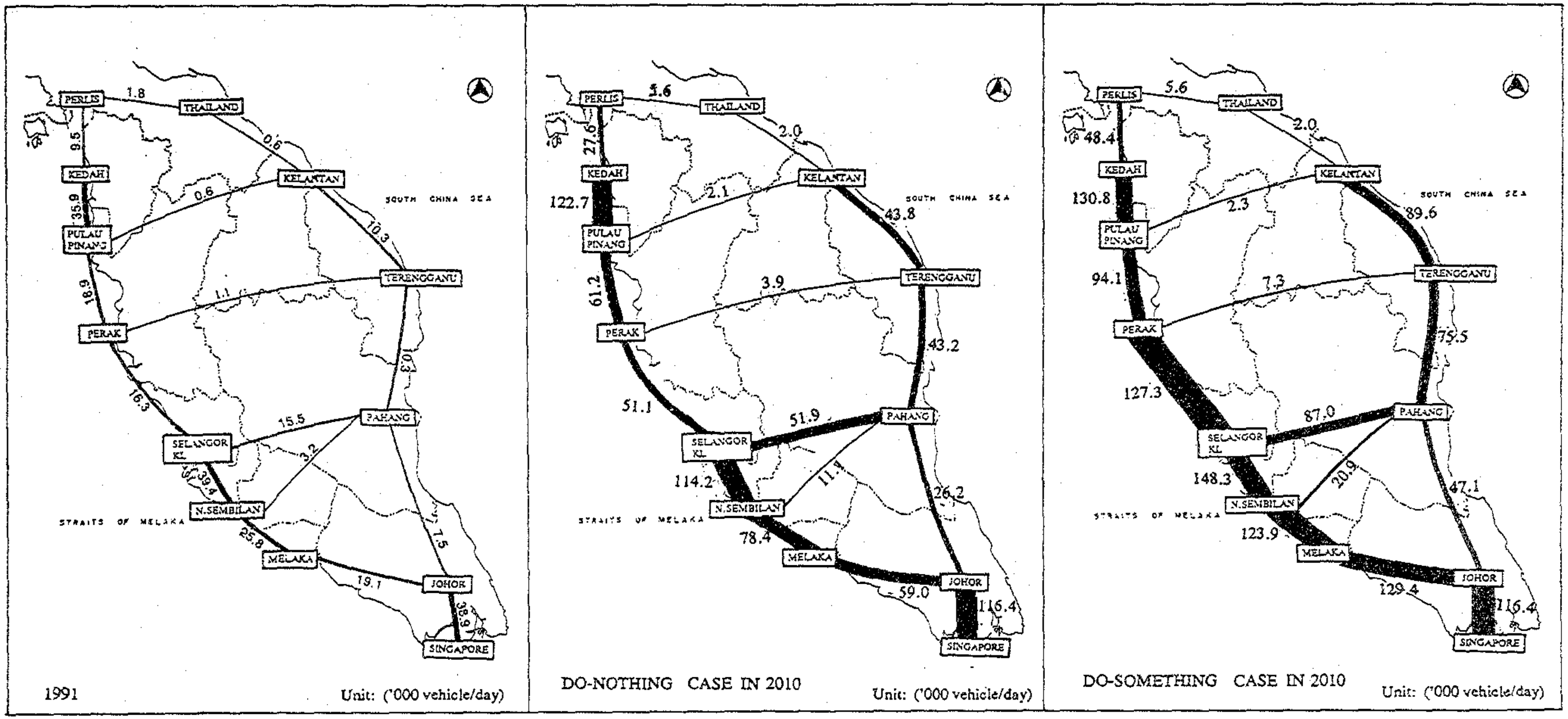


Figure 5.9 : Comparison of Corridor Vehicle Traffic Demand in P. Malaysia under "Do-Nothing" and "Do-Something" Scenarios in 2010

5.4 Micro Level Traffic Demand Forecasting in Peninsular Malaysia

Having done the macro level traffic demand forecasting, the total demand can now be broken into the micro level, that is, into district or traffic zones. Results of the macro level forecasting are used as controls. The micro level forecasting is done only under the "Do-Something" scenario.

Figure 5.10 shows the procedure in micro level traffic demand forecasting. The trip generation and attraction models are calibrated using the existing (1991) zonal traffic movements and the socio-economic indicators. Future trip generation and attraction by zone are then calculated using the models and estimated future zonal socio-economic indicators. This produces an initial forecast after which the trip generations and attractions are further adjusted using the control totals by state.

Fratar method is used for trip distribution at the micro level traffic demand forecasting instead of the gravity model used in the macro level.

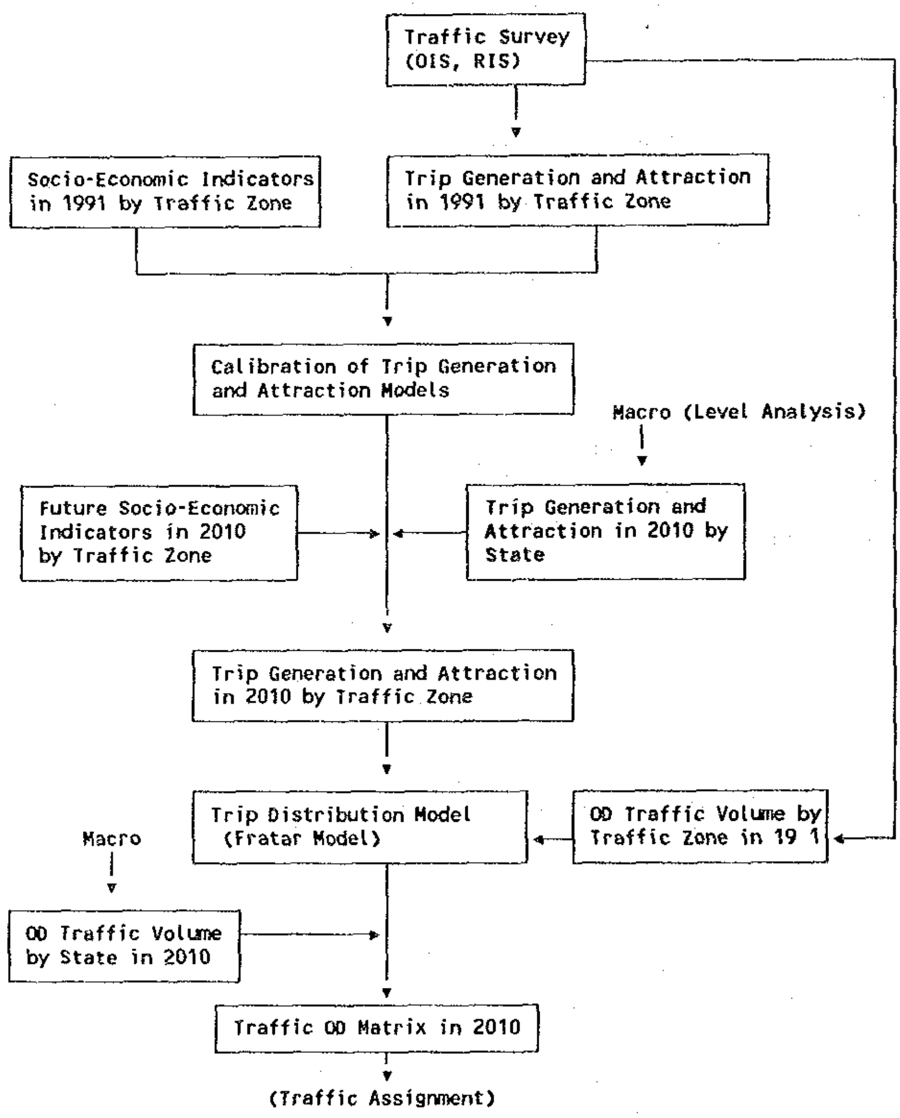


Figure 5.10 : Process of Micro-Level Traffic Demand Forecasting

5.4.1 Micro Level Trip Generation and Attraction Forecasting

The socio-economic indicators by district in 1991 were estimated from the results of the traffic surveys as such district level data were not available. The independent variables used are population, employment and GDP which are found to have high correlation coefficients to traffic demand. The trip generation and attraction models calibrated at traffic zone level are given in Table 5.4.

Table 5.4: Trip Generation and Attraction Model at Traffic Zone Level

Type of Vehicle		Formula	Correlation Coefficient
P. Car	GEN	75.84POP + 962.18EMP	0.857
	ATT	75.84POP + 962.15EMP	0.857
Bus	GEN	4.18POP + 1.49GDP	0.797
	ATT	4.19POP + 1.49GDP	0.797
Lorry	GEN	48.09POP + 166.52EMP	0.779
	ATT	48.10POP + 166.49EMP	0.779

Note GEN : Generation
ATT : Attraction
POP : Population
EMP : Employment
GDP : Gross Domestic Product

5.4.2 Trip Assignment

The Equilibrium Trip Assignment Model is used for traffic assignment in this Study. The behavioral assumption of this model is that each users chooses the shortest route he perceives best. This results in a set of flows such that all paths used between an OD pair is of equal time and to the total vehicle hour of the network system is minimized. Figure 5.11 indicates the steps in performing the traffic assignment.

Tolls on the North-South Expressway and other toll roads are converted to additional travel time, adopting a toll rate of 5 cents per kilometre (1991 toll rate) with an average time value at M$6.26 per hour.

Trips handled in the traffic assignment model are in PCU (Passenger Car Unit). The PCU conversion factors used for this Study are:

Vehicle Type	PCU
Passenger Car	1.00
Lorry *	2.00
Bus	3.00

Note; * PCU unit (on Rural Roads) for lorry is taken as 2.00 and not 3.00 as in the JKR Design Manual as the category of "lorry" in this Study includes a high proportion of van and medium lorries.

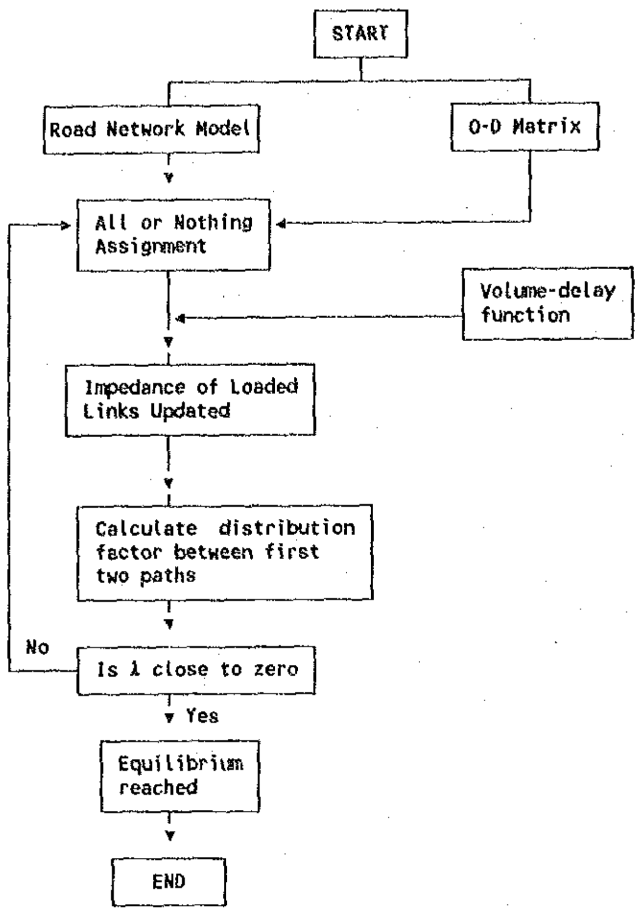


Figure 5.11 : Procedure of Equilibrium Traffic Assignment

5.5 Traffic Demand Forecasting In Sabah and Sarawak

Transport system and traffic demand in Sabah and Sarawak are very different from Peninsular Malaysia. Major urban areas and towns are scattered in the two states. The distances between Kota Kinabalu with Sandakan and Tawau in Sabah for example are nearly 300km. The distances between Kuching and Sibu, Bintulu and Miri are between 200km to 400km. In addition to these long distances, existing roads linking these major towns are in poor condition. Coupled with the lower development level in these two states, inter-state road traffic demands are very small at present when compared to those in P.Malaysia. Air and water transports on the other hand are more predominant instead but still limited. Inland water transport in Sarawak for instance are limited to mainly the Rajang River Basin and coastal shipping is concentrated between Kuching and Sibu. Many small villages have sprang up along river banks in the interior and coastal areas especially in Sarawak as water transport offers the only means of moving around in these areas.

There is no direct road linkage between Sabah and Sarawak at present except by passing through neighbouring Brunei. Road network and traffic movement can be considered as two separate entities in these two states. Existing road traffic demand analyses for Sabah and Sarawak are therefore carried out separately in this Study. For the future scenarios, however, traffic demand in the two states will be analyzed as one entity as a direct linkage will be planned in the future highway network.

Data used in traffic demand analyses in 1991 in Sabah are taken from the results of roadside interview and traffic count survey. For Sarawak, OD data on road, air and water transport is extracted from the Master Plan Study for Coastal & Riverine Transport in Sarawak conducted in 1988 (hereinafter referred to as the CRT Master Plan), but updated to 1991 using traffic survey results obtained by this Study.

5.5.1 Existing Vehicle Traffic Demand in Sabah

Vehicle traffic demand forecasting in Sabah also uses the four step method of trip production, generation/attraction, distribution and assignment. Figure 5.12 below shows the procedure used in estimating the 1991 vehicle OD matrix for Sabah.

(1) Trip Production

The vehicle trip production volume in Sabah is estimated using the trip production rate technique. The formula for trip production rate method can be written as :

$$Pm = Rm \times Km$$

Where,

Pm : Traffic Demand Production by vehicle type m
Rm : Trip production Rate of vehicle type m
Km : Number of vehicle by type m

The trip production rates by vehicle type is obtained from the Travel Mode Survey and found to be 4.1 trips/day for car, 7.1 for bus and 4.5 for lorry.

Trip production rates will change in future as discussed in the analysis for Peninsular on page 5-5. Trip production rates in the past cannot be analyzed due to absence of data. Trip production rates in future tend to decrease as mentioned in the earlier discussion for P.Malaysia. Forecasting the future trip production using existing trip production rates will therefore tend to over estimate the total demand.

The number of existing vehicle number and types by Division in Sabah is estimated using the Annual Bulletin of Statistics 1989, Sabah, whereas the existing total number of vehicle by types was obtained from the Ministry of Transport. The estimated existing vehicle trip production by Division in Sabah are then used as control in estimating the trip generation and attraction by zone in the next step.

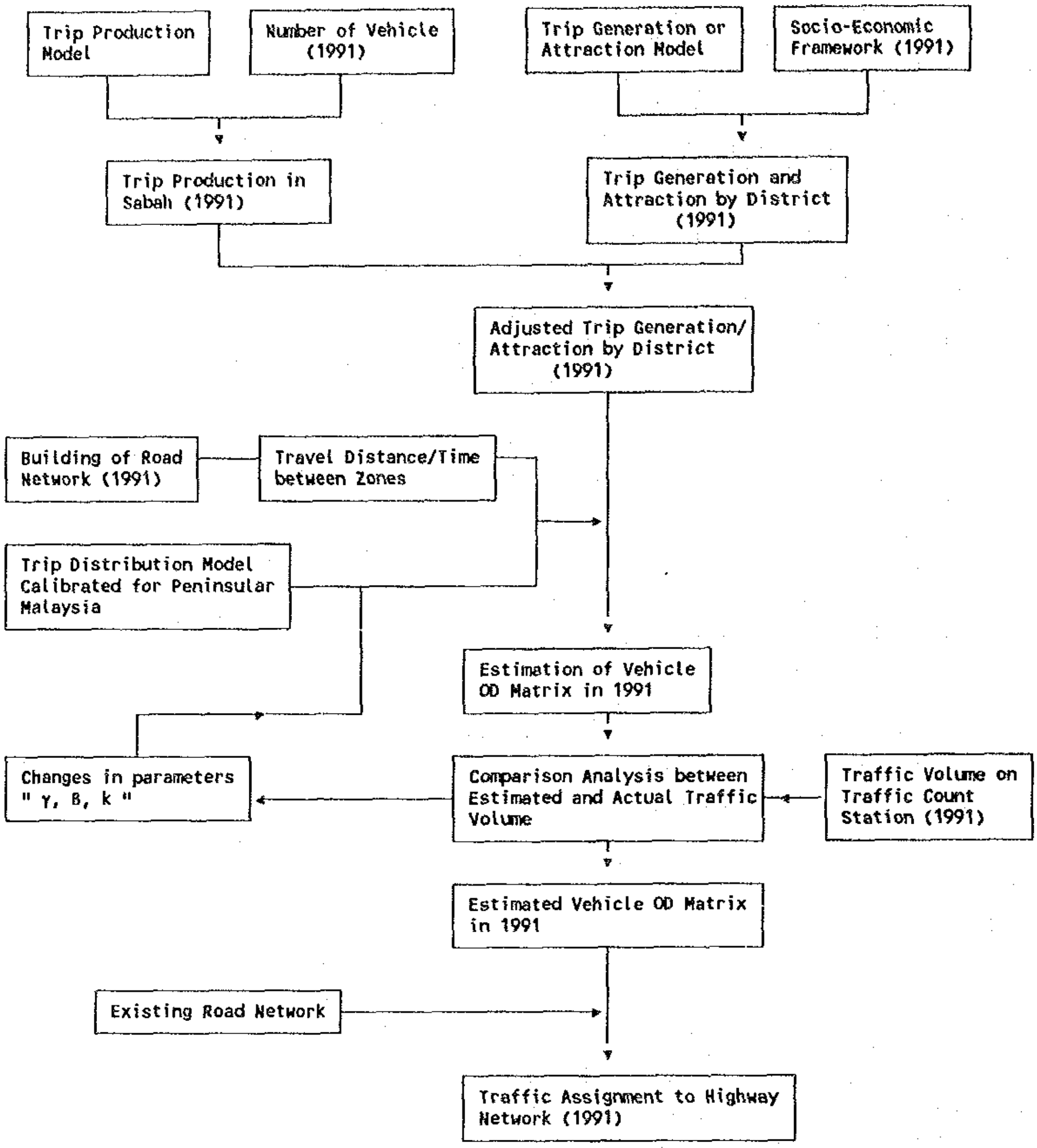


Figure 5.12: Procedure for Estimating Vehicle Traffic Demand in Sabah in 1991

(2) Trip Generation and Attraction.

Vehicle trip generation and attraction of each traffic zone is estimated and adjusted using results of the trip production volume by division discussed above.

As there is no data to calibrate trip generation and attraction model for Sabah, trip generation and attraction models for Peninsular Malaysia are adopted. These models are given in Table 5.2 in section 5.2.2. The vehicle trip generation and attraction volume by zone for Sabah in 1991 is given in Figure 2.7 in Chapter 2.

(3) OD Distribution

OD distribution in Sabah uses the BPR type Gravity model as in vehicle trip distribution for P.Malaysia under the 'Do-Something' scenario discussed in section 5.3.2. The trip distribution pattern in Sabah in 1991, expressed in desire lines between zones is given in Figure 2.9 in Chapter 2.

5.5.2 Existing Vehicle Traffic Demand in Sarawak

The estimation of existing traffic demand in Sarawak has to adopt a different approach from that for Sabah, mainly because of the availability of past OD data in the CRT Master Plan Study. Data collected from the roadside traffic count, travel mode and vehicle owner interview surveys are used to update the 1988 OD traffic volume for Sarawak.

The procedure for estimating vehicle traffic demand in 1991 is illustrated in Figure 5.13 which consists of four (4) major steps :-

a) Estimation of Trip Production
b) Estimation of Trip Generation and Attraction
c) Updating 1988 vehicle traffic OD in the CRT Master Plan Study to 1991,
d) Trip assignment and adjusting the 1991 vehicle traffic OD through comparison analyses between the assigned and actual observed traffic volumes.

(1) Trip Production

Trip production rate method used for estimating existing trip production by division in Sabah is also applied for the estimation of vehicle trip production volume in Sarawak. Trip production rates by vehicle type in Sarawak are obtained from the traffic surveys. These are found to be 3.5 trips/day for car, 7.1 for bus and 3.3 for lorry.

The existing vehicle trip production volume by division in Sarawak is estimated with the above trip rates by vehicle type and the corresponding number of vehicles registered by division.

(2) Trip Generation and Attraction

As in the estimation of trip generation and attraction for Sabah, trip generation and attraction models calibrated for Peninsular Malaysia are applied with the estimated zonal socio economic indicators to arrive at trip generation and attraction by zone for Sarawak in 1991. The trip generation and attraction calculated for Sarawak are then adjusted with the estimated trip production volumes. The trip generation and attraction by zone in Sarawak in 1991 is given in Figure 2.8 in Chapter 2.

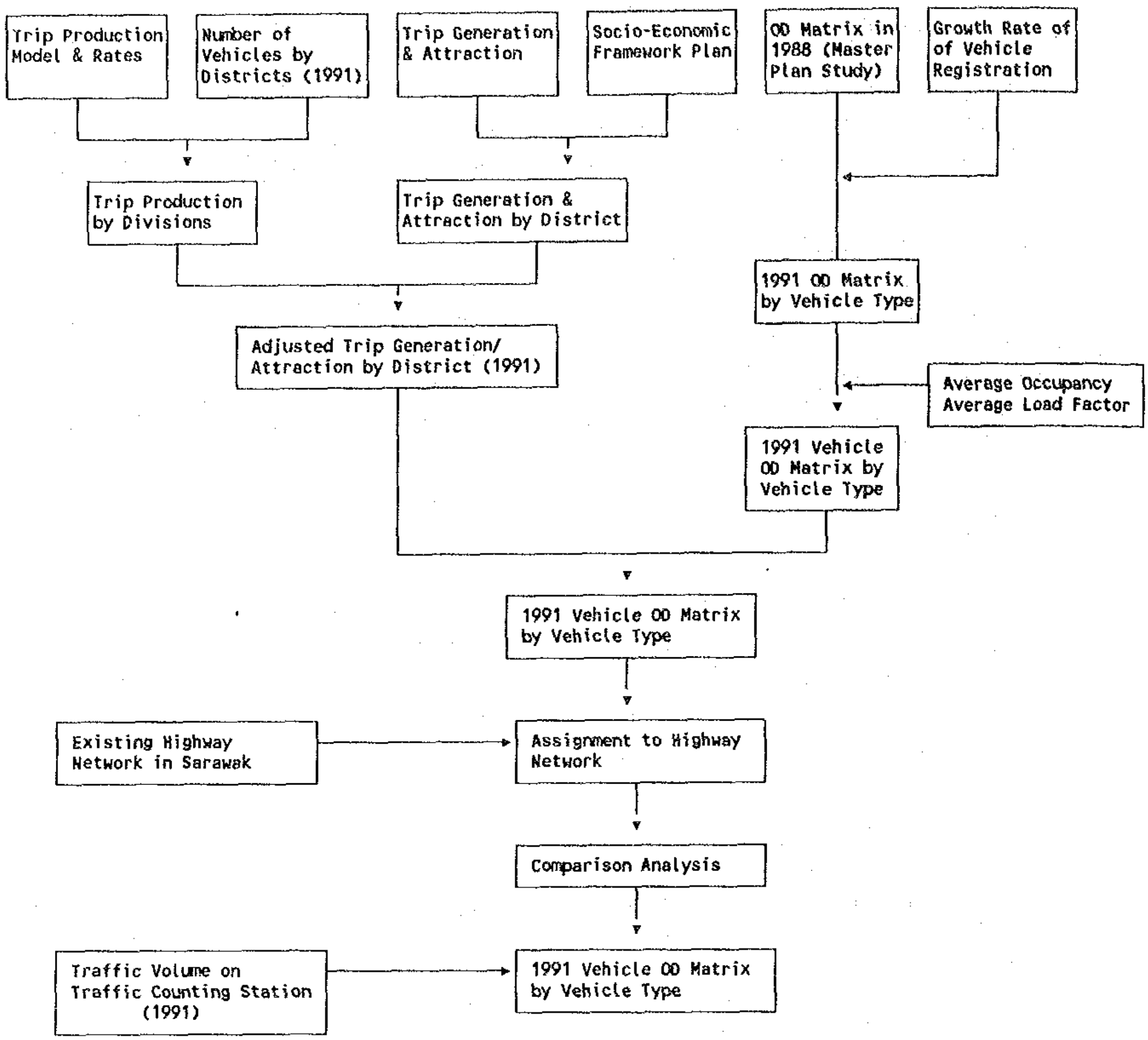


Figure 5.13 : Procedure for Estimating Vehicle Traffic Demand in Sarawak, 1991

(3) Updating the 1988 Vehicle OD Traffic Volume

The updating of the 1988 vehicle OD matrix reported in the CRT Master Plan Study for Sarawak is carried out with the execution of the following steps.

a) Update the vehicle OD matrix from 1988 to 1991 by vehicle type using growth factor of vehicle registration by zone from 1988 to 1991,
b) Adjust this updated 1991 vehicle OD matrix by vehicle type using the estimated trip generation and attraction by zone,
c) Compare the results between estimated trip distribution between zones with actual traffic volumes observed across screen lines,
d) Finalise and fine-tune the 1991 vehicle OD matrix by vehicle type in Sarawak.

The 1991 vehicle trip distribution in Sarawak expressed in desire lines between zones in Sarawak is given in Figure 2.10 in Chapter 2.

5.5.3 Vehicle Traffic Demand Forecasting for Sabah and Sarawak to Year 2010

The forecasting of future traffic demand in Sabah and Sarawak to year 2010 will be done in one single process as these two states will be linked by a proposed highway in future. The procedure of forecasting future traffic demand in Sabah and Sarawak also basically follows the four step method of trip production, trip generation and attraction by zone, trip distribution and trip assignment.

Future trip production volumes are obtained from both the future number of vehicles and trip production rates. Future trip generation and attraction volumes by zones are estimated using the future socio-economic framework by zone. Future trip distribution pattern is forecasted using the BPR Gravity Model to take into account the improved accessibility of zones. Figure 5.14 shows the procedure for future traffic demand forecasting for Sabah and Sarawak to year 2010.

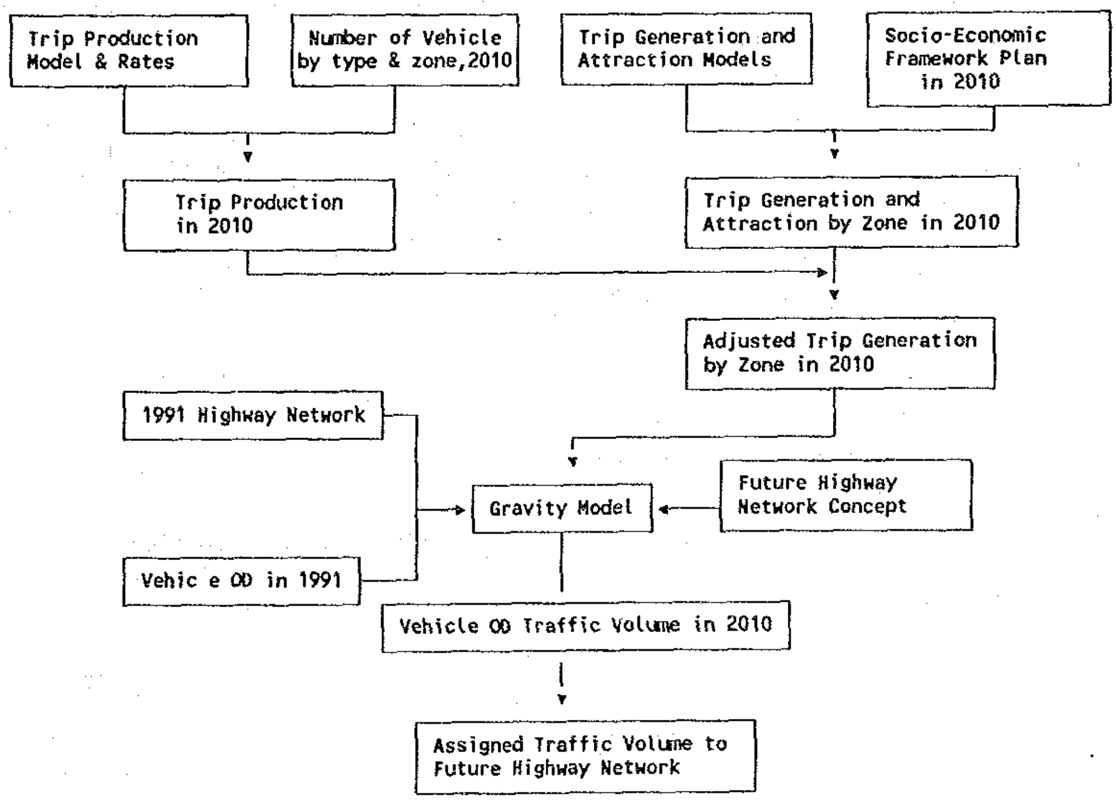


Figure 5.14 : Procedure for Future Traffic Demand Forecasting in Sabah and Sarawak

(1) Future Trip Production in Sabah and Sarawak

The Trip Production Rate Method is used to forecast the future trip production in Sabah and Sarawak to the year 2010. The future trip demand is expected to grow by 6.1% in Sabah and 6.0% in Sarawak per year to 2010. The future total vehicle trip production (vehicles per day) by vehicle type for Sabah and Sarawak are given in Tables 5.5 and 5.6 respectively.

Table 5.5 : Future Vehicle Trip Production by Vehicle Type for Sabah, 2010

Type of Vehicles	Year 2010			Year 1991	Average Annual Growth Rate 1991-2010
	No. of Vehicles ('000)	Trip Rate (Trips/Veh)	No. of Trips ('000)	No.of Trips ('000)	
Car	456.5	4.1	1872	574	6.4
Bus	13.2	7.1	94	28	6.6
Lorry	31.6	4.5	1042	369	5.6
Total	701.3	-	3008	971	6.1

Table 5.6 : Future Vehicle Trip Production by Vehicle Type for Sarawak, 2010

Type of Vehicles	Year 2010			Year 1991	Average Annual Growth Rate 1991-2010
	No. of Vehicles ('000)	Trip Rate (Trips/Veh)	No. of Trips ('000)	No. of Trips ('000)	
Car	448.6	3.5	1570	494	6.3
Bus	3.8	7.1	27	9	6.0
Lorry	103.8	3.3	343	137	4.9
Total	556.2	-	1940	640	6.0

(2) Trip Generation and Attraction

Trip Generation and Attraction models used in estimating the 1991 traffic volumes in Sabah and Sarawak are applied to forecast future trip generation and attraction to year 2010. The independent variables of employment and GDP by Traffic Zone are used as socio-economic indicators for the forecasting. Figure 5.15 depicts the trip generation and attraction by zone for Sabah and Sarawak in 2010.

(3) OD Distribution

The gravity model is applied for Sabah and Sarawak as the Fratar model is not applicable in a situation where a new zone is created after the base year volume has been determined. The BPR Gravity Model is selected which allowed the existing OD distribution pattern to be considered. The future traffic demand pattern for Sabah and Sarawak expressed in desire lines between traffic zones is shown in Figure 5.16.

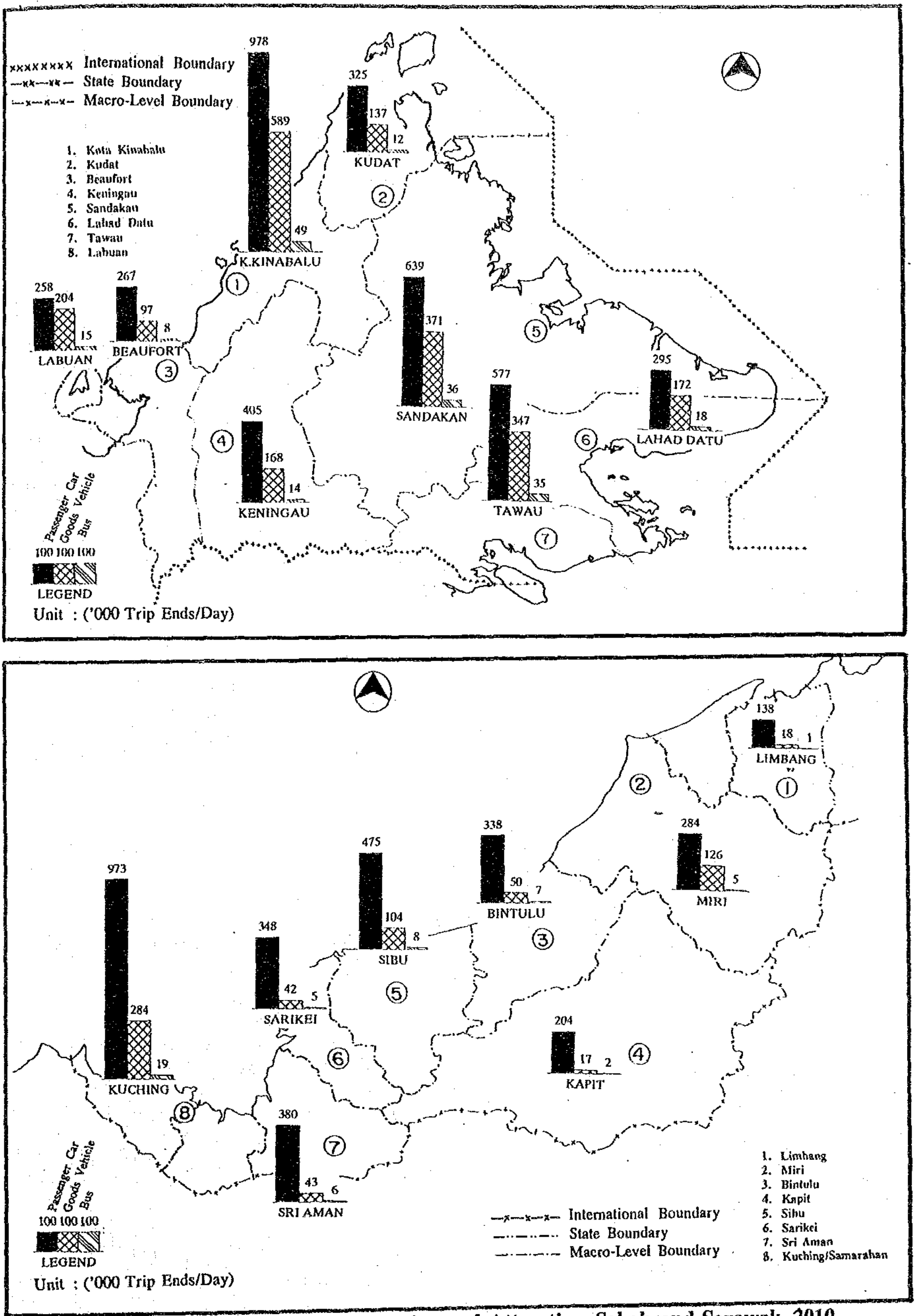


Figure 5.15: Vehicle Trip Generation and Attraction, Sabah and Sarawak, 2010

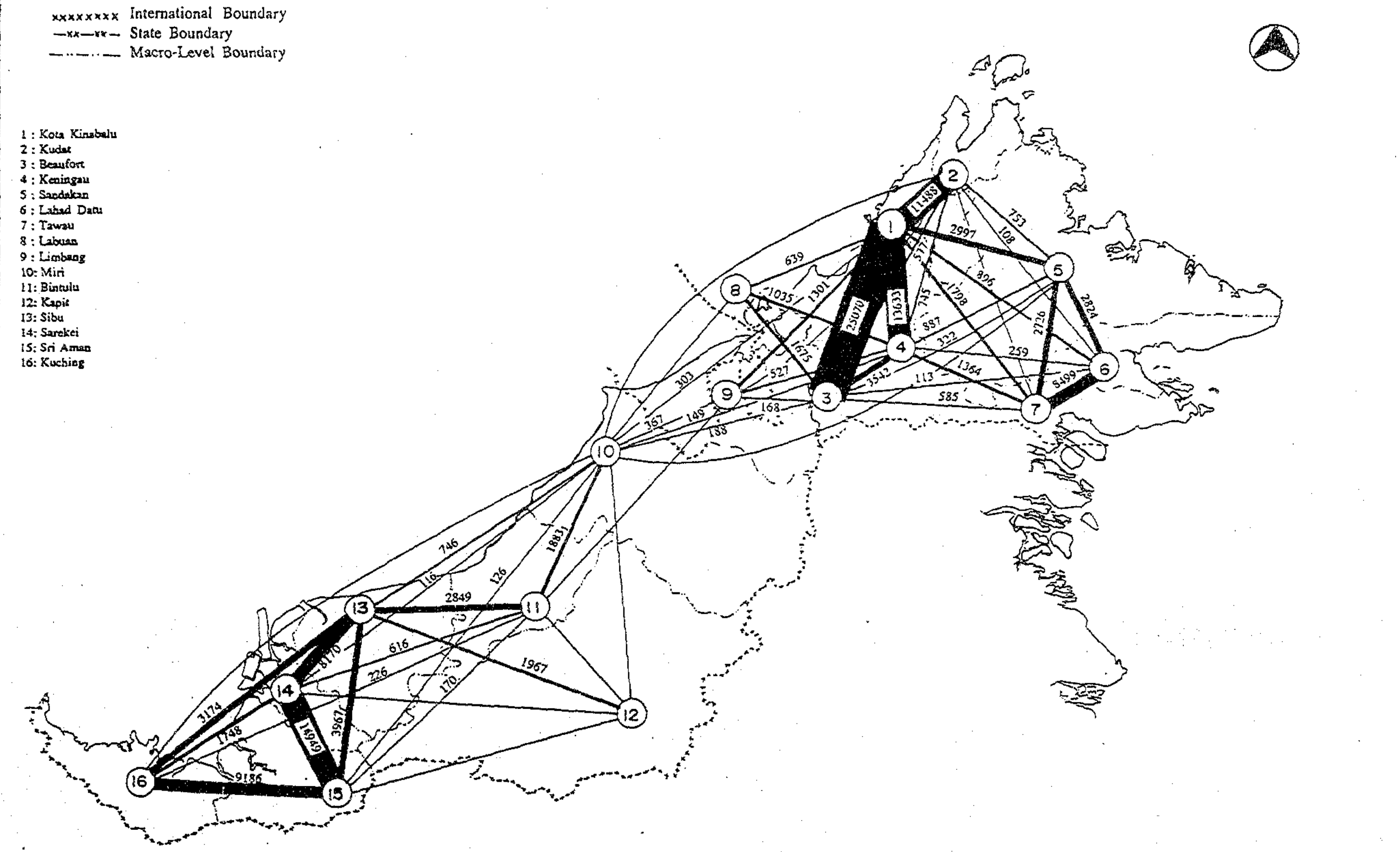


Figure 5.16 : Vehicle Trip Distribution Pattern in Sabah and Sarawak, 2010 Unit: (Vehicle/day)

CHAPTER 6

HIGHWAY NETWORK DEVELOPMENT PLANNING

FEDERAL ROUTE NO 3 BETWEEN
KOTA BAHRU AND KUALA TERENGGANU

CHAPTER 6 : HIGHWAYNETWORK DEVELOPMENT PLANNING

6.1 Introduction

In formulating the highway network development plan, all planning factors must be taken in consideration. These factors include the natural features of the study area, socio-economic characteristics, existing road facilities and conditions, location of special development projects, traffic volume and environmental aspects.

The natural features that must be considered when formulating the highway network development plan are topographic, geology and other natural constraints such as swamps, rivers and heavy rainfall areas. The socio-economic indictors reflect the various national development programs or projects the country has set to achieve. Urban development strategy of developing a well balanced hierarchy of urban centers, industrial development especially in resource rich but lagging regions, tourism and regional land development schemes are some of the socio-economic development factors considered in the Study.

The approach in this Chapter in formulating the highway network development plan thus follows the four major steps of:

(a) Setting of Goals and Objectives
(b) Considerations of Planning constraints and factors,
(c) Highway Network Planning Strategies and Concept Plan,
(d) Formulation of Alternative Network Plans.

This approach is further illustrated in Figure 6.1.

The planning goals and objectives are formulated to solve the existing highway development problems and to achieve a desirable state of highway development in the country. Five goals and their respective detailed objectives are described in section 6.2. Specific network development strategies were developed based on the goals and the various planning constraints and considerations.

An overall network development concept outlining the corridors of highway development and linkages was then drafted. Three alternative network plans were developed and their respective alternative regional networks (for the Northern, Southern, Eastern and Central Regions) were developed and examined for P.Malaysia.

Analyses on the impacts of these three alternative network plans in handling future traffic demand were carried out and the results can be found in the Appendix Volume. The alternative plans were further evaluated economically in Chapter 8.

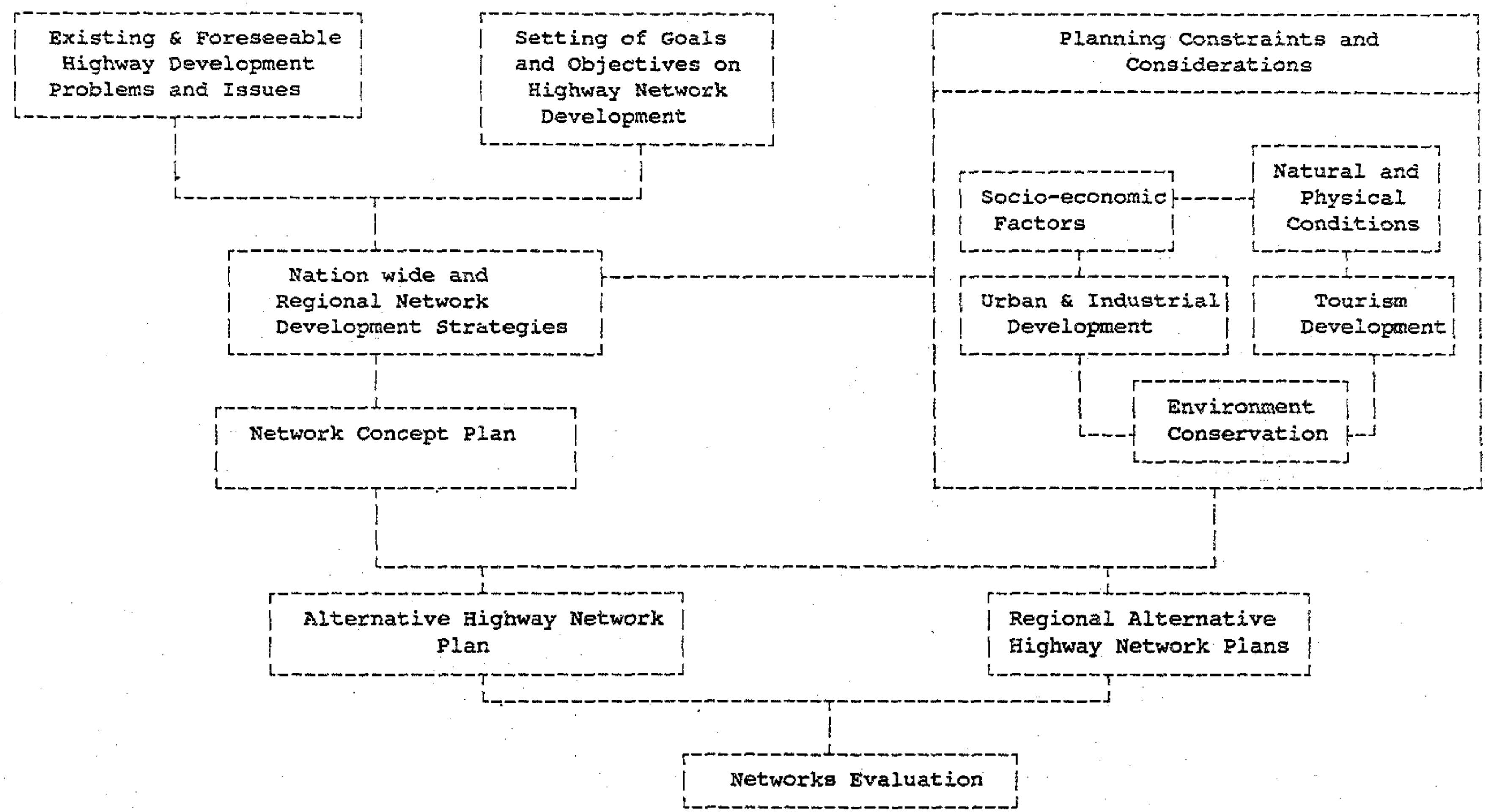


Figure 6.1: General Approach in Developing Alternative Highway Network Plans

6.2 Planning Goals and Objectives

The planning of a national highway network requires comprehensive analyses on the various factors which include the natural features of the planning areas, regional socio-economic development characteristics, existing transport facilities and traffic demand.

Regional socio-economic development characteristics are in turn determined by a number of factors such as urban, industrial and regional development programs. Transport facilities include not only the existing and planned road facilities but also development of other facilities like airports, seaports and others. Together with considerations on the natural features is the concern for environmental conservation. All these issues and factors have to be carefully weighed and considered when planning the network.

The planning of an efficient national highway network is also an important effort in the overall national development program in achieving the national development goals and aspirations such as Vision 2020 and the NDP (New Development Policy) in the OPP2. The national highway development plan shall aim at achieving the following broad goals and specific objectives:

Goal-1: ***To develop a national highway network that complement the national economic and regional development plans of Vision 2020 and NDP of the OPP2.***

Objectives

* *To develop a highway network that possess sufficient capacity and flexibility to meet the increased travel demand generated from growth of the various economic sectors in the country towards the year 2010.*

* *To develop a highway network that can sustain the rapid growing regions as well as one that promote regional development of the lagging areas in the country.*

* *To put forth a highway network development plan that is realistic and attainable while meeting all the requirements and needs yet possesses expansibility when future needs arise.*

Goal-2: ***To develop a national highway network that is compatible with the important role played by road transport for the efficient, reliable and safe mobility of goods and people throughout the country.***

Objectives

* *To provide a highway network linking the national capital with states administrative centres and other urban service centres; points of production or supply with points of consumption or demand, as well as between points of import and export.*

* *To provide road infrastructures that encourage efficient intermodal transfers of goods and people with other major modes of travel in the country.*

* *To provide road infrastructures that minimize external diseconomies associated with transporting of goods and people, such as traffic congestion, road bottlenecks, blockages, air and noise pollutions.*

* *To provide a highway network that possess clear functional hierarchy of road types, capacity and design.*

Goal-3: ***To act as one of the means in extending urban amenities, social and infrastructure facilities to lagging regions and rural areas.***

Objectives

* *To provide road infrastructures that are in line with the urban hierarchy system set forth, thus promoting appropriate level of accessibility and distribution as well as tricking down effects of benefits to lower level centres.*

* *To provide sufficient road infrastructure to rural areas as a means to uplift the accessibility of these areas, thus bringing economic opportunities and improve investment environment to these areas.*

Goal-4: ***To develop a national highway network that does not jeopardise the quality of the natural environment and community wellbeing.***

Objectives

* *To ensure that development of road infrastructures does not incur extensive destruction to the natural environment and where possible, unique and sensitive natural habitat must be preserved.*

* *To ensure that the development of road infrastructures does not disrupt community life, adversely affecting public health, well being and safety of local communities.*

Goal-5: ***To develop a national highway network that encourages a more balance distribution of transport needs among the various modes of travel in the country.***

Objectives

* *To ensure that investment on road transport infrastructure does not become an over burden to the national resource through the encouragement of a more balance share of transport demand among the other modes of travel.*

6.3 Highway Network Planning Approach

The approach applied in this Study in formulating a national highway network plan for Malaysia basically dealt with the following four major steps:

a. Identification of existing and foreseeable road transport problems and issues,

b. Analyses of highway network planning constraints, considerations and other factors,

c. Formulate a functional highway network concept or classification,

d. Formulate an overall highway network development concept plan that takes into account the highway development policies and strategies outlined above, while satisfying the various physical development constraints, socio-economic development aspirations and environmental requirements.

e. Preparation of alternative network plans and the evaluation of these plans.

6.4 Existing and Foreseeable Road Transport Problems and Issues

The existing road transport situations and inherent problems have been elucidated in Chapter 3. The followings are necessary to mitigate the various problems.

a. The need to strengthen the present highway network
b. The need to mitigate traffic congestion
c. The need to strengthen road structure and alignment
d. The need to rationalize the role of road transport.

Future traffic demand forecasted as described in Chapter 5 envisaged an increase of about 3 times from the present level. By 2010, some inter-state travel demand on the west coast of Peninsular Malaysia for instance will face an increase as high as 7 times the present traffic demand.

The implications of such an increase are many fold unless road development can also increase the present road infrastructure facilities correspondingly by 3 to 7 times. As such future scenario is unlikely, many of the present road transport problems identified will worsen in the near future.

a. Traffic congestion due to insufficient capacity of highway will deteriorate with the results that travel cost will increase rapidly as well as increase air and noise pollution.

b. Many of the industrialization and regional development programs cannot be fully achieved due to the hampering of transport efficiency that is needed to promote growth of these sectors.

c. Traffic accidents are likely to increase very rapidly causing more losses to properties and lives.

6.5 Highway Network Planning Constraints and Considerations

Various planning factors and considerations must be carefully taken into account when formulating the national highway network in order to achieve the goals and objectives given in section 6.2 and in solving if not mitigating the present and foreseeable future road transport problems. Planning factors and considerations that need to be examined and studied range from the natural topographic and geological properties of the study area to man-made development programs like industrialization projects, ports and airport construction. Among the various factors considered in this Study are:

(1) Topographic and Geological Features

Severe topographic features posed by the central Main Range in Peninsular Malaysia, the Croaker Range in Sabah and Sarawak are the natural constraints to highway development. Steep slopes and rapid rivers or large water bodies would present challenges in design and high cost of construction. More importantly, the cutting of slope and removal of natural vegetation to make way for highway construction may pose environment problems such as soil erosion and loss of ground cover.

(2) Climatic Influences

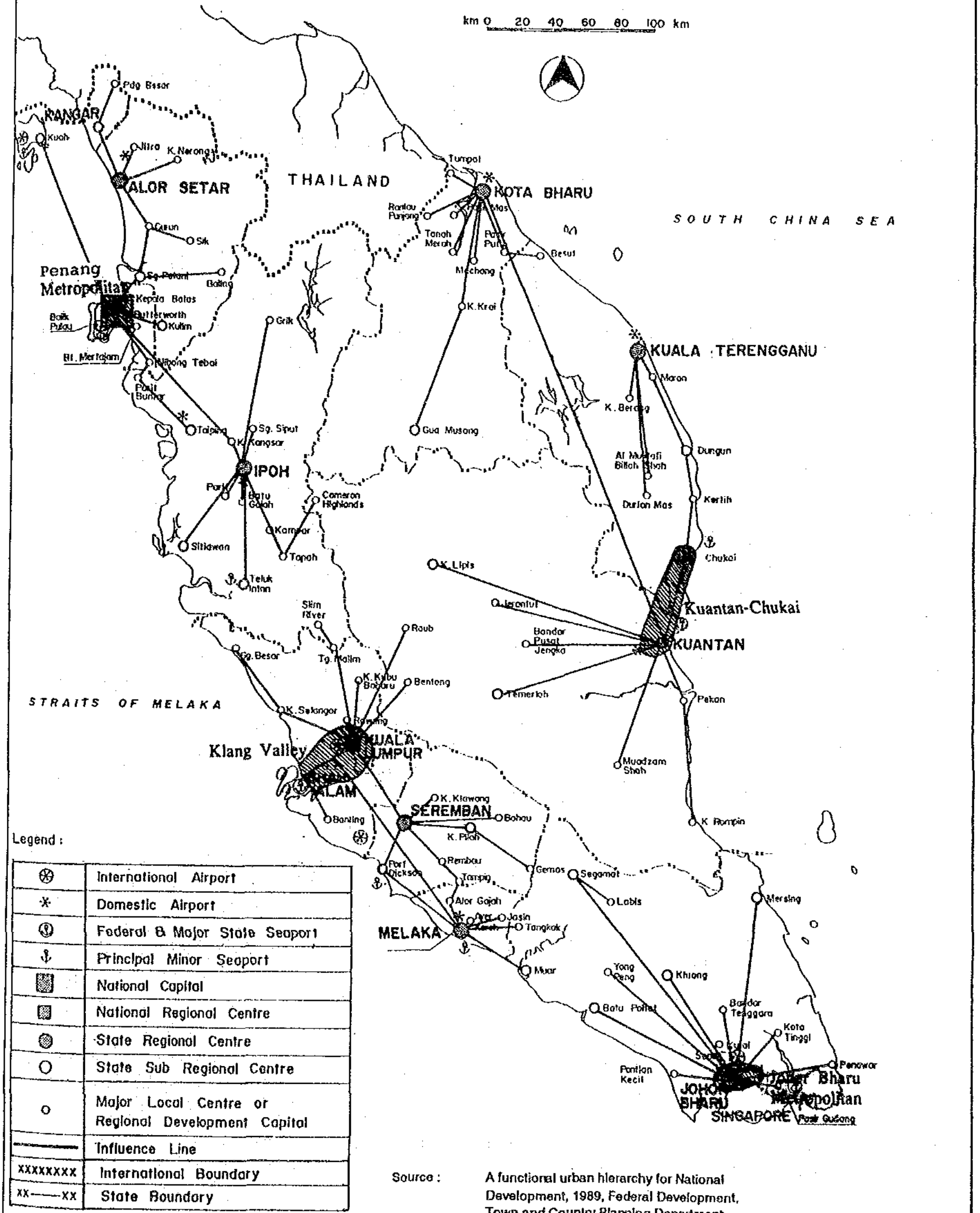
Climatic considerations in highway planning involve the identification of areas that experience consistent heavy rainfall or strong winds. Areas with heavy rainfall may require special emphasis to structural design and drainage. Mitigation measures may also be required against flash floods and slope failures.

(3) Urban Development and Hierarchy System

The National Urbanization Policy targets that about 50% of the Malaysian population will be residing in urban areas by the end of 2010. This will be achieved through the development of a systematic urban hierarchy system as indicated in Figures 6.2 and 6.3. It consists of 7 tiers of urban centres from national capital to rural growth centre in Peninsular Malaysia, and 4 tiers in Sabah and Sarawak.

(4) Industrial Development Plans and Programs

The Industrial Estates Study in Malaysia (IESM) conducted by EPU proposes a pattern and sequence of development over the coming short (5 years), medium (10 years) and long term (20 years) periods. This study was done in view of the rapidly changing socio-economic situations since the Industrial Master Plan (IMP) was incorporated in 1983.



Source : A functional urban hierarchy for National Development, 1989, Federal Development, Town and Country Planning Department.

Figure 6.2: Urban Hierarchy in Peninsular Malaysia

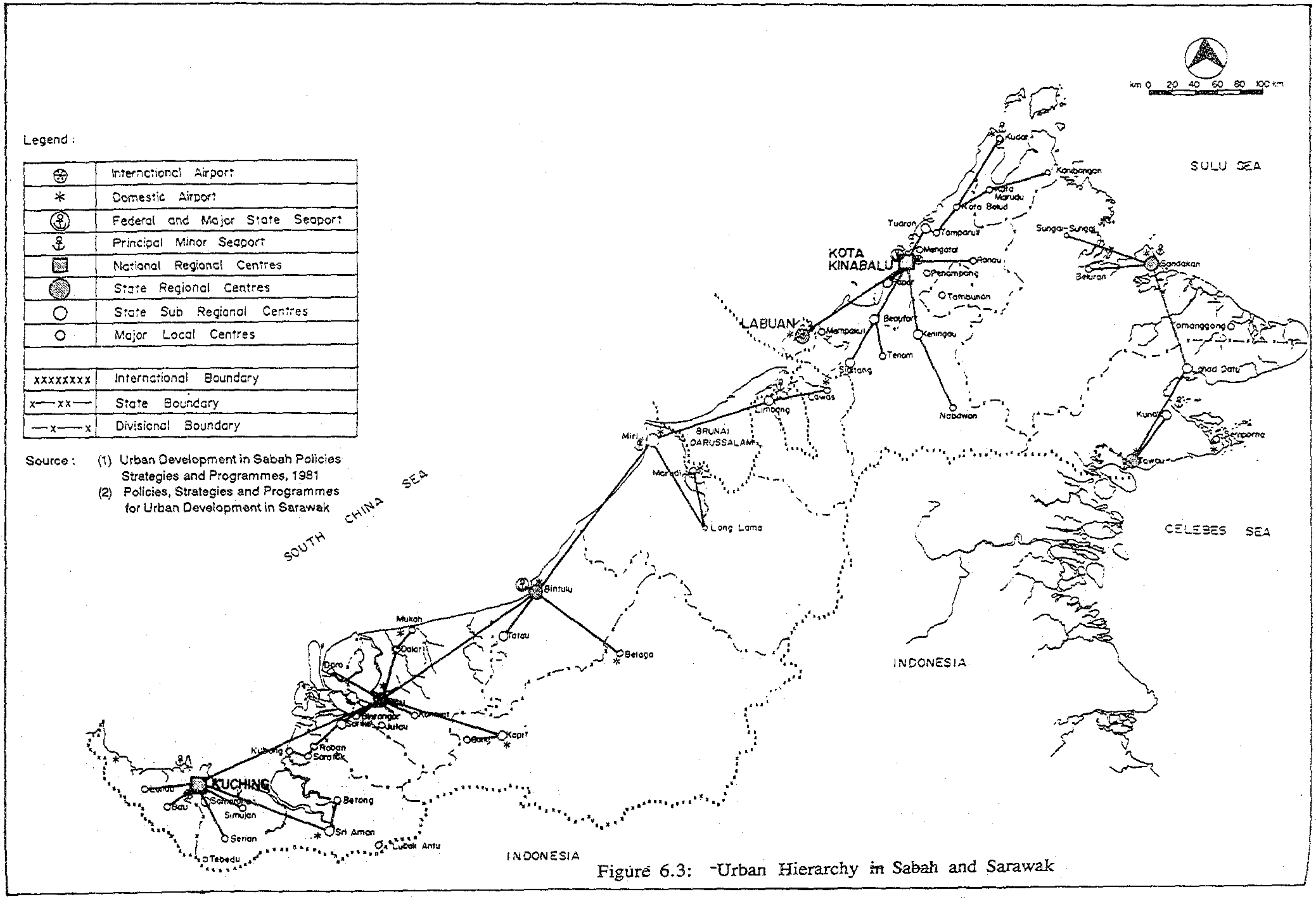


Figure 6.3: Urban Hierarchy in Sabah and Sarawak

The IESM is to adopt a new industrial development strategy by identifying Principal Growth Area (PGA) and to concentrate industrial developments in selected growth centres so as to disperse benefits of industrial growth to the less developed rural areas.

The PGA and selected growth centres under the IESM are shown in Figures 6.4 and 6.5. There are a total of 10 PGA in Peninsular Malaysia and 2 in Sabah and Sarawak. Each PGA is basically a grouping of towns linked with good transport network and communication system. Developments are to be emphasized in secondary growth centres within each of these PGA.

The formulation of the national highway network shall therefore take cognizance of this industrial development strategy and plan for a network to promote the realization of this program.

(5) Major Tourist Development Areas

Great emphasis has been given by the Government to promote this fast growing and important service sector of tourism. Besides the direct facilities that need to be developed for the tourists, the success of this effort also lies in the level of accessibility to the tourist attraction areas in the country. Access by air and roads are two transport facility considerations. The major tourist development areas are Langkawi Island, Tioman Island, Pangkor Island, Penang Island, Melaka, Kenyir Lake, Muda Lake, Kuantan-Pekan, Desaru, Port Dickson, Cameron Highland and Taman Negara in Peninsular Malaysia. Areas in Sabah and Sarawak are Mulu Caves Park, Niah Caves Park, Bako National Park and Mt.Kinabalu Park.

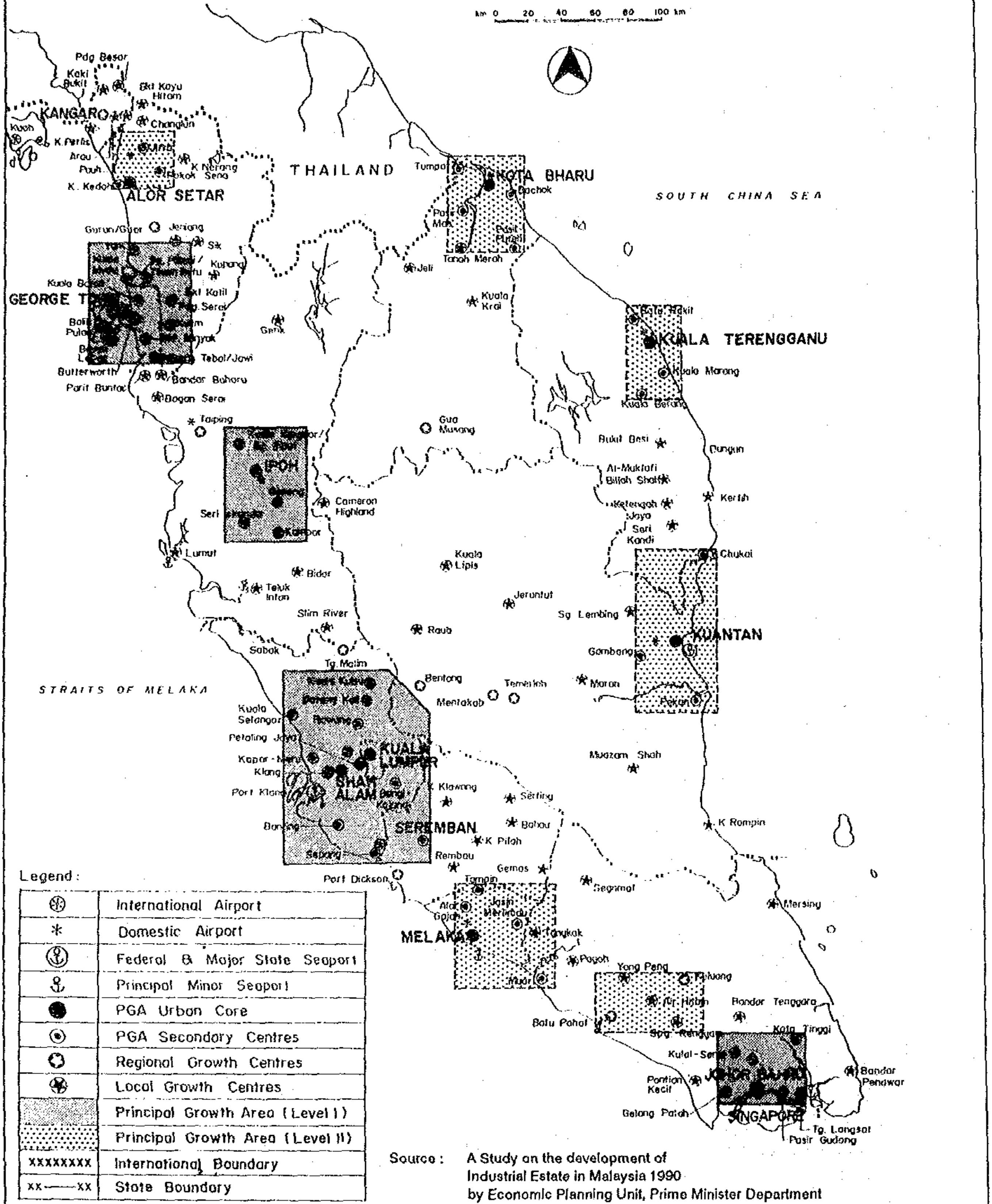
While some of these areas are presently well served with air and road transport, many are in need of good transport linkage with established towns. Considerations shall therefore be given to the provision of highway linkages to these areas in the future highway network plan.

(6) Transport Facilities

Airports and ports (including inland ports) all require highway accesses to function. Although most of the existing ports and airports in the country are well served with road accesses, future facilities such as Rajang Port, Lumut Port, and other planned inland ports require the provision of good road accessibility.

(7) Regional Land Development Schemes

Regional land development schemes form the main thrust of regional development strategy in Peninsular Malaysia. Schemes such as DARA, KETENGAH, KEJORA, KEDA, KESEDAR, and JENGKA are aimed at eradicating poverty in rural and under-developed regions. Each of these schemes are planned with specific growth centres in providing basic urban facilities and amenities to the settlers. Linkages to these growth centres with established towns are therefore vital for their growth and development.



Source: A Study on the development of Industrial Estate in Malaysia 1990 by Economic Planning Unit, Prime Minister Department

Figure 6.4: Industrial Development PGA in Peninsular Malaysia

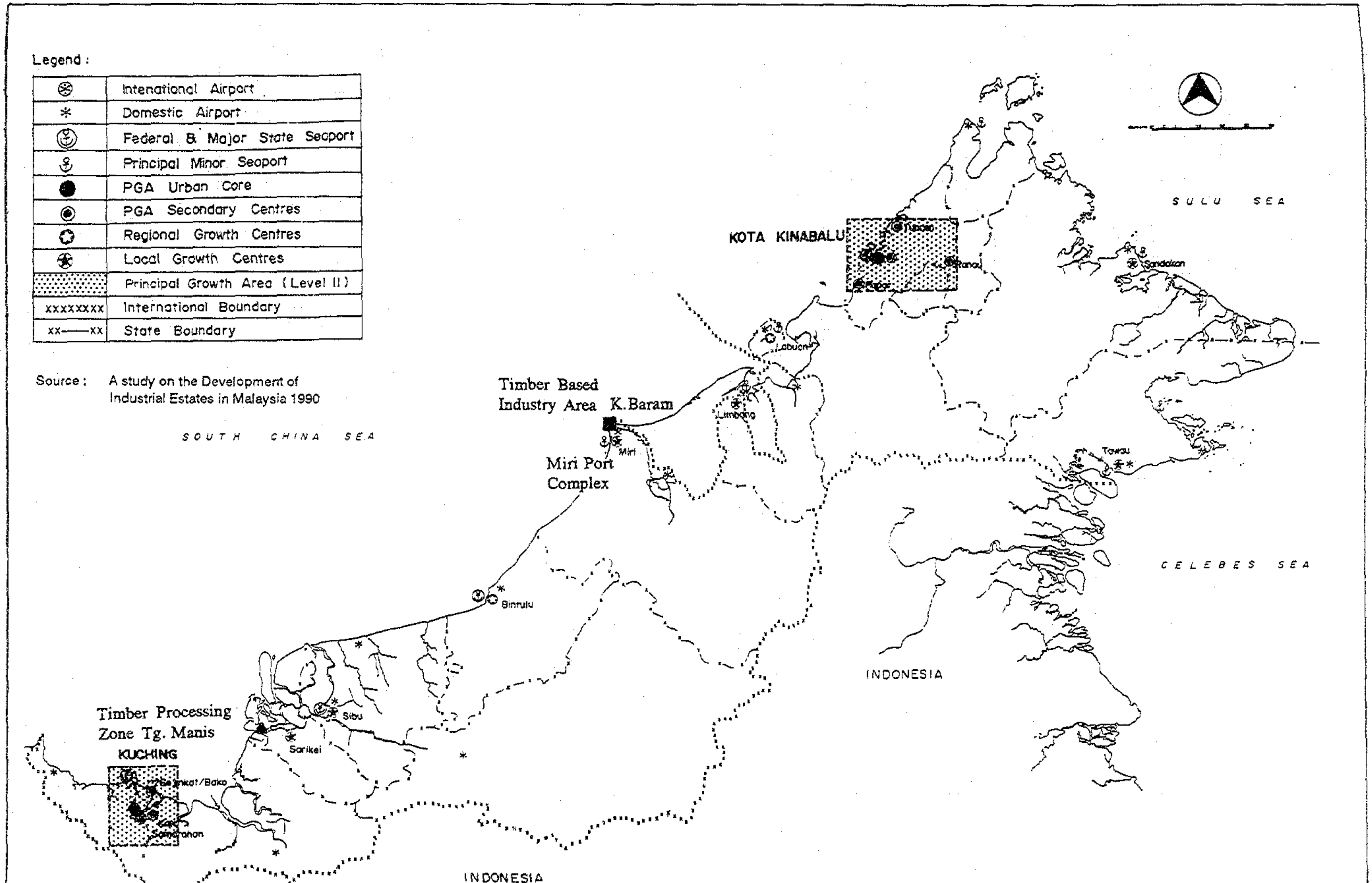
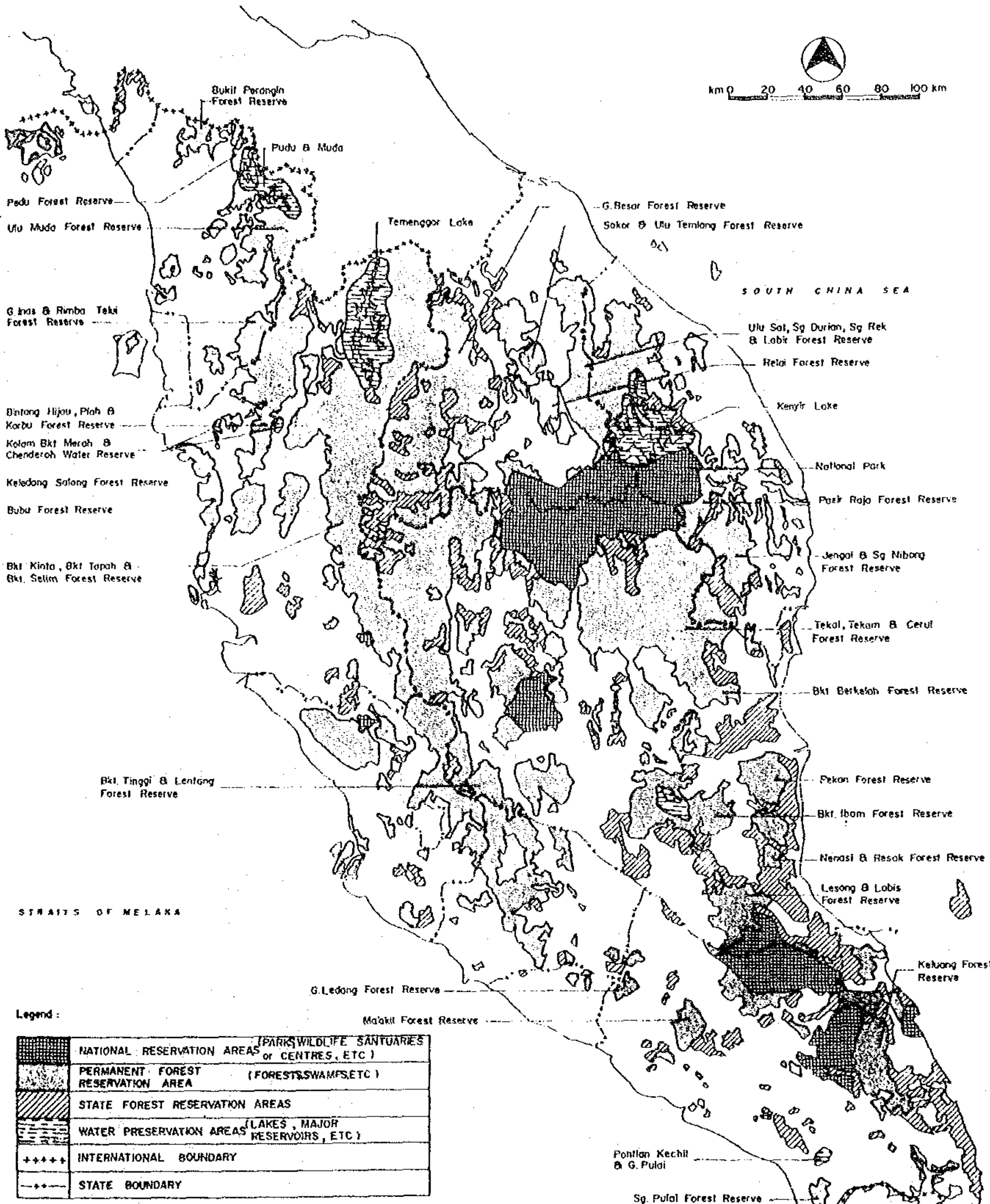


Figure 6.5: Industrial Development PGA in Sabah and Sarawak

(8) Environmental Conservation and Reservation Areas

Conservation and preservation of natural forests, fauna and flora are increasingly given great importance in national development planning. The growing concern on environmental destruction of ecosystem indicates that road construction should be balanced with the preservation of natural resources. Special concern should be paid to the consequences of opening new hinterland and reserve areas to major highway development. The existing reserve areas such as the National Parks, mangrove areas, permanent forest reserves, limestone hills, water catchment areas and other reserves must be carefully studied and taken into consideration in highway development planning. Sound management of these valuable assets are essential in ensuring the continuous availability of such vital assets as water, timber, marine life and natural recreation areas while simultaneously prevent possible environmental pollution and hazards.

There are many national parks and nature reserves gazetted by the Government. The forest department and wildlife department are also continuously identifying new areas to be conserved or preserved. These are shown in Figures 6.6 and 6.7. Major highway development through these sensitive habitats must be avoided at all cost while provision of minor road accesses to these areas is important both for the promotion of tourism as well as facilitating properly management and patrol of these parks.



Source : Forest Department,
Geology Department,
National Mapping Department and
Environmental Department, 1991.

Figure 6.6: Natural Conservation Areas in Peninsular Malaysia

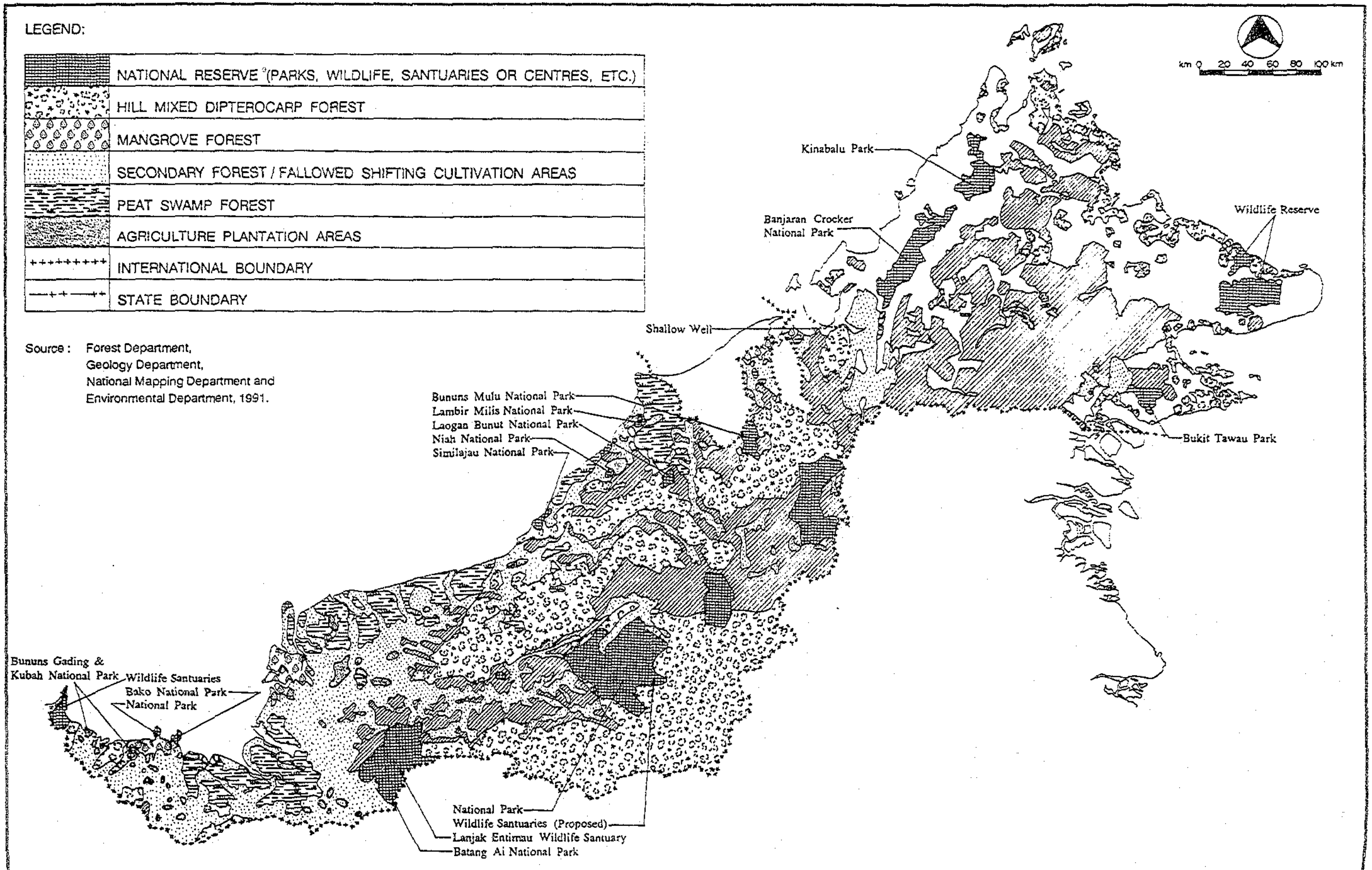


Figure 6.7: Natural Conservation Areas in Sabah and Sarawak

6.6 Highway Network Development Strategies

6.6.1 Highway Development Strategies at the National Level

(1) Strengthen highway linkages of the North-South corridor in the west coast of Peninsular Malaysia since it still possesses the highest economic growth potentials; and those in the east coast and central corridors of Peninsular Malaysia for promoting urban and industrial development in these less developed corridors thus contributing to the achievement of a more balanced socio-economic development throughout the Peninsular.

(2) Improve and strengthen the coastal trunk road network in Sabah and Sarawak to provide a more reliable road transport infrastructure and promote further socio-economic growth of the coastal townships, growth centres and industrial development areas.

(3) Strengthen linkages between the east and west coasts of Peninsular Malaysia to help speed up growth of the east coast regions and land development schemes.

(4) Provide a direct linkage between Sabah and Sarawak via Limbang to promote further socio-economic growth and cooperation between the two states.

(5) Expand the road network in Sabah and Sarawak to the hinterland areas in providing basic road accessibility to facilitate the provision of better and basic urban facilities and amenities to their inhabitants.

(6) Provide better road accesses to important focal points such as ports, airports, tourist and industrial development areas, new growth centres and regional land development schemes.

(7) Minimize intrusions into gazetted national parks, nature reserves, mangrove habitats; reduce cutting of steep terrain and avoid major disruptions of established social communities.

These highway development strategies are figuratively expressed in Figures 6.8 and 6.9.

While these are broad strategies for highway network development at the national level, more specific strategies are established at the regional level to specifically address the regional highway planning issues and needs. These will later guide the development of regional highway network (the north, east, south, central regions in Peninsular Malaysia, and Sabah, Sarawak).

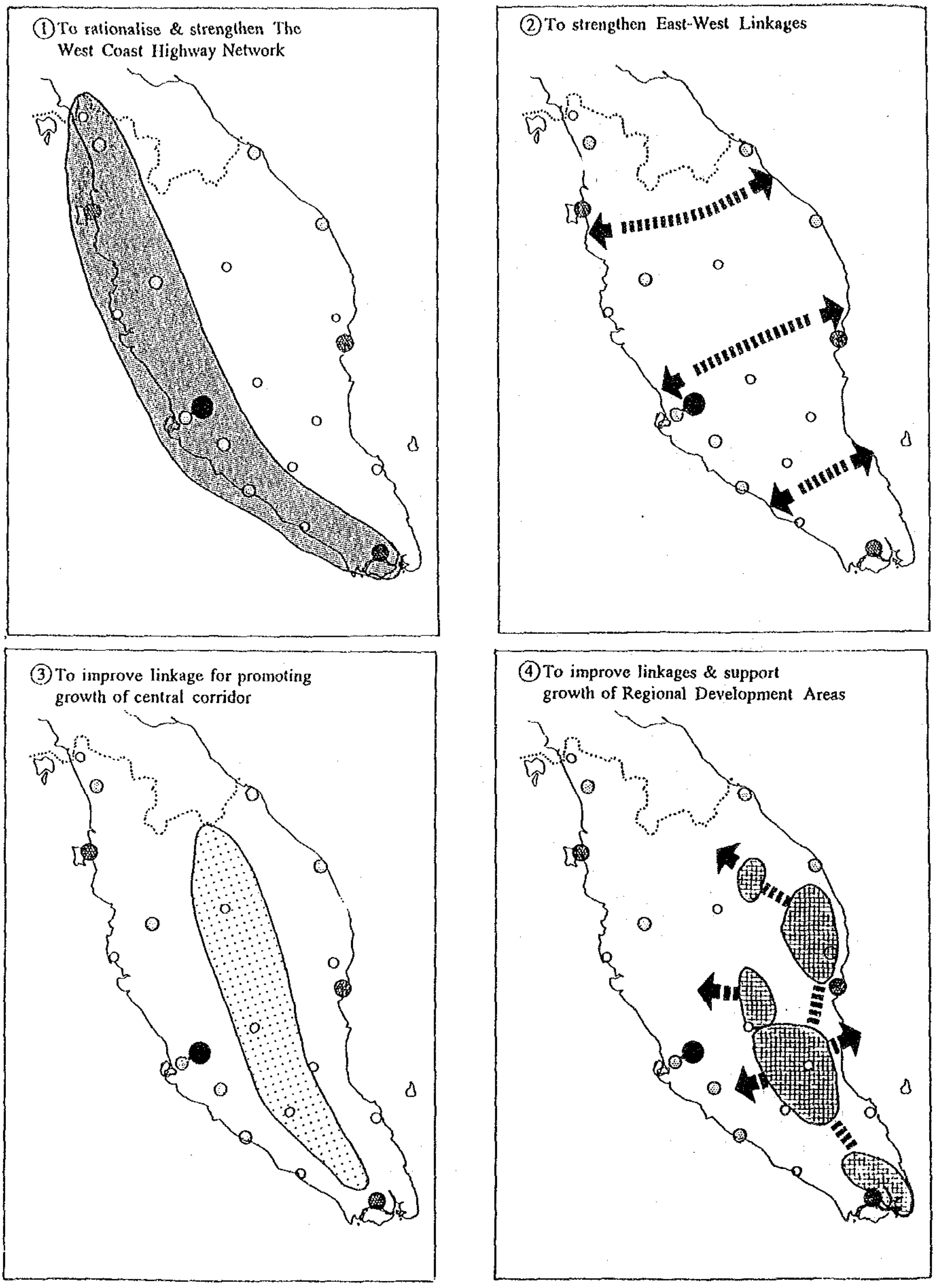
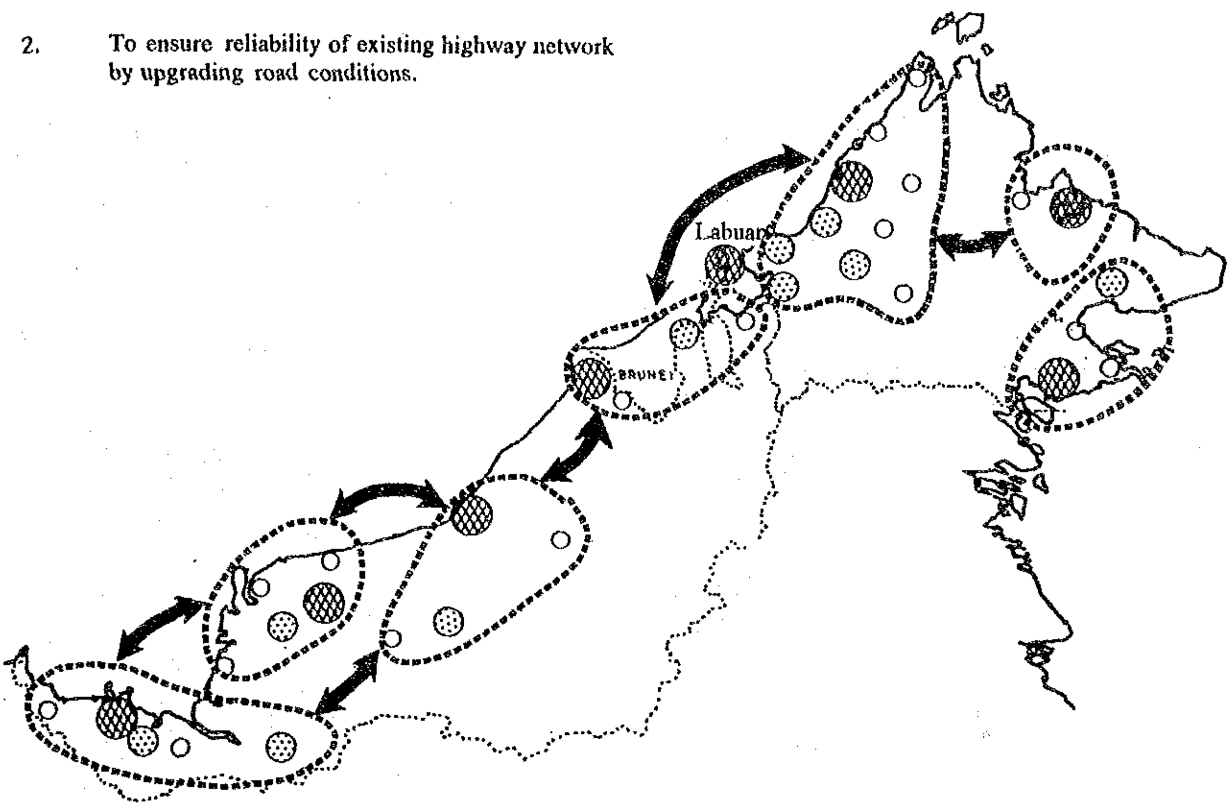


Figure 6.8: Highway Development Strategies in Peninsular Malaysia

1. To foster increased economic linkages among scattered urban centres.

2. To ensure reliability of existing highway network by upgrading road conditions.



3. The integration of Kuching in Sarawak to Kota Kinabalu in Sabah for promoting the growth of coastal corridor.

4. To provide adequate accessibility to coastal towns, the interiors and sub-regional centres including accessibility to Brunei via Sabah and Sarawak

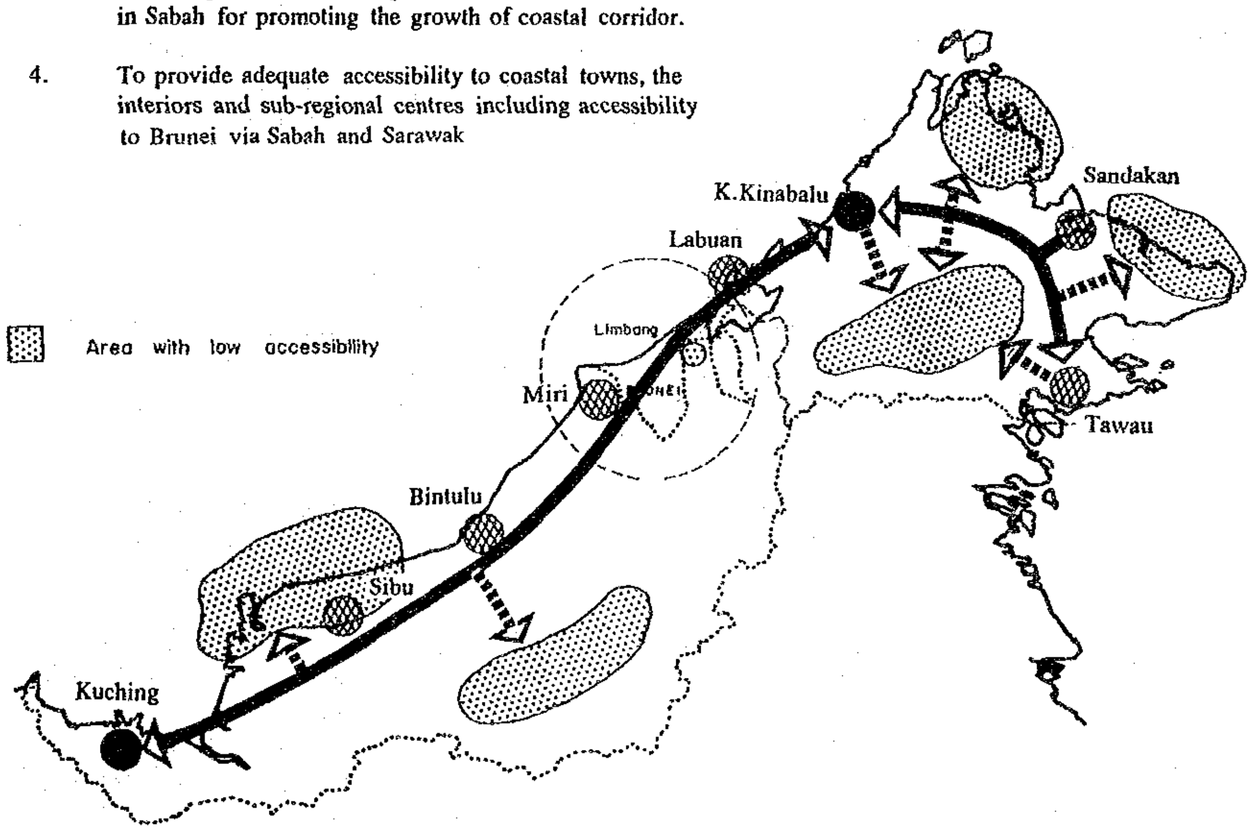


Figure 6.9: Highway Development Strategies in Sabah and Sarawak

6.6.2 Highway Development Strategies at Regional Level

(1) Correct unbalanced socio-economic growth between state regional centres and state sub-regional centres within the region; and promote equity in distribution of benefits by means of providing better highway linkages to major or minor local centres.

(2) Promote modernization of agriculture, development of agro-based and cottage industries within the region, by providing better highway links from the higher functional urban centre to lower functional centres.

(3) Provide better linkages from established state regional centres to planned growth centres in regional land development schemes in Johor, Trengganu, Kelantan, Pahang and Kedah.

(4) Provide direct linkages for the scattered inland towns to the more established coastal centres, in an effort to strengthen better economic ties and help promote development of the hinterlands in Sabah and Sarawak.

(5) Improve road network configuration and capacity in the most developed central region of Peninsular Malaysia in alleviating transport diseconomies associated with traffic congestions, accidents and air pollution by vehicles.

These regional strategies are reflected in the establishment of regional highway network in section 6.7 below.

6.7 National and Regional Highway Network Concept Plans

6.7.1 Functional Highway Network Classification

The national highway network envisaged for Malaysia in future shall consists of the following highway systems with their respective service level and functions:

(1) Principal Highway System

The principal highway system shall make up of routes spanning over the country with the following functions and service characteristics:

a. to cater for corridor movement with long trip length and high density commensurate with national and interstate travel,

b. to cater for travels between the national capital and state regional centres,

c. to link international seaports, airports and major international boundary connections.

The principal highway system is thus made up of expressways and highways. An expressway for this Study is taken to be a divided highway with full access control, allowing high speed travel and direct linkages to national capital and national regional centres. Highways classified in this category are routes that form part of the basic framework of the national trunk road network and are designed to provide high speed travel and smooth traffic flow.

The principal highway system thus forms the basic backbone on which a denser road network can be built. The North-South Expressway, NKVE are examples of expressways in this category. The Bukit Kayu Hitam-Gurun Highway, Senai-Johor Bahru Highway, KL-Karak Highway are examples of highways defined above.

(2) Minor Highway System

The minor highway system shall consist of a network that possess the following service characteristics which support and complement the Principal Highway System.

a. to cater for movements between state regional centres,
b. to link major traffic generators such as industrial zones or estates or resort areas,
c. to facilitate integration of interstate services,
d. to function as alternative route to the Principal Highway System.

The minor highway system shall therefore constitute routes designed to provide relatively high speed travel and minimum interference from through traffic movements. The major federal routes 1, 2, 3, 4 and 5 , are examples of routes that make up this minor highway system.

(3) Primary Road System

Roads under this system generally serve intra-state movement rather than inter-state. They form the basic framework of the road system within a state connecting state regional centres and state sub-regional centres or major towns. They serve travels having intermediate trip lengths and medium travel speeds. Smooth traffic flow is provided through partial access control. Some federal routes and most of the state roads are examples of routes forming this road system. The ideal network spacing is in the ranges of 5 - 10 km.

(4) Secondary Road System

These are routes that form the road network within a district of regional development areas. They are designed to serve trips with relatively short trip lengths. They provide linkages to major local centres and state sub-regional centres within the district or regional development centres. This system of roads thus cater to many trips related to daily living and needs. Most of the state roads come under this category of classification. The ideal network spacing is in the ranges of 1 - 5 km.

(5) Minor Road System

This is the lowest road system within the total highway network. Minor road system is thus made up of roads forming the basic road network within a land scheme, a residential estate or a village. They serve mainly local traffic with short trip lengths such as between villages or from and to the local growth centres. The ideal network spacing is 1 or less than 1 km.

All the above functional road classification is closely related to the urban hierarchy system discussed earlier and as defined by the National Urbanization Plan. The network spacing above suggested general guidelines which are influenced largely by geographical conditions and density of settlements. Figure 6.10 provides a figurative representation of the above network system concept.

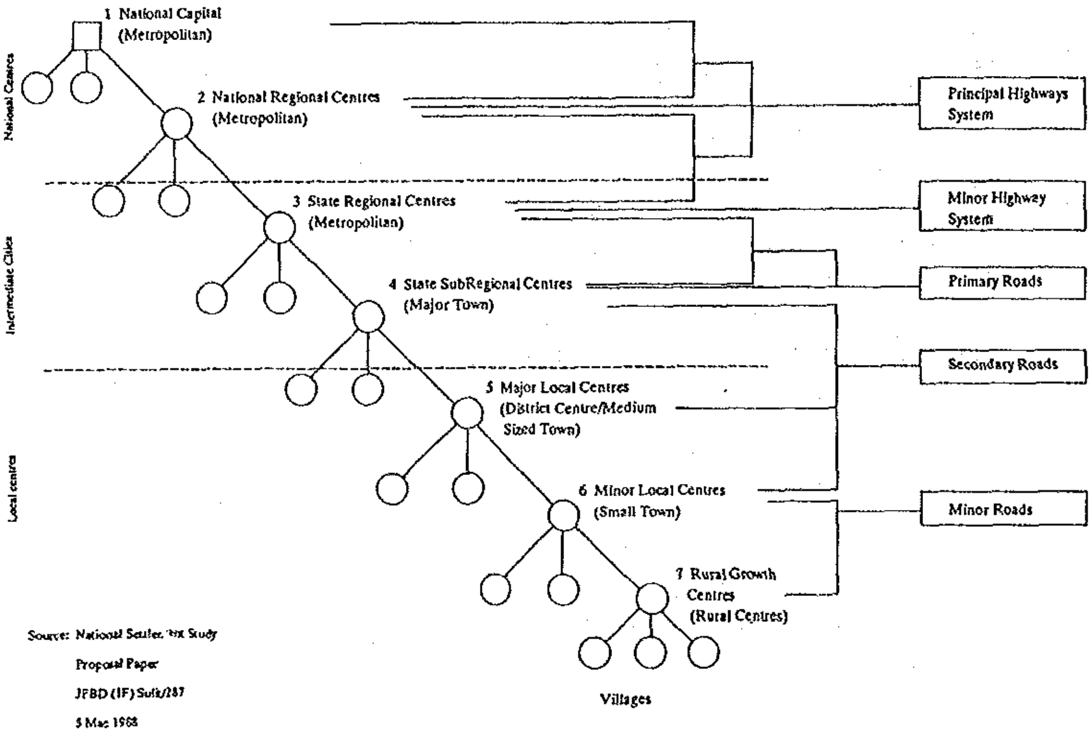


Figure 6.10: The Functional Highway Network Concept and Classification

6.7.2 Proposed National Highway Network Configuration

The national highway network configuration or concept plan is derived through a systematic network building incorporating all the planning constraints and considerations discussed in section 6.5; as well as fulfilling the strategies outlined in section 6.6.

(1) Network Configuration for Peninsular Malaysia

Figure 6.11 shows the network configuration for Peninsular Malaysia, a network formed by the principal and minor highway routes as defined above. There are three distinct north-south corridors and six east-west corridors.

The west coast corridor remains the most important corridor for sustaining the country's economic growth. The principal highways here consist of the North-South Expressway and Federal Route 1,5 and 7 duly upgraded with realignments such as between Tampin and Yong Peng along Route 1. These principal highways thus link all the three important metropolitan areas (Klang Valley, Penang-Butterworth and Johor Bahru) as well as four major state regional centres of Alor Setar, Ipoh, Seremban and Melaka. The upgrading of these federal routes will improve the accessibility of major centres like Kangar, P.Dickson, Lumut, Segamat, Keluang and Kota Tinggi to the Principal Highway Network to within a radius of 20 km.

The east coast corridor contains the national regional centre of Kuantan and state regional centre of K.Bahru and K.Trengganu. This corridor also contains most of the regional land development schemes namely, DARA, KEJORA, KETENGAH and KESEDAR. The network configuration thus consists of upgrading the federal routes 3 and 14 as part of the principal highway system.

The central corridor starts from Kota Bahru and traverses through the central areas of the Peninsular and passing by towns of Gua Musang, K.Lipis, Jerantut, Temerloh, Segamat and Keluang before ending at Johor Bahru. This corridor is important for the development of new frontier areas in the central hinterland of Pahang, Trengganu and Johor.

The proposed future highway network configuration strives to strengthen east-west linkages. New linkages like Ipoh-K.Trengganu, Ipoh-Kuantan are proposed. Kuantan will remain the main regional growth centre in the east coast and to further strengthen its ties with the Klang Valley. A new KL-Kuantan highway is proposed to achieve this objective. Other east-west linkages in Johor and in the north will be upgraded further to provide better level of services on linkages between the better developed and less developed regions.

(2) Network Configuration for Sabah and Sarawak

Figure 6.12 shows the proposed highway network configuration for Sabah and Sarawak. The network configuration comprises basically of a coastal corridor in Sarawak and a complete coastal loop in Sabah.

For Sarawak, the network configuration aims to strengthen the coastal corridor and to encourage further development of the existing towns of Sri Aman, Sarikei, Sibu, Bintulu and Miri. This important corridor is further extended with a new linkage proposal to Lawas in Sabah, thus providing the most needed Sabah-Sarawak Linkage. Development of the coastal towns will induce development to the interior. Up to the target year of 2010, linkages to the interior settlements of Kapit, Song, Belaga or Long Lama may not warrant a high grade highway but certainly so in the far future beyond 2010.

In Sabah, social and economic development are to be further encouraged on the east as well as the west coasts. Linkages between the two coasts therefore must be strengthened. The existing corridor of K.Kinabalu-Sandakan must be upgraded while a new corridor is to be developed between Tawau-K.Kinabalu in the south, thus forming a complete loop.

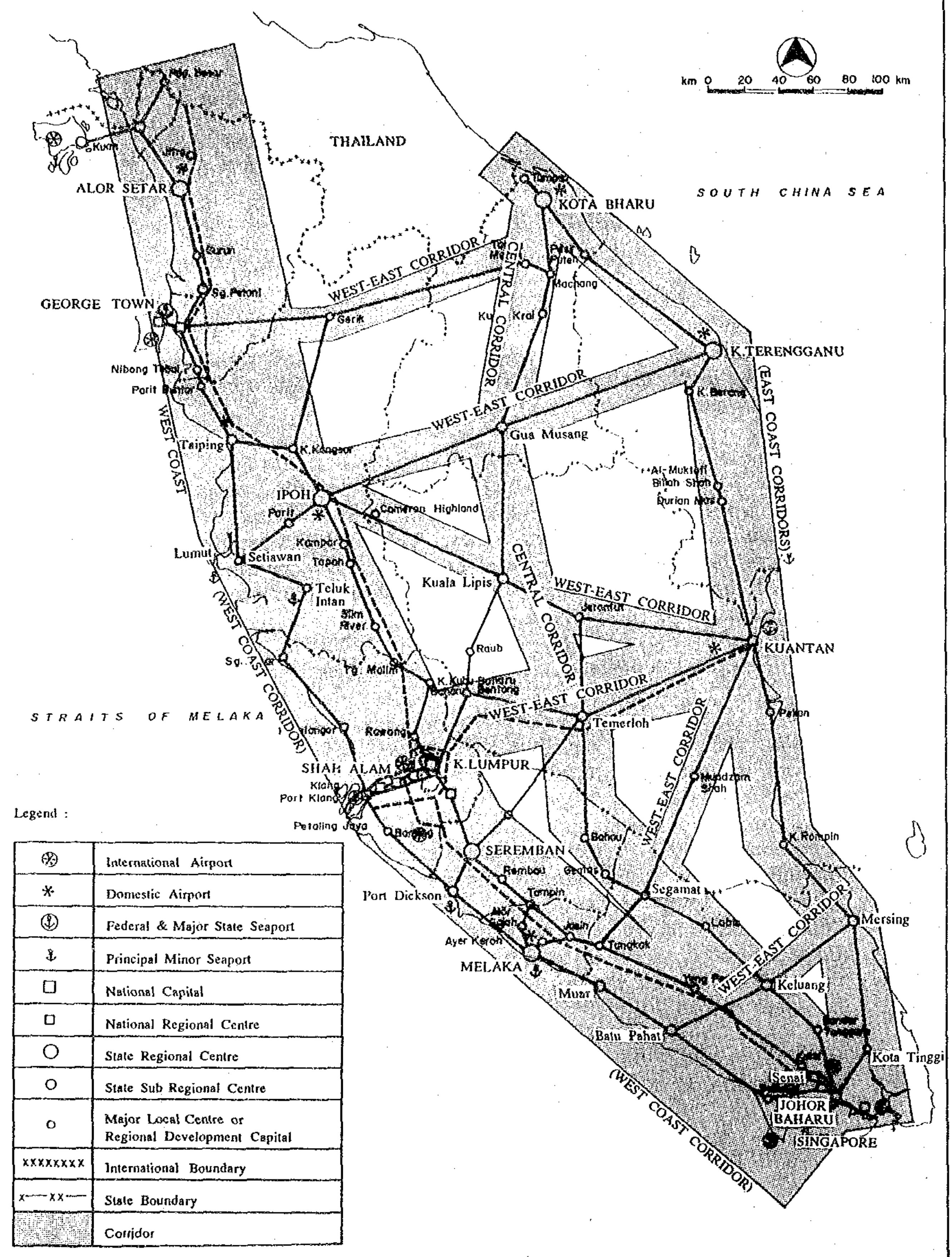


Figure 6.11: Highway Network Configuration in Peninsular Malaysia

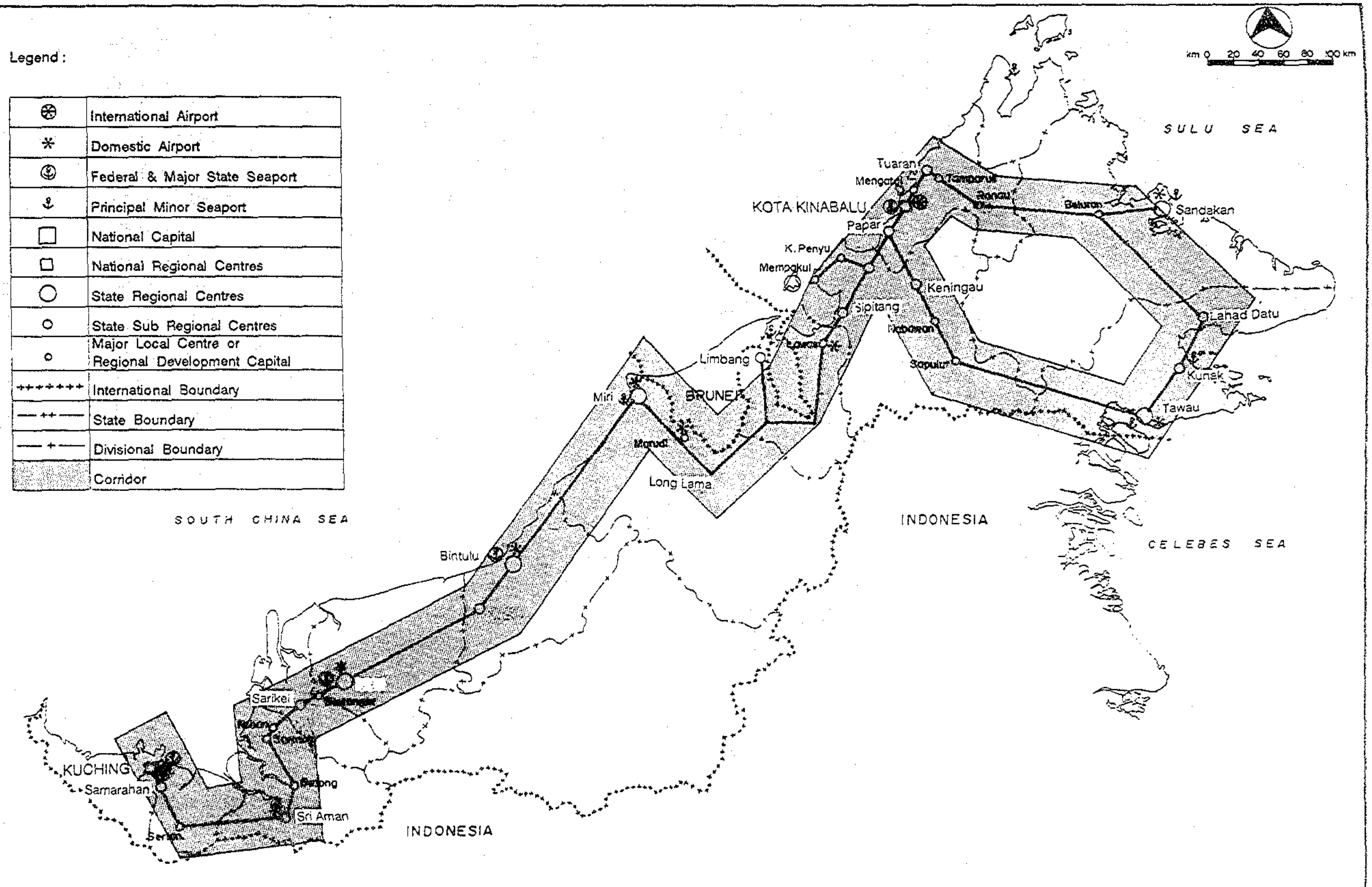


Figure 6.12: Highway Network Configuration in Sabah and Sarawak

6.7.3 Regional Highway Network Configuration

Having accomplished the formulation of the overall conceptual highway network configuration both in Peninsular Malaysia, Sabah and Sarawak, the Study proceeded to draft out the conceptual regional highway network configuration based on the overall configurations discussed above.

At the regional level, therefore, the consideration of routing for road lower than the minor highway is included. The regional network configuration therefore aims at achieving the more specific regional development policies and development strategies.

(1) North Region in Peninsular Malaysia

Figure 6.13 shows the conceptual highway network configuration for the Northern Region of Peninsular Malaysia. Within this region, Georgetown, Butterworth, Ipoh and Alor Setar are the focal points for urban and industrial development. Within the spheres of each of these centres are sub-centres which have been identified for specific industrial projects. For Ipoh, for instance, Seri Iskandar/Setiawan/Lumut and Gopeng/Kampar/Tapah/Bidor are two industrial corridors. Roads to these areas are upgraded or improved. Referring to Figure 6.13, a network of primary roads is conceived and shown along these industrial corridors. This primary road network is closely linked to the highway network discussed previously. Besides providing accesses to industrial estates, this network also serve agriculture and land development schemes like KEDA and PERDA, tourist development projects in Pangkor and Lumut.

(2) South Region in Peninsular Malaysia

The regional highway network for South Region is given in Figure 6.14. Industrial development corridors radiate out from Johor Bahru, JB-Pasir Gudang, JB-Kota Tinggi-Mersing, JB-Bandar Tenggara-Keluang, JB-Kulai-Ayer Hitam, JB-Pontian Kecil. To lessen the likelihood of congestions long these radial highways, ring roads are promoted. The primary network in this region thus aims at providing or strengthening accesses to the industrial corridors, the land development scheme in KEJORA, DARA, and tourist areas in Desaru and Tioman.

(3) Central Region in Peninsular Malaysia

The proposed construction of Shah Alam Highway and the Middle Ring Road II will further strengthen the highway network around the Klang Valley Region. Highway network configuration in this region aims at dispersal of traffic converging to Kuala Lumpur and the Klang Valley; and to provide smooth linkages to region-wide highway and expressways. The conceptual highway network configuration for the Central Region depicted in Figure 6.15 shows the proposal for a outer ring road around Kuala Lumpur and a primary road network that strengthen horizontal linkages between inner and coastal corridors.

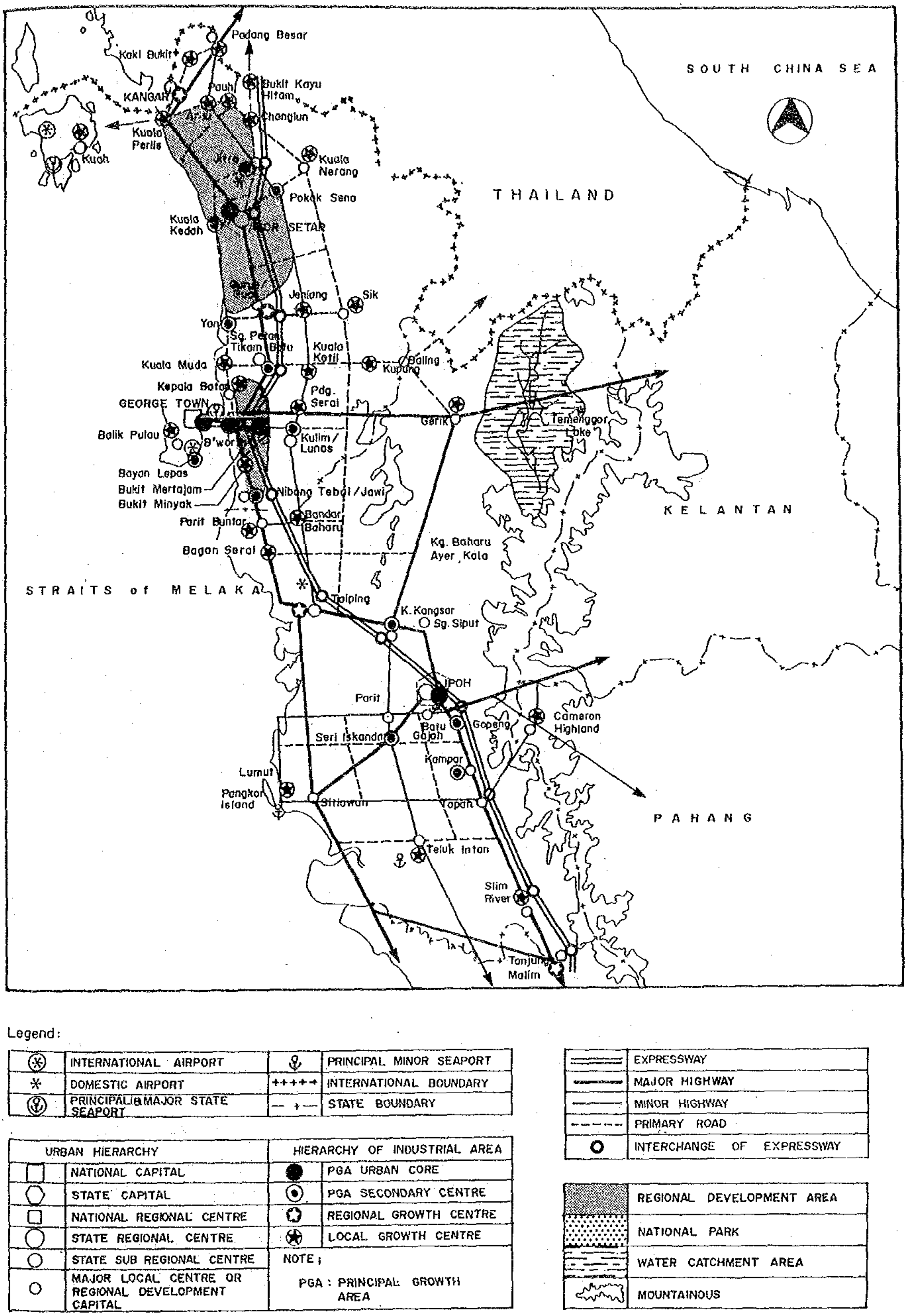


Figure 6.13: Conceptual Regional Highway Configuration For North Region in Peninsular Malaysia

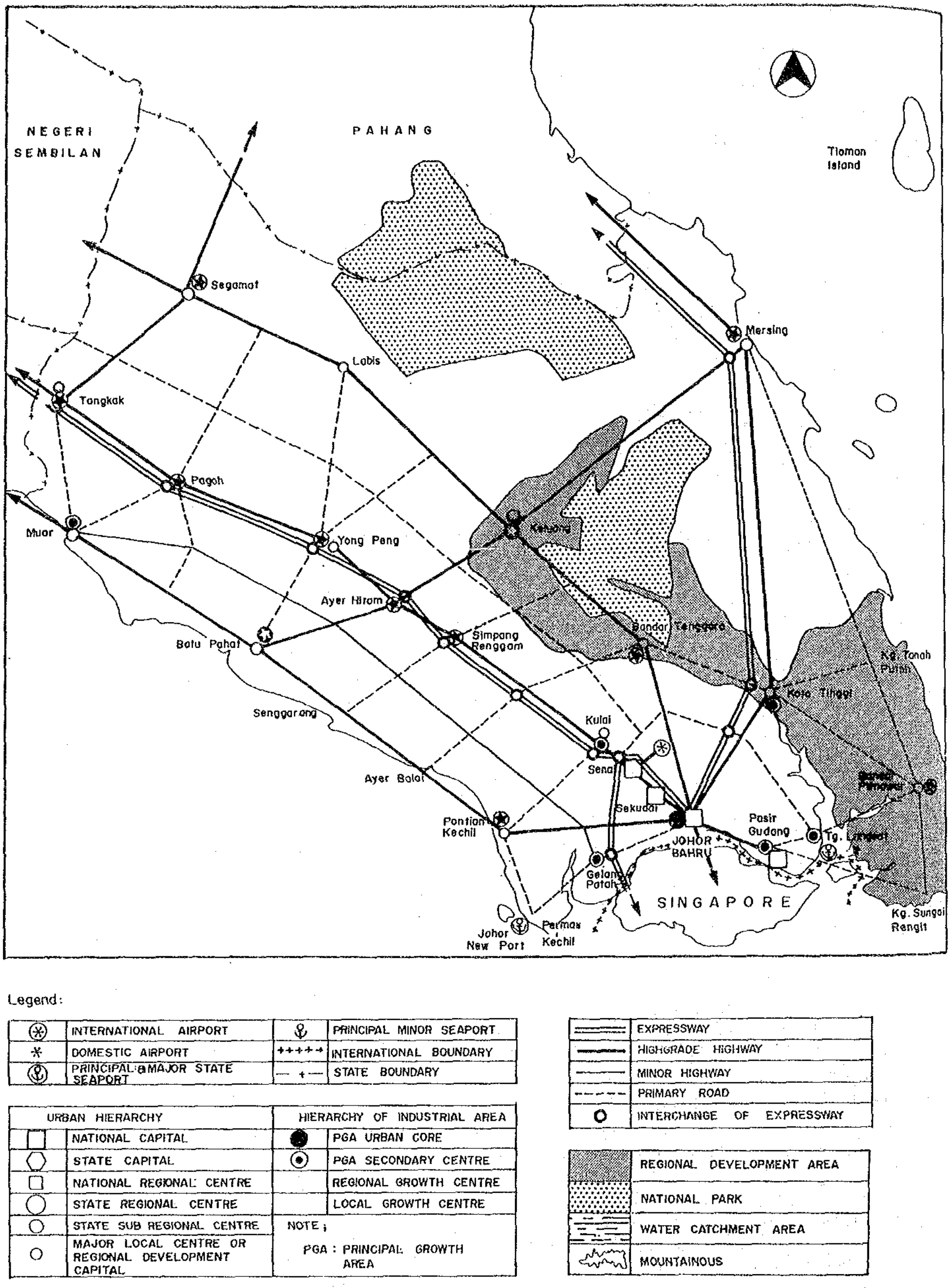


Figure 6.14: Conceptual Regional Highway Configuration For South Region in Peninsular Malaysia

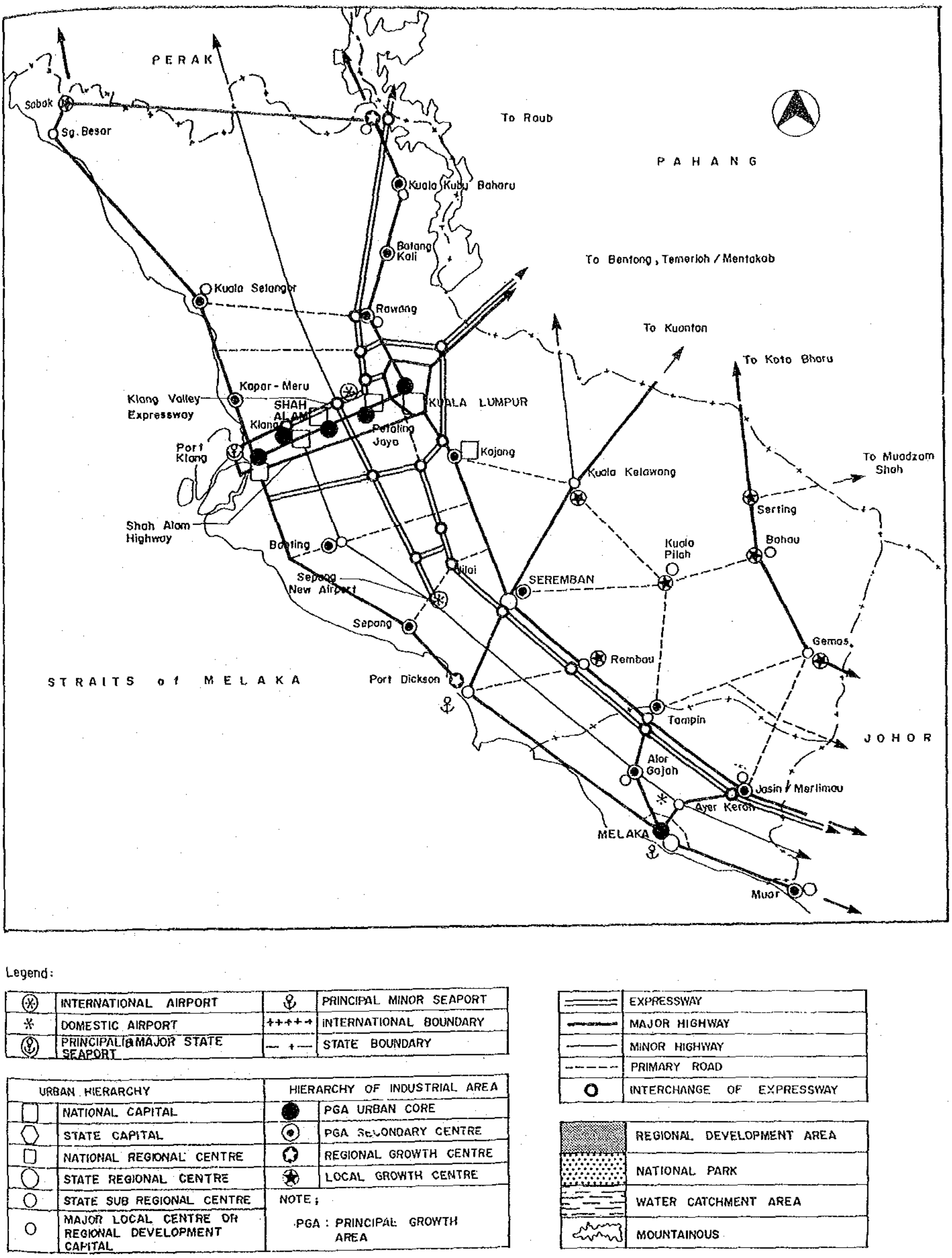


Figure 6.15: Conceptual Regional Highway Configuration For Central Region in Peninsular Malaysia

(4) Eastern Region in Peninsular Malaysia

Regional highway configuration in the east region of Peninsular Malaysia aims at inducing urban and industrial development parallel to the west coast. Besides strengthening the coastal corridor where most of the urban settlements and industrial areas are located, the network also provide better linkages in the hinterland corridor and strengthen horizontal linkages to the west coast.

As shown in Figure 6.16, accessibility to the industrial corridors of Sg.Lembing-Jerantut-Kuala Lipis, Maran-Temerloh, Pekan-Rompin, Dungun-Kerteh-Chukai, Bukit Besi-Al-Mukhtafi Billah Shah-Ketengah Jaya-Seri Bandi, Bachok-Kuala Besut, Pasir Puteh-Bandar Permaisuri, Machang-K.Krai-Gua Musang, Pasir Mas-Tanah Merah, Tumpat-Rantau Panjang-Jeli are provided with highway and primary road networks.

Considerations are also given to provide road access to KETENGAH, DARA land development schemes and tourist areas like Kenyir Lake and the National Parks.

(5) Sabah

Many urban areas are presently scattered and not link by good roads to the regional or sub-regional growth centres. The only linkage between the east and west coasts of Sabah is in poor condition. The highway network configuration for Sabah aims at promoting linkages between towns in the east with those in the west. Second level growth centres like Papar, Ranau and Tuaran are provided with better accessibility.

(6) Sarawak

As in Sabah, the regional highway configuration aims to provide road accesses to many of the scattered settlements. The other consideration is to strengthen the level of road services along existing growth corridors to spearhead further the growth of these areas.

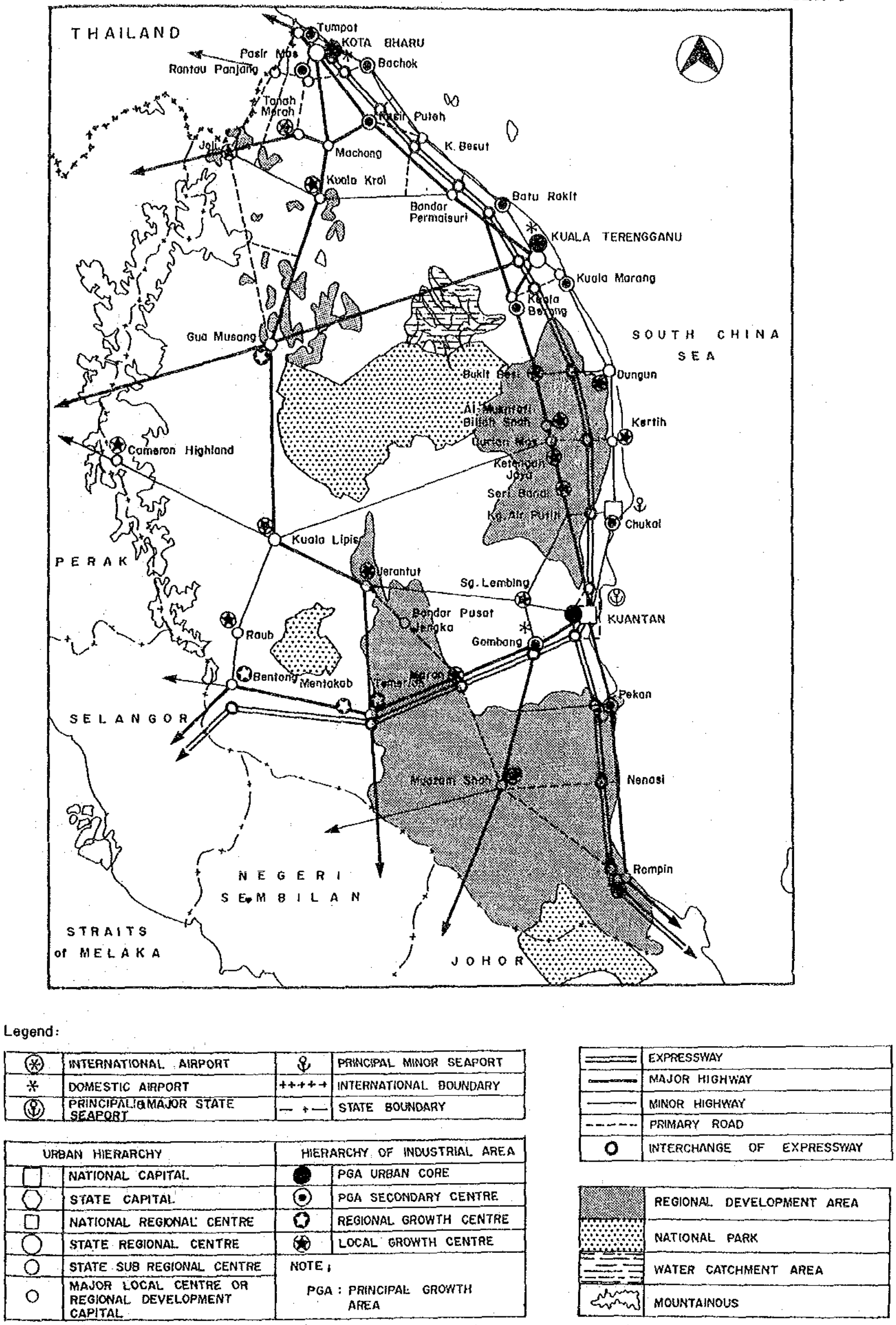


Figure 6.16: Conceptual Regional Highway Configuration For East Region in Peninsular Malaysia

6.7.4 Proposed Highway Network Conceptual Plan

Combining the nationwide and all of the regional highway network conceptual plan, a future highway network conceptual plan for the country is obtained as in Figure 6.17 and Figure 6.18.

6.8 Alternative Future Highway Network Development Plans

Having derived the future conceptual plans for highway network development in Peninsular Malaysia, Sabah and Sarawak, this section examines the possible highway networks that can satisfy the future traffic demand as forecasted in Chapter 5.

For Peninsular Malaysia, three alternative highway networks were formulated which are all based on the conceptual plan, meaning that all the alternatives satisfy the linkages between urban growth centres and development areas. The three alternatives differ in the provision of the type of highway linkages, either along an entire corridor or within a specific region.

For Sabah and Sarawak, however, only one highway network development plan was formulated to meet the future traffic demand.

The three alternative highway network development plans for Peninsular Malaysia are given in Figures 6.19 to 6.21. These three networks seem similar because they are formulated based on the configuration in the future highway concept plan in Figure 6.17.

Alternative 1 basically proposes an extensive highway network including an expressway (4-lane) along the east coast from Kota Bahru down to Johor Bahru and from Kuala Lumpur to Kuantan. Alternative 1 thus strives for a densest highway network system for the west coast of Peninsular Malaysia. Special attention is given to the provision of a dense network from KL down to Johor Bahru and in the Kedah-Penang Region.

Alternative 3 proposes a minimum highway network that satisfy the minimum requirement. No new expressway will be built on the east coast except for the new expressway between KL and Kuantan and most of the existing federal routes are upgraded to 4 lanes highways.

Alternative 2 proposes an intermediate network between alternative 1 and 3. This moderate network proposal incorporates a new expressway in the east coast from Kuantan to K.Bahru and upgrading the federal routes 1, 3, 5, 2 to 4-lane highways. Moderately dense ladder pattern highway networks are proposed along the west and east coasts of Peninsular Malaysia.

Some linkages were excluded when identifying the proposed network configuration due to the low traffic demand or/and the geographical conditions. Figure 6.22 shows the future highway network development plan proposed for Sabah and Sarawak based on the configuration concept plan in Figure 6.18.

The length of alternative Highwhay Network development Plans are shown in Table 6.1.

Table 6.1 : Total Road Length of Inter-Urban Highway Network in 2010

Road System		Peninsular Malaysia			Sabah	Sarawak
		Alt 1	Alt 2	Alt 3		
Principal Highway System	Expressway	1669	1394	1078	-	-
	Major Highway	4114	4114	4114	892	972
Minor Highway System		1971	1826	1501	-	35
Primary Road System		3986	3516	3327	1113	1436
Total		11740	10850	10020	2005	2443

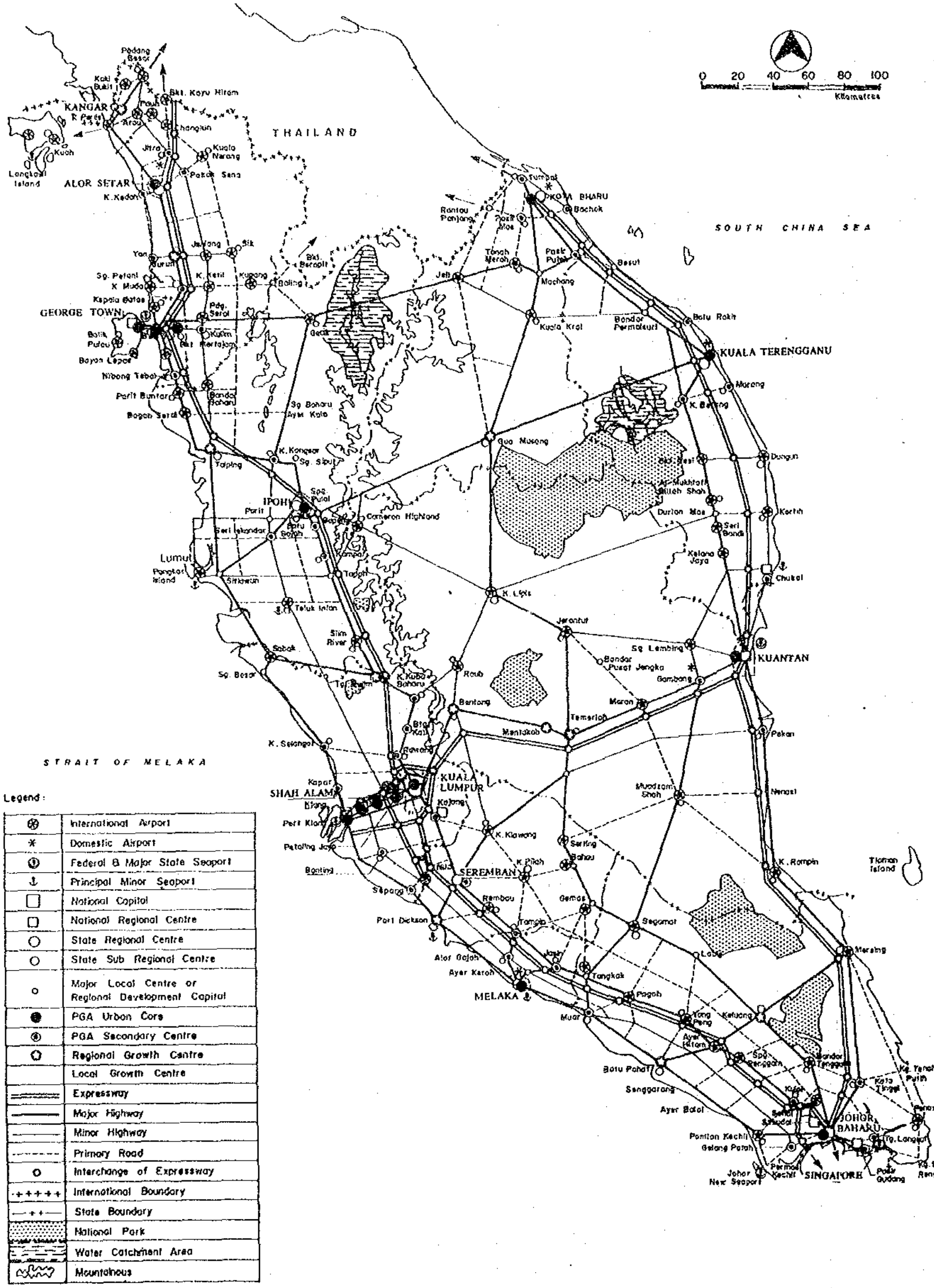


Figure 6.17 : Conceptual Future Highway Network In Peninsular (By Functional Classification)

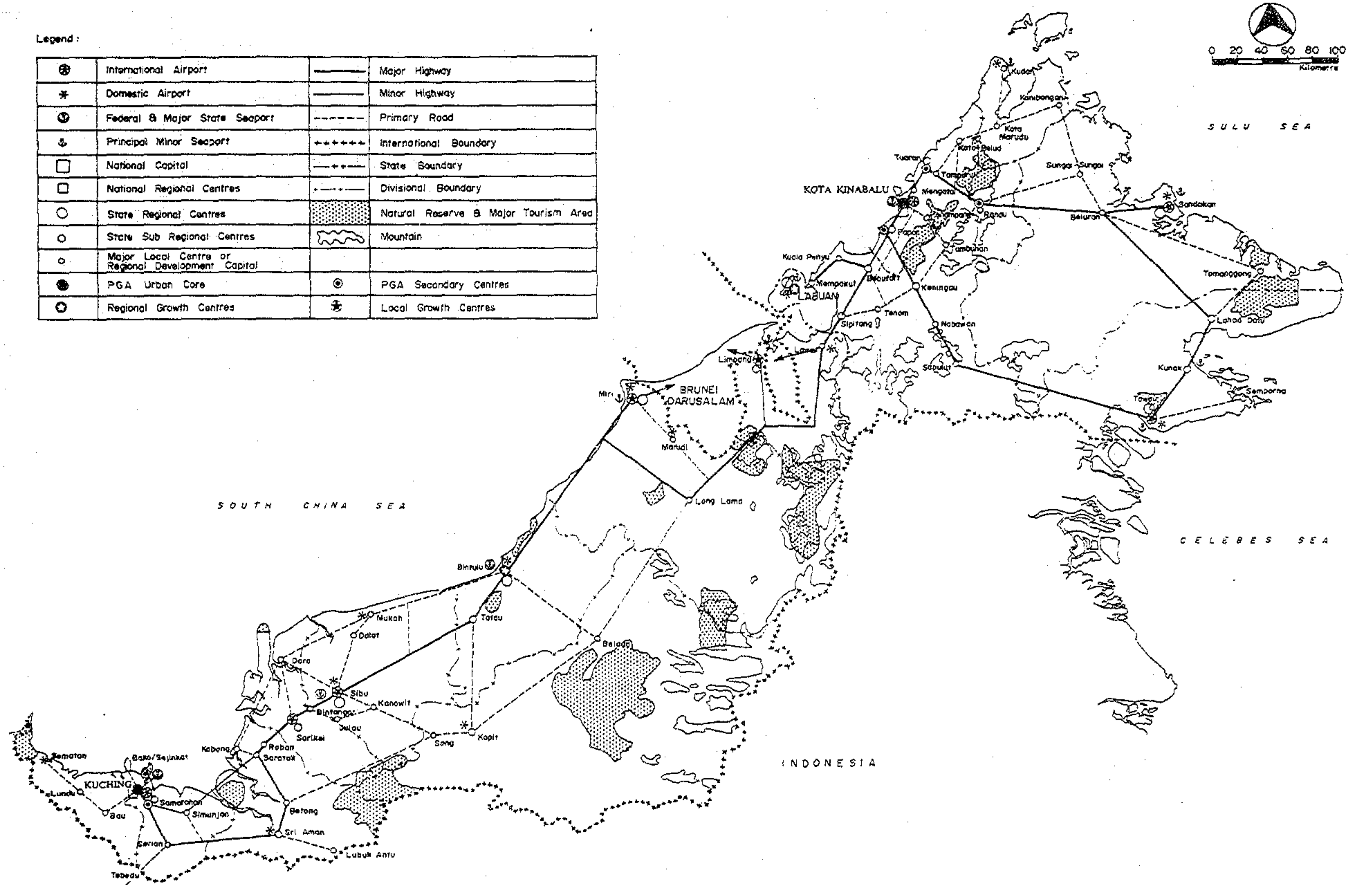


Figure 6.18 : Conceptual Future Highway Network In Sabah and Sarawak (By Functional Classification)

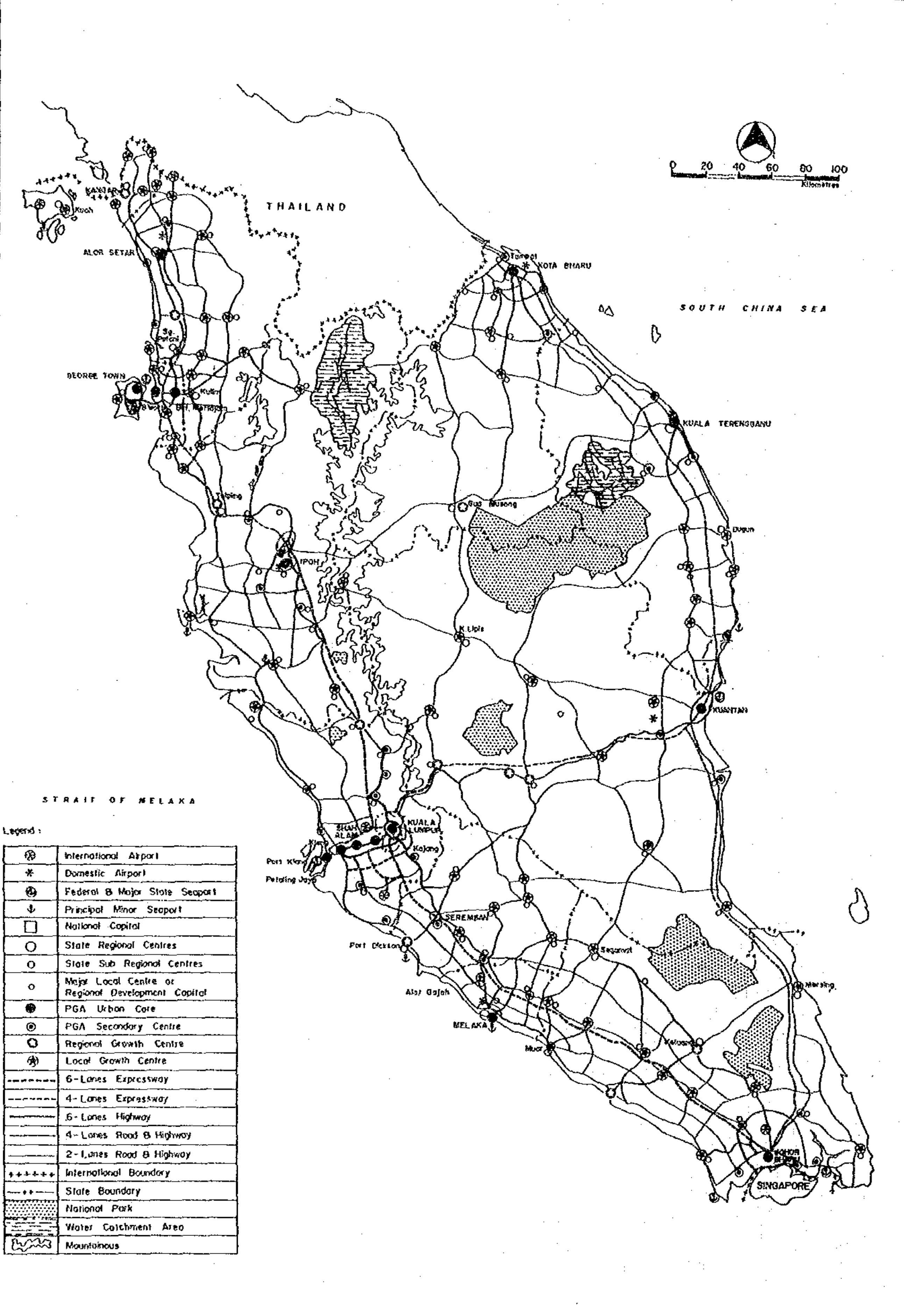


Figure 6.19: Future Highway Network Alternative 1

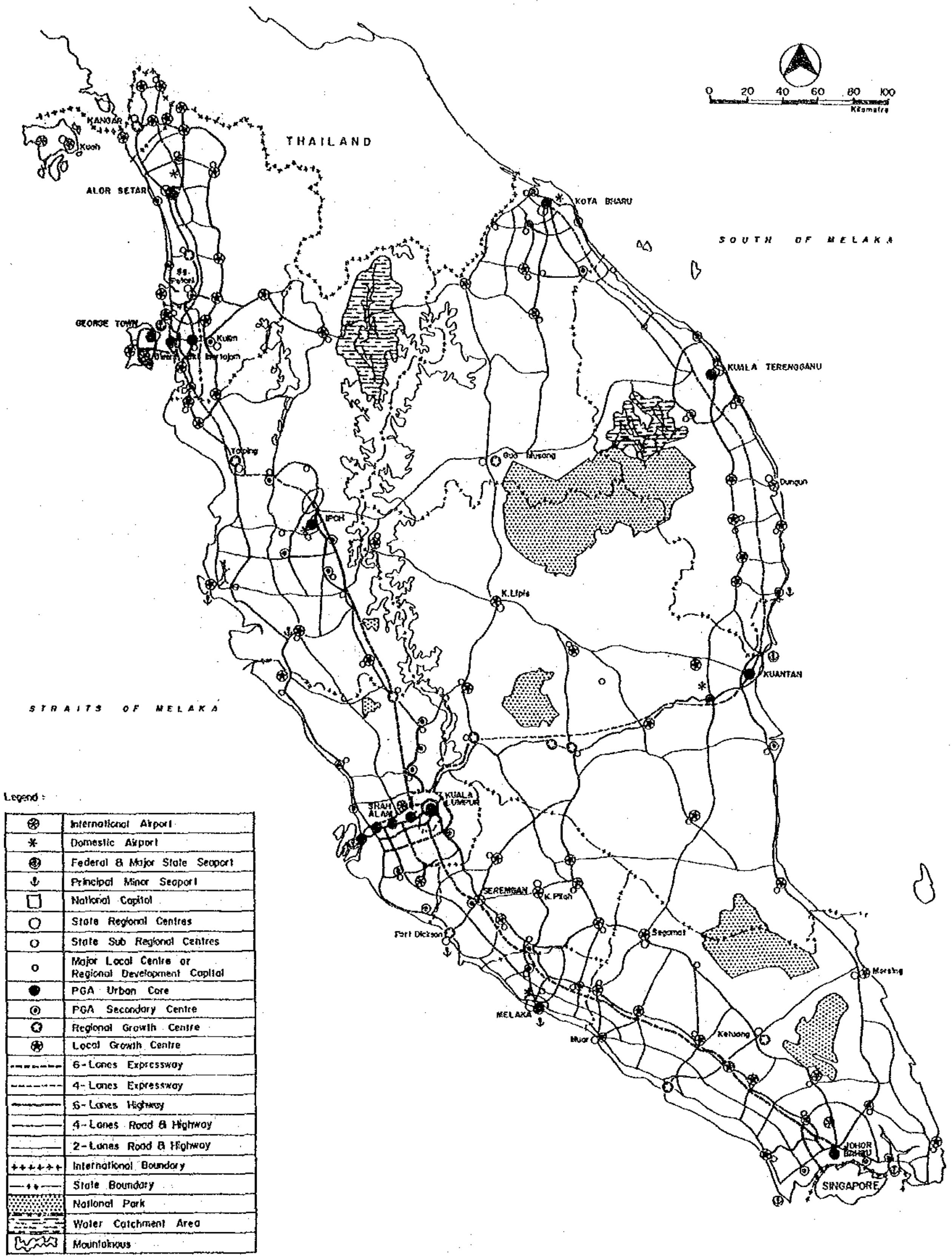


Figure 6.20: Future Highway Network Alternative 2

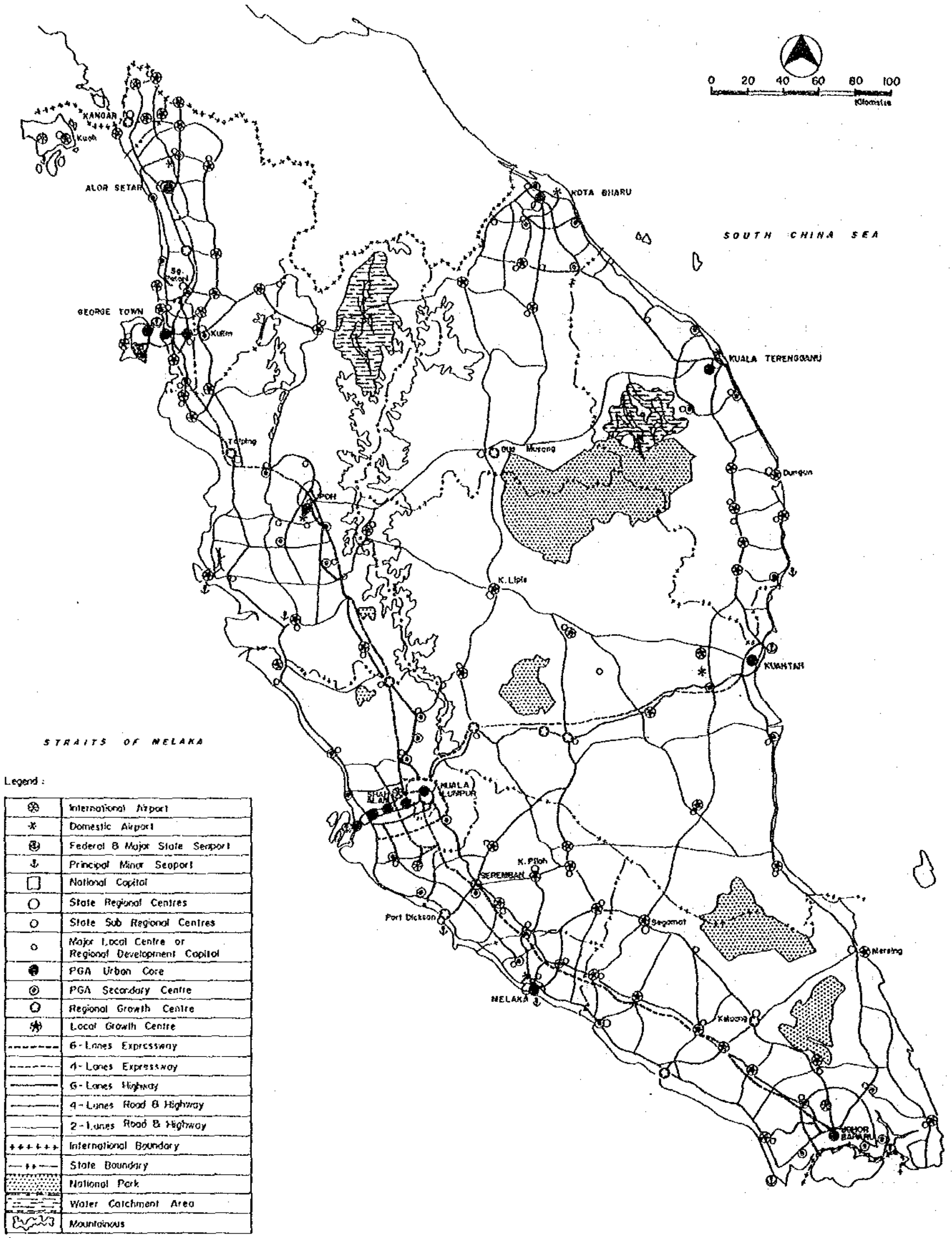


Figure 6.21: Future Highway Network Alternative 3

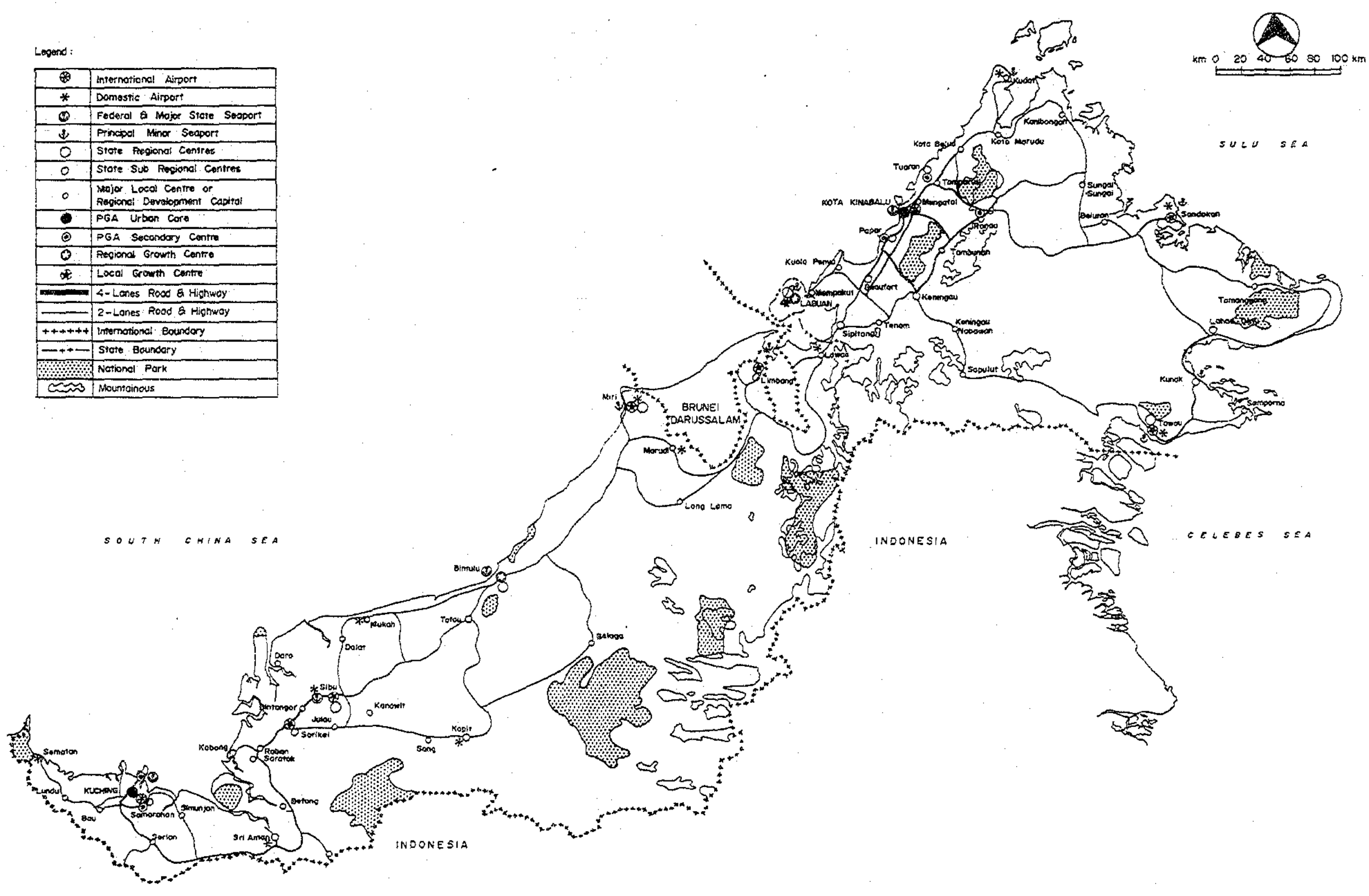


Figure 6.22: Future Highway Network Development Plan for Sabah and Sarawak