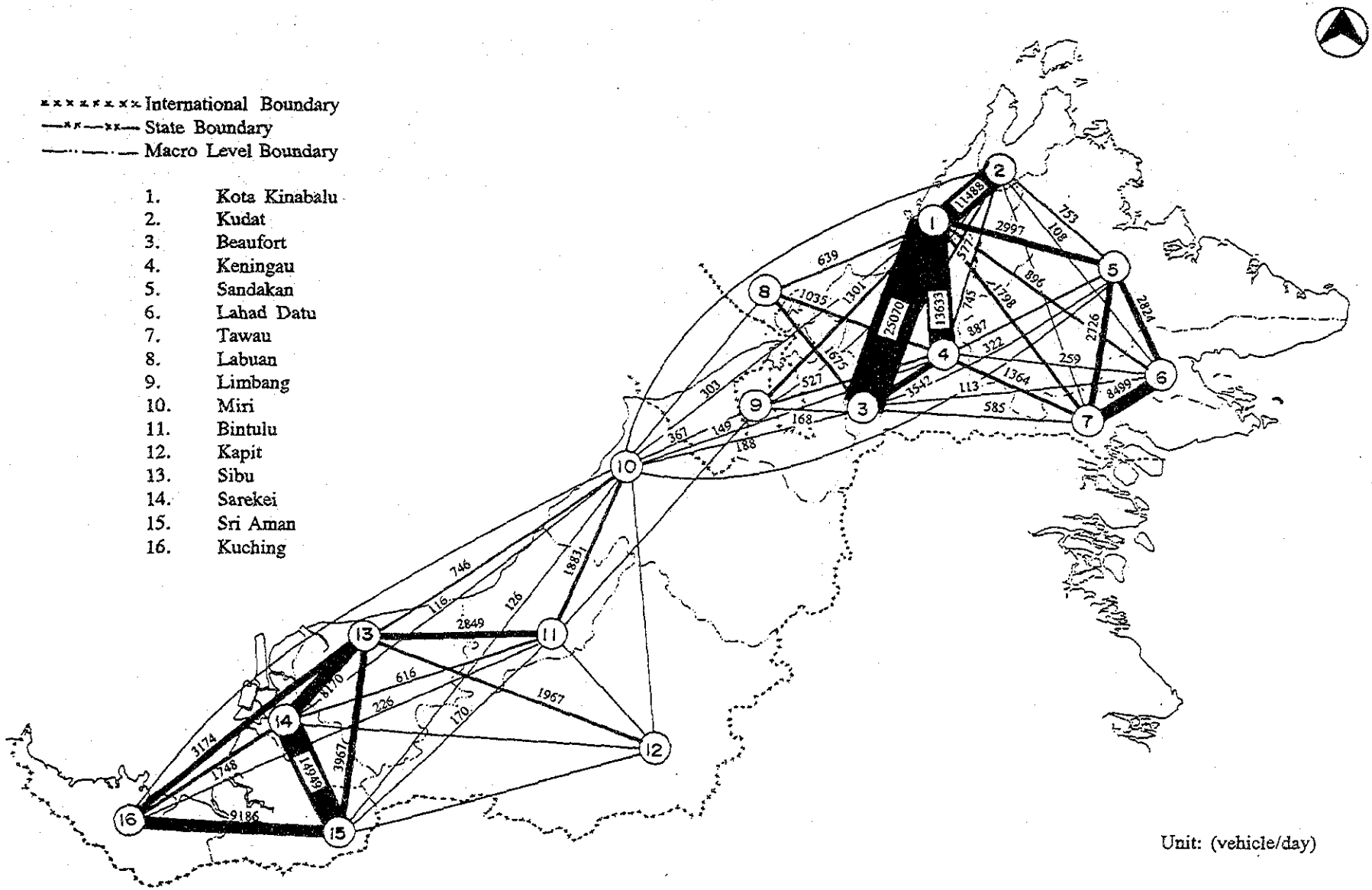


Figure 3.9: Vehicle Trip Distribution Pattern in Sabah and Sarawak, 2010

3.4 Highway Network Development Planning

3.4.1 Planning Steps

The approach for highway network planning in this Study follows the four major steps of:

- Setting of Planning Goals and Objectives
- Considerations of Planning constraints and factors,
- Formulation of Highway Network Planning Strategies and Concept Plan,
- Preparation of Alternative Highway Development Network Plans.

3.4.2 Planning Goals and Objectives

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 pollution.*

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

Goal-3: ***To develop a national highway network that can 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 well being.***

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 balanced 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 balanced share of transport demand among the other modes of travel.*

3.4.3 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 and in solving if not mitigating the present and foreseeable future road transport problems.

(1) Topographic and Geological Features

Severe topographic features pose 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 lose 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 thus require special emphasis on structural design and drainage. Mitigation measures are also required against flash floods and slope failures.

(3) Urban Development and Hierarchy System

The National Urbanization Policy targets that about 50% of the Malaysia population will be residing in urban areas by the end of 2010. This will be achieved through the development of a planned urban hierarchy system in the country as indicated in Figures 3.10 and 3.11. 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 has identified Principal Growth Area (PGA) for formulating a national industrial development strategy which is to concentrate industrial developments in selected growth centres so as to disperse benefits of industrial growth to the less developed rural areas.

There are a total of 10 PGA in Peninsular Malaysia and 2 in Sabah and Sarawak (Figures 3.12 and 3.13). 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 PGAs.

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 the 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 the two main transport facility considerations. The major tourist development areas are Langkawi Island, Tioman Island, Pangkor Island, Penang Island, Melaka, Kenyair Lake, Muda Lake, Kuatan-Pekan, Desaru, Port Dickson, Cameron Highland

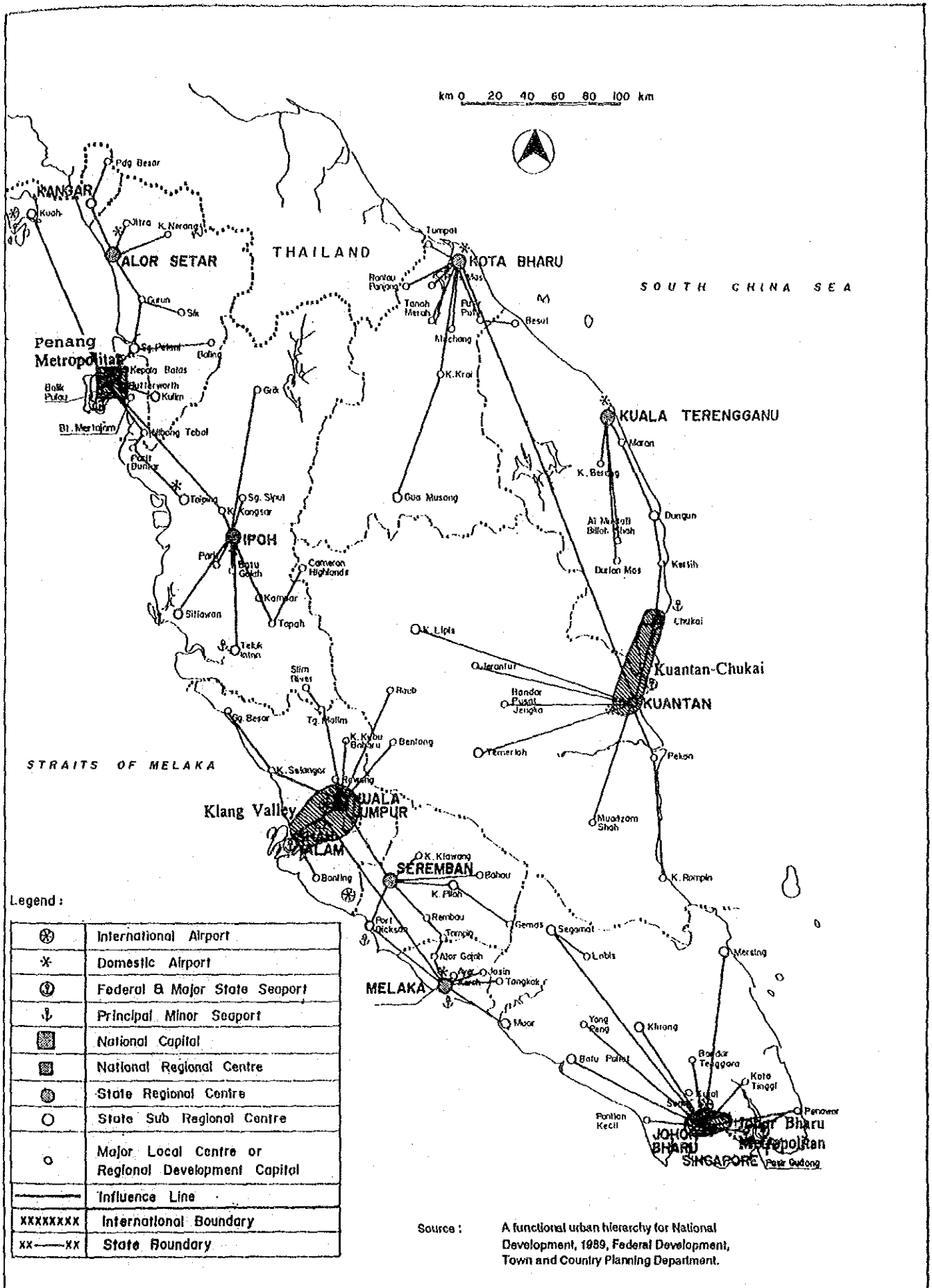


Figure 3.10 : Urban Hierarchy System in Peninsular Malaysia

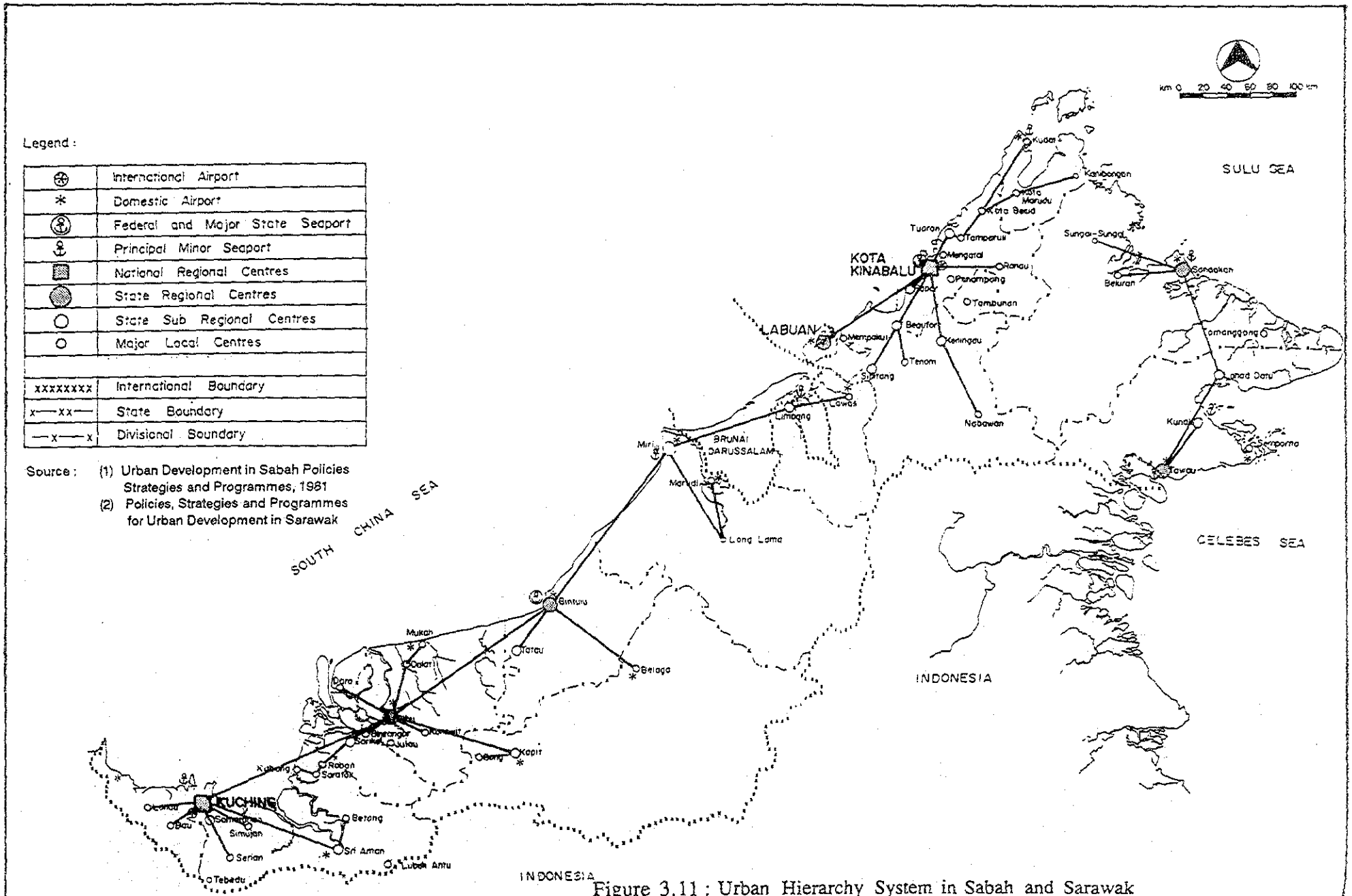


Figure 3.11 : Urban Hierarchy System in Sabah and Sarawak

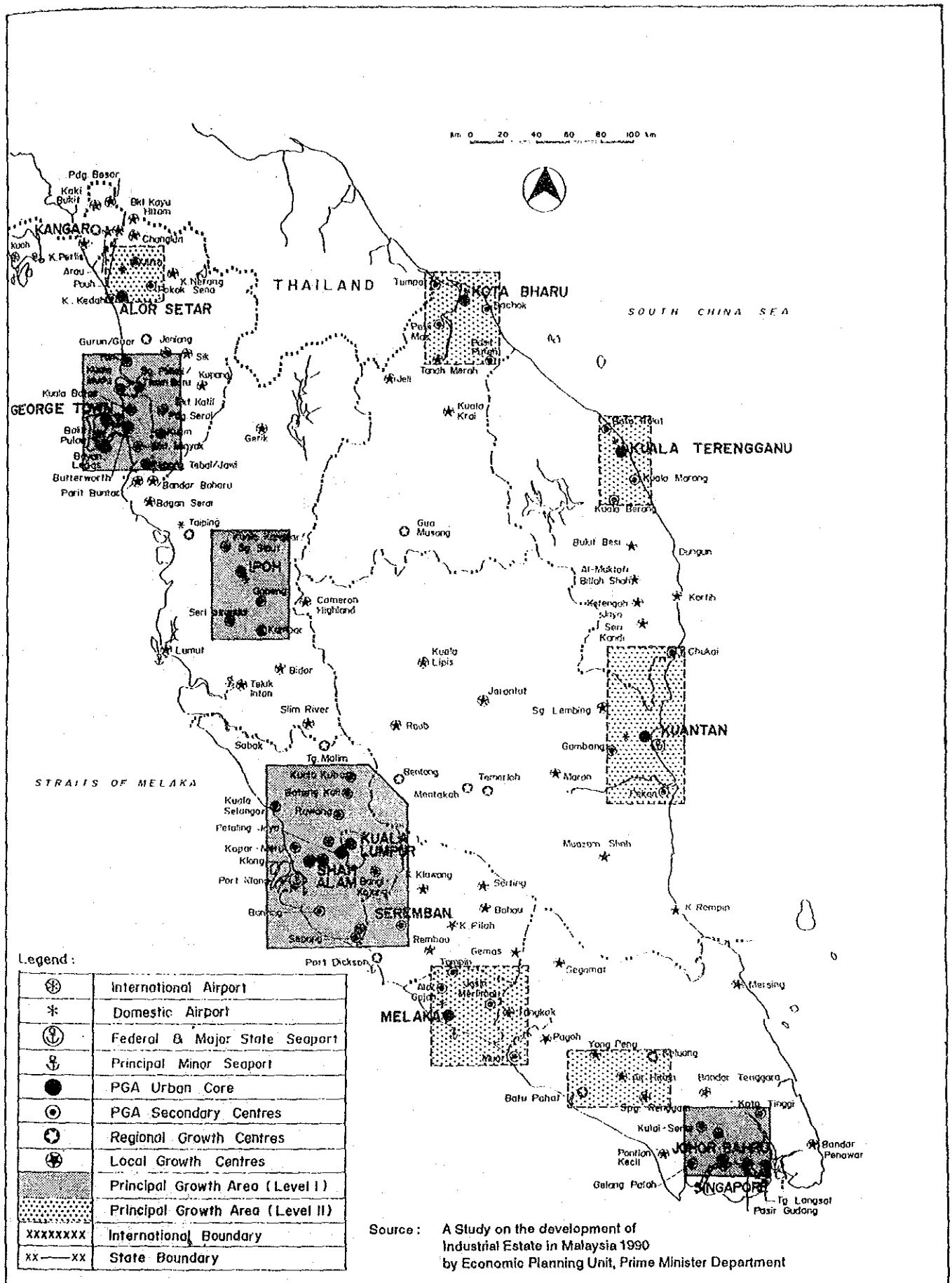


Figure 3.12: Industrial Development PGA in Peninsular Malaysia

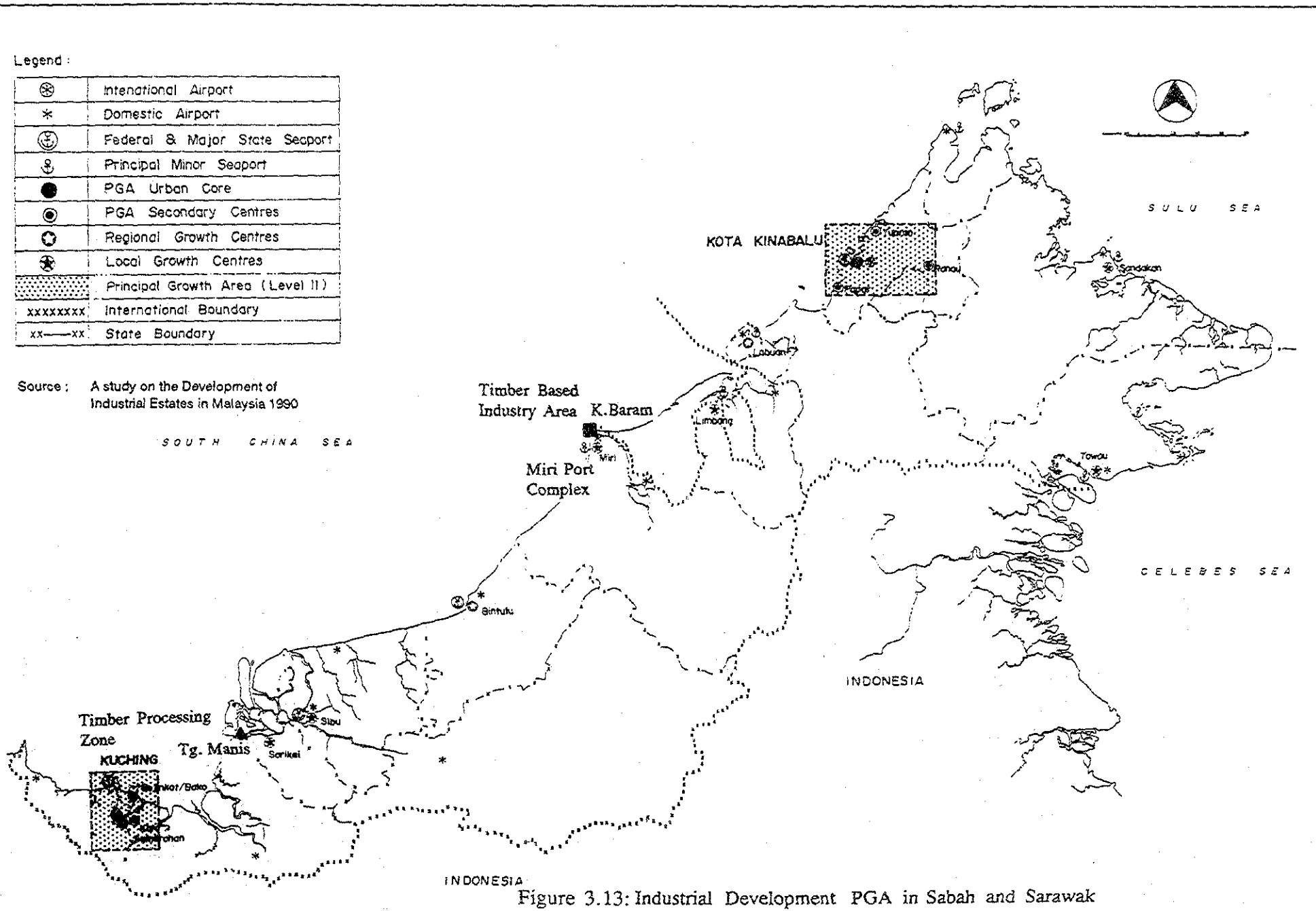


Figure 3.13: Industrial Development PGA in Sabah and Sarawak

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 linkages with the established points of entry. Considerations shall therefore be given to the provision of highway linkages to these areas in the future highway network plan.

(6) Transport Terminal Facilities

Airports and ports (including inland ports) all require highway accesses to function efficiently. 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.

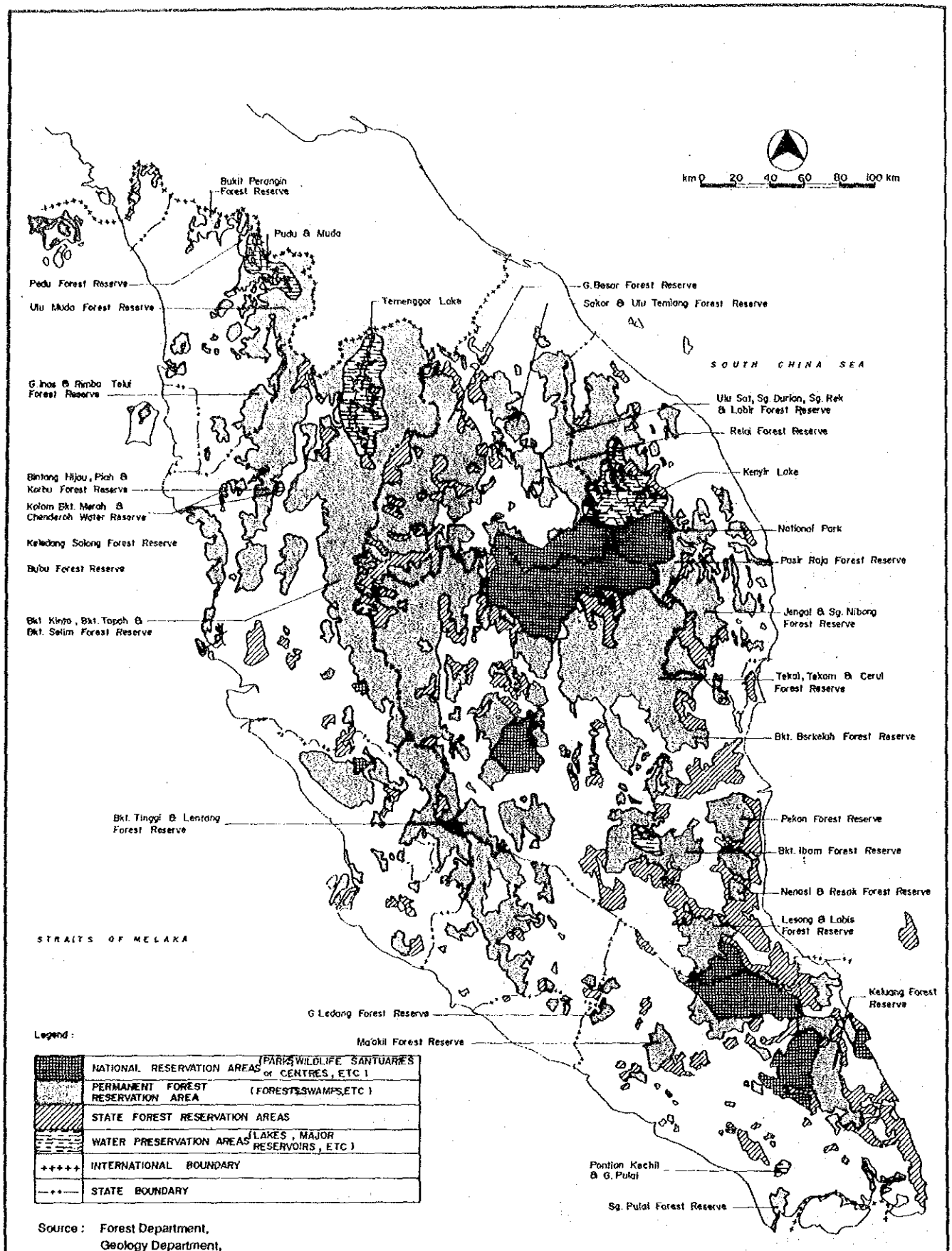
(7) Regional Land Development Schemes

Regional land development schemes form the main thrust of regional development strategy in Peninsular Malaysia. Schemes such as DARA, KETENGAH, KEJORA, KADA, MADA and JENKA 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.

(8) Environmental Conservation and Reservation Areas

Conservation and preservation of natural forests, fauna and flora are increasing been 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 concerns 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 things 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 conserve or preserve. These are shown in Figures 3.14 and 3.15. Major highway development through these sensitive habitats much 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 3.14: Natural Conservation Areas in Peninsular Malaysia

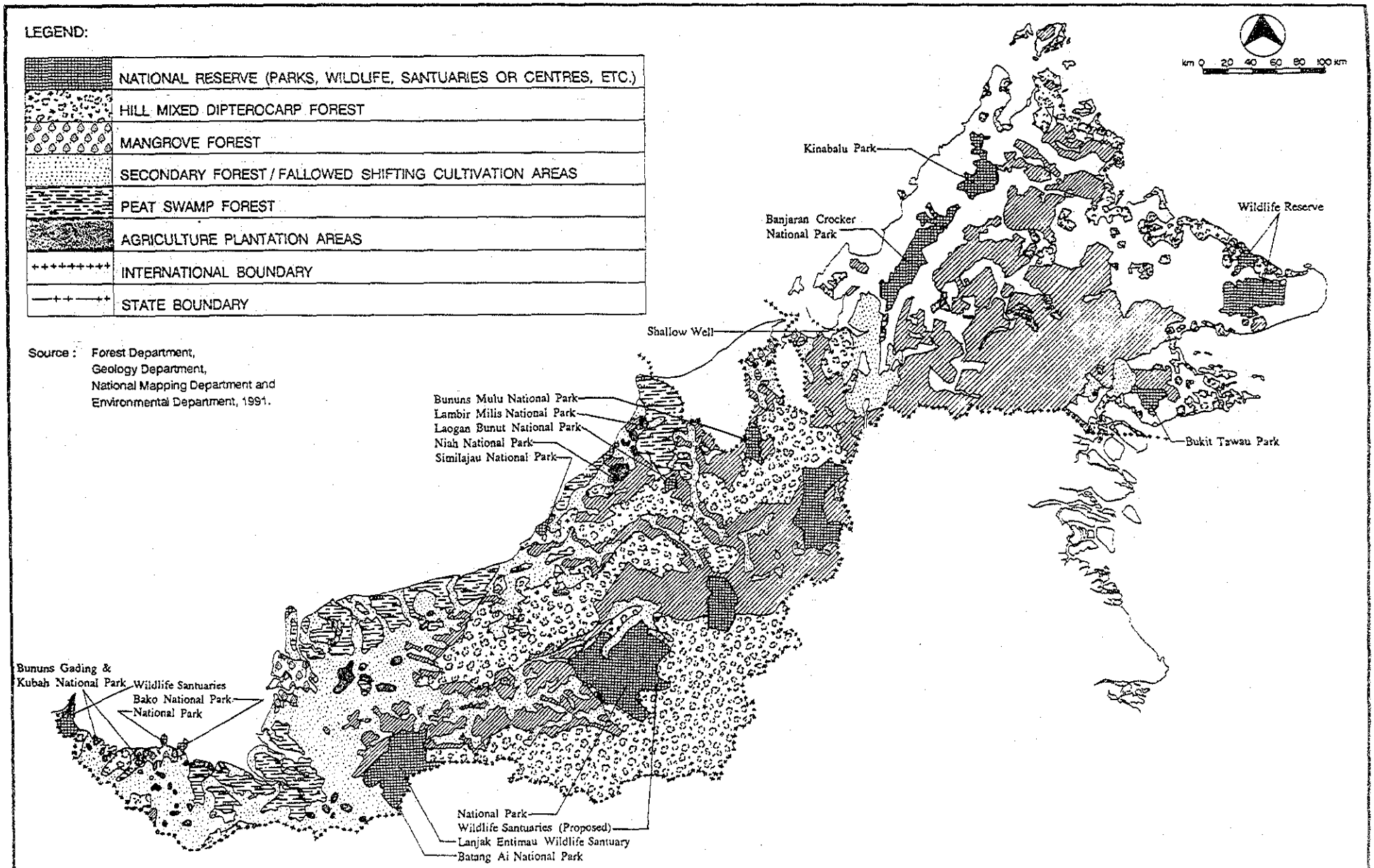


Figure 3.15: Natural Conservation Areas in Sabah and Sarawak

3.4.4 Highway Network Development Strategies

(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.

(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, regional land development schemes, while

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

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 for the north, east, south, central regions in Peninsular Malaysia, and Sabah, Sarawak.

(i) 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.

(ii) 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.

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

(iv) 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.

(v) 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.

3.4.5 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 to cater for corridor movement with long trip length and high density commensurate with national and interstate travel, travels between the national capital and state regional centres, and direct accesses to 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. 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 is one level lower than the principal highway system yet complimenting it to cater for movements between state regional centres, major traffic generators such as industrial zones or estates or resort areas, and for integrating interstate services. This minor highway network shall also 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 make 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.

3.4.6 Proposed National Highway Network Conceptual Plan

The national highway network configuration or conceptual plan is derived through a systematic network building incorporating all the planning constraints and considerations discussed above and fulfilling the objectives and strategies.

(1) Network Configuration for Peninsular Malaysia

Figure 3.16 shows the network configuration for Peninsular Malaysia. It is a network formed by the principal and minor highway routes with 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 consists 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 state regional centres of Alor Setar, Ipoh, Seremban and Melaka. The upgrading of these federal routes will improve the accessibility of state sub-regional 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.

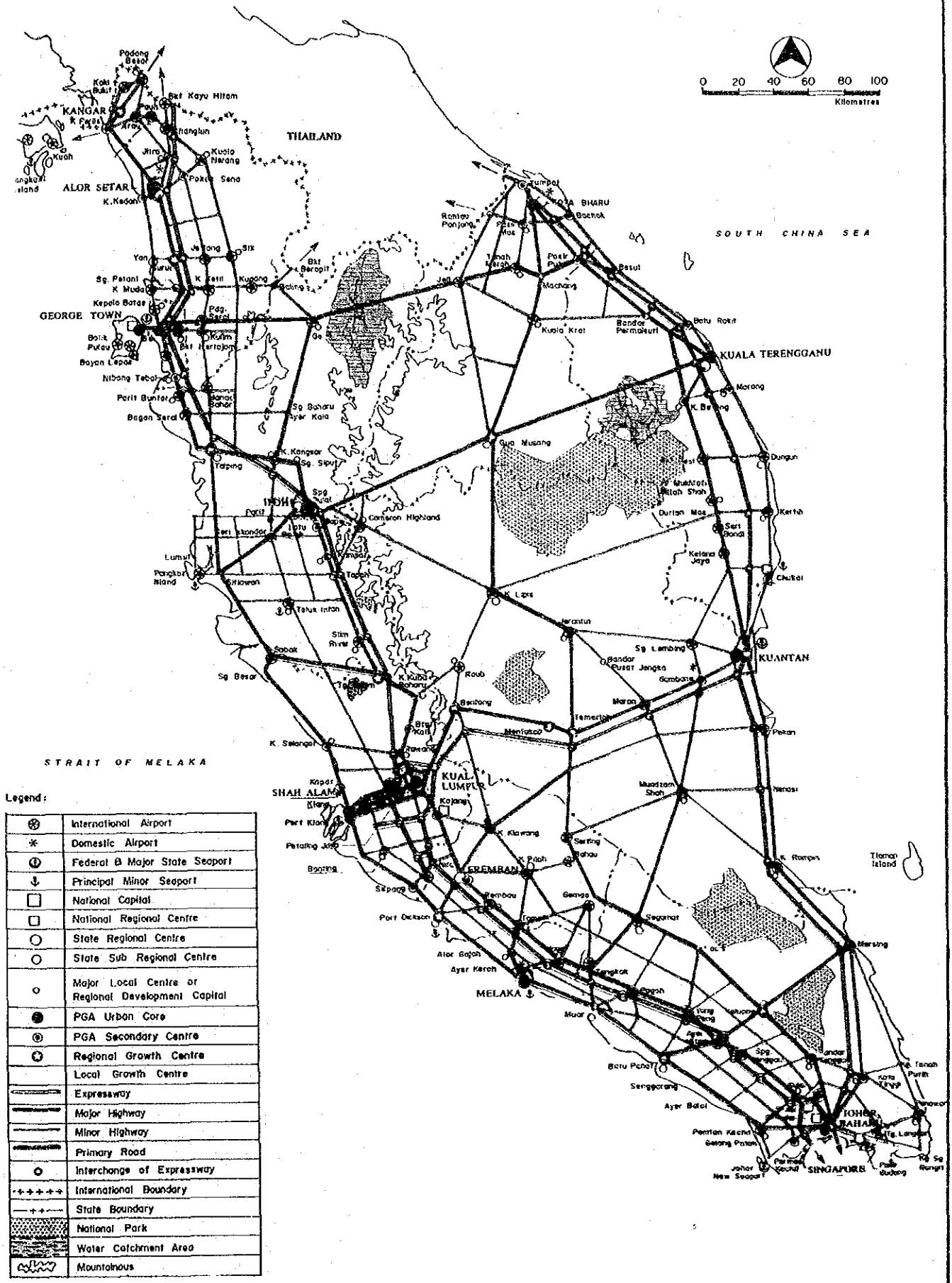


Figure 3.16 : Highway Network Conceptual Plan in Peninsular Malaysia

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 expressway 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 more developed and less developed regions.

(2) Network Configuration for Sabah and Sarawak

Figure 3.17 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 in further encouraging 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 must 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 future beyond 2010.

In Sabah, on the other hand, development is to be further encouraged on the east as well as the west coasts. Linkages between the two coasts 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.

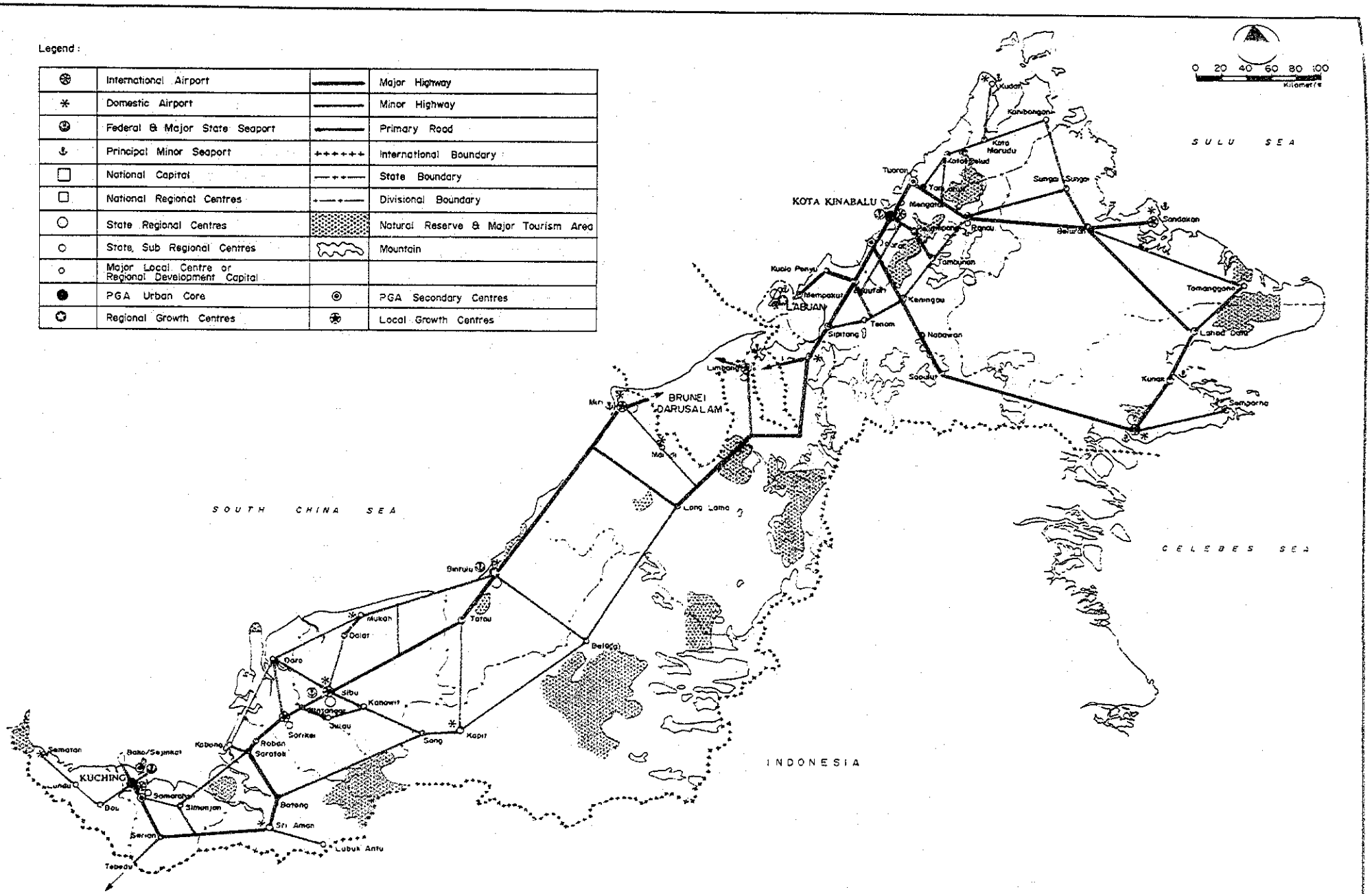


Figure 3.17 : Highway Network Conceptual Plan in Sabah and Sarawak

3.4.7 Alternative Highway Network Development Plans

(1) Alternative Highway Network Development Plans for P.Malaysia

For Peninsular Malaysia, three alternative highway networks are formulated based on the conceptual plan. Although all three alternatives basically satisfy all the linkage requirements suggested by the conceptual plan, Alternative 1 proposes a more extensive highway network than the other two.

Alternative 1 proposes a highway network that include an expressway (4-lane) along the east coast from Kota Bahru down to Johor Bahru and from Kuala Lumpur to Kuantan. Alternative 1 also strives for a densest highway network configuration for the west coast of Peninsular Malaysia. Special attentions are given to the provision of a dense network from KL down to Johor Bahru and in the Kedah-Penang Region, both of which are expected to grow very fast in the next two decades.

Alternative 3 proposes a minimum highway network that satisfy the minimum requirement, with less emphasis given to new construction but more on upgrading and improvement of existing federal roads. No new expressway will be built on the east coast except for the new expressway between KL and Kuantan.

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. The three alternative highway network plans are given in Figures 3.18 to 3.20.

(2) Highway Network Development Plan In Sabah and Sarawak

For Sabah and Sarawak, however, only one highway network development plan is formulated to meet the future traffic demand since future traffic demand remains low and travel corridor pattern is simple and confined to only the coastal corridor. Figure 3.21 shows the future highway network development plan proposed for Sabah and Sarawak.

(3) Total Road Length of Alternative Highway Network Development Plans

Table 3.8 shows the total road length of Alternative Highway Network Plans. The total inter-urban highway length for the proposed Alternative 1 amounts to 11,740 km. This is the extensive network plan. For the least network plan in Alternative 3, the total highway length is 10,020 km. Alternative 2 has a total length of 10,850 km.

The future network plan for Sabah and Sarawak amounts to 2,005 km in Sabah and 2,443 km in Sarawak.

Table 3.8: Total Road Length By Function for the Alternative Network Plans

(Unit: km)

Category		Peninsular Malaysia			Sabah	Sarawak
		Alt. 1	Alt.2	Alt.3		
Principal Highway System	Expressway	1,669	1,394	1,078	-	-
	Major Highway	4,114	4,114	4,114	892	972
Minor Highway System		1,971	1,826	1,501	-	35
Primary Road System		3,986	3,516	3,327	1,113	1,436
Total		11,740	10,850	10,020	2,005	2,443

3.4.8 Preliminary Engineering and Cost Estimation

The study team carried out detail studies and analyses to determine the unit construction cost of various highway cross-sectional types, cost of road improvement and widening works. Based on these unit costs, the total project costs by alternative plans and category of highways are estimated and the results are summarized and given in Table 3.9.

Table 3.9 : Project Cost Estimates by Alternative Plan and Highway Category

(unit: RM million)

Catergory		Alternative 1		Alternative 2		Alternative 3	
		Length (km)	Project Cost	Length (km)	Project Cost	Length (km)	Project Cost
Principal Highway System	Expressway	1,278	19,680.38	1,003	8,134.10	687	5,410.62
	Major Highway	3,513	13,811.95	3,513	14,030.54	3,513	15,366.27
Minor Highway System		1,971	8,234.29	1,826	6,981.17	1,501	5,885.12
Primary Road System		2,560	8,384.24	2,163	6,864.72	2,163	6,864.72
Total Peninsular		9,332	40,110.86	8,505	36,010.53	7,869	33,526.73

Category	Sabah		Sarawak	
	Length (km)	Project Cost	Length (km)	Project Cost
Major Highway System	892	4,213.18	972	3,724.19
Minor Highway System	0	0	35	118.64
Primary Road System	1,083	3,879.13	1,436	4,967.20
Tatal	1,975	8,092.31	2,443	8,810.03

Note: Committed projects of 6th Malaysia Plan are excluded.

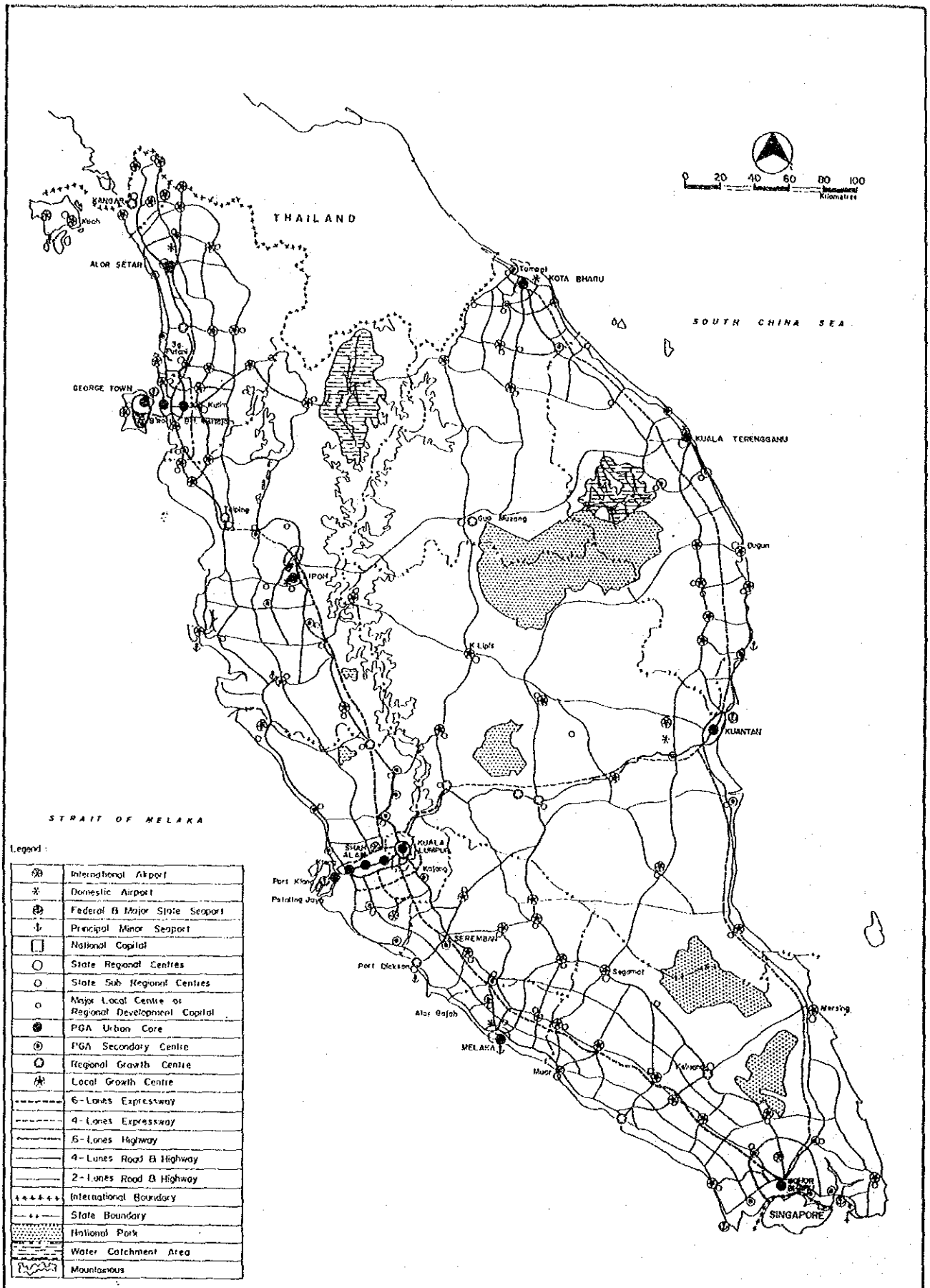


Figure 3.18 : Future Highway Network Alternative 1 for P.Malaysia

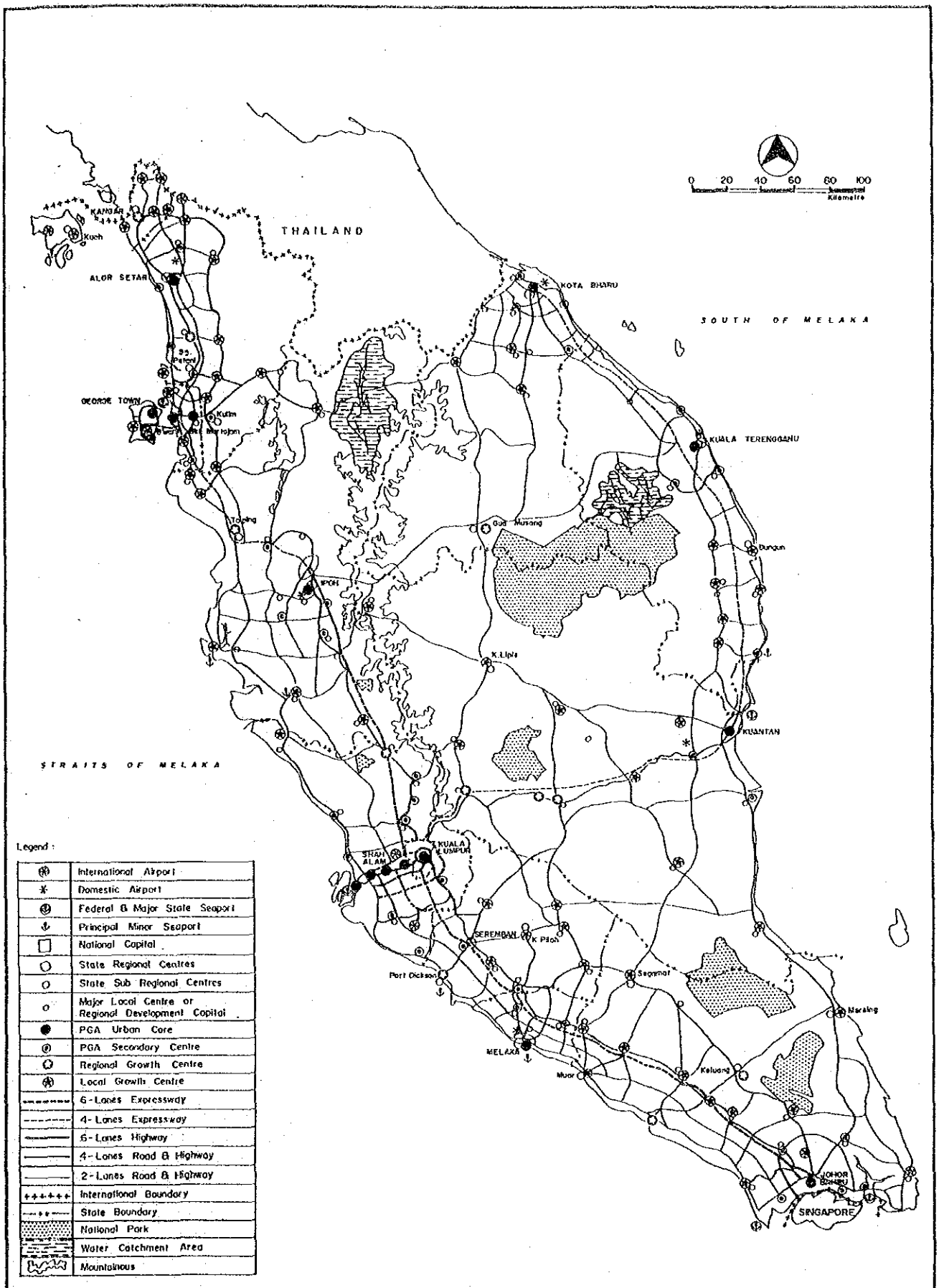


Figure 3.19 : Future Highway Network Alternative 2 for P.Malaysia

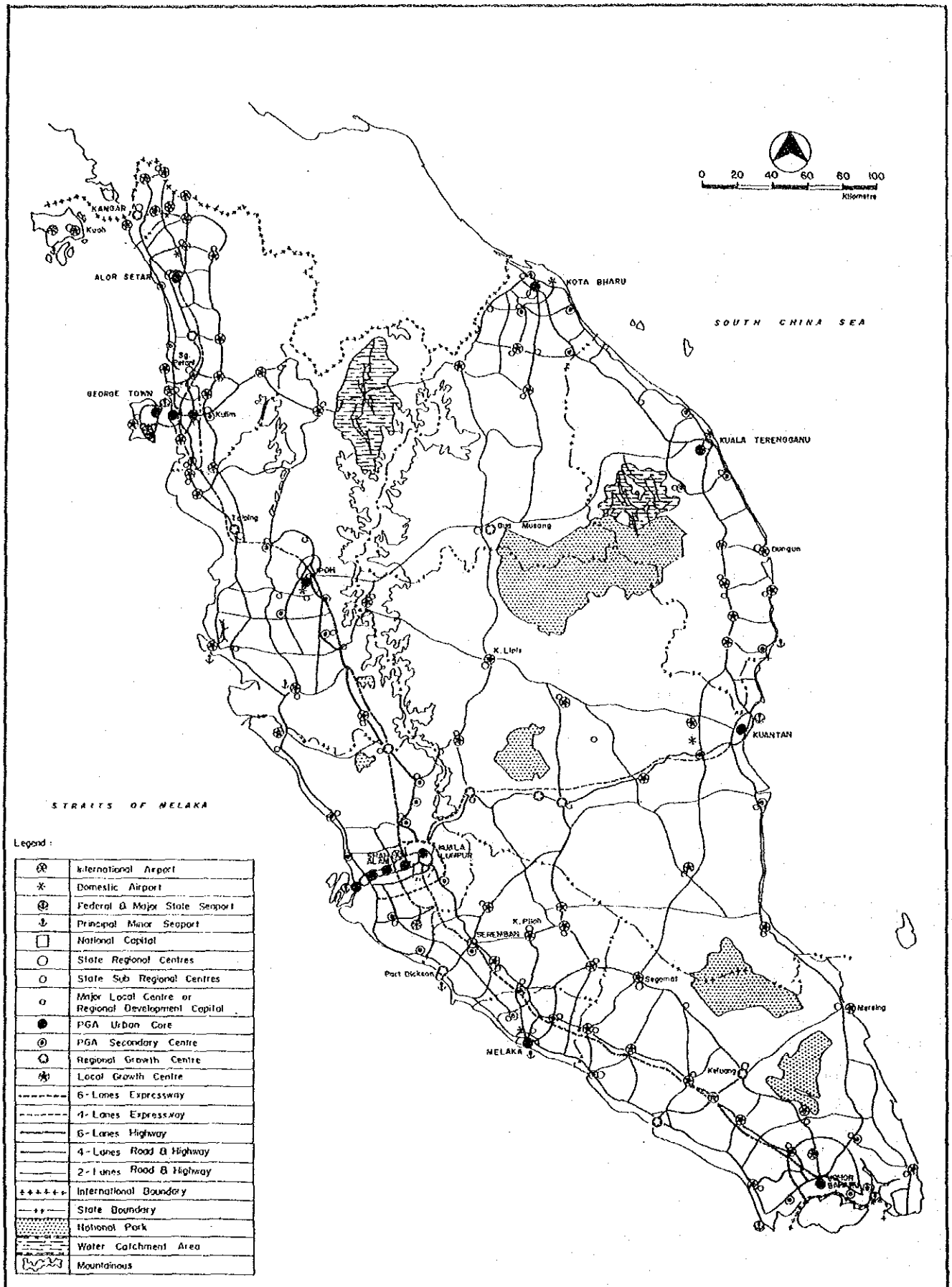


Figure 3.20 : Future Highway Network Alternative 3 for P.Malaysia

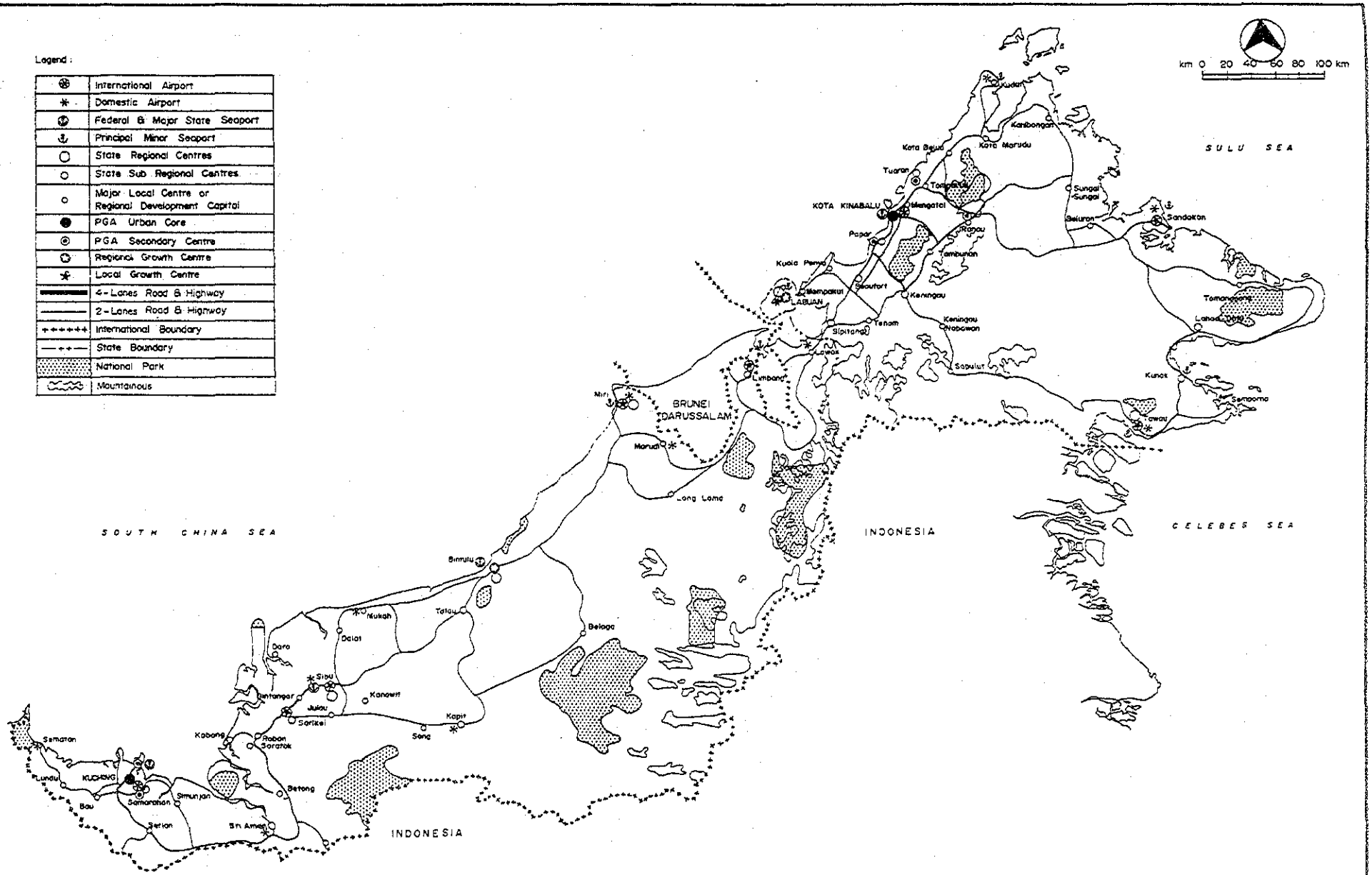


Figure 3.21 : Future Highway Network Development Plan for Sabah and Sarawak

3.5 Evaluation Of Alternative Plans

3.5.1 Evaluation Procedure

The alternative highway network development plans are evaluated on three perspectives:

- Functional Suitability of the Network Configuration,
- Economic Evaluation,
- Likely impacts on Social/Regional Development.

3.5.2 Functional Suitability of Network Configuration

The functional suitability of a highway network in this study is assessed using three fundamental factors of level of service namely volume/capacity ratio, travel speed and average trip length.

(1) Peninsular Malaysia

The average volume/capacity (v/c) ratio on the present highway network in P.Malaysia is 0.527. From results of the trip assignment under the "Do-Nothing" scenario, this average ratio is expected to increase to 2.164 by the year 2010 if no road development is undertaken. Under this condition, most of the main traffic corridors will be heavily congested and the national road transport system will be almost paralysed.

Compared with this "Do-Nothing" scenario, all the alternative plans produce a drastic and significant improvement in the average v/c ratio, ranging from 0.675 to 0.696 by the year 2010. These are acceptable levels considering that future traffic demand would be about 3.8 times higher than the present level.

Table 3.10 : Level of Service by Alternative Network Plans for Peninsular Malaysia, 1991 & 2010

Case	1991	2010			
Indicators		Do-Nothing	Alternative 1	Alternative 2	Alternative 3
Total Road Length (km)	7690*	8570**	11739	10850	10021
Average Travel Speed (km/hr)	50.2	23.1	58.9	60.0	59.8
Average Trip Length (km/trip)	34.4	47.4	42.0	42.3	42.4
Average Volume/Capacity Ratio	0.527	2.164	0.686	0.675	0.696

Note: * including expressway, toll highway and federal trunk road

** including sections of the N-S expressway under construction and committed projects in the SMP.

The average trip length can be expected to increase in future on account of increased mobility and accessibility. Poor highway network that necessitate frequent detours may also increase average trip length. Under the "Do-Nothing" scenario, the average trip length is estimated to increase to 47.4 km in 2010 compared with 34.4 km in 1991. All the three alternative plans are able to shorten the average trip length to about 42.2 km, indicating that the element of detours from the "Do-Nothing" case is removed with the proposed highway networks.

All the three alternative plans are predicted to improve the average travel speed from 23.1 kph in the "Do-Nothing" scenario to about 59 - 60 kph, a level that is even better than the present condition.

(2) Sabah and Sarawak

Since only one alternative plan is prepared for Sabah and Sarawak, analyses are made between "Do-Nothing" scenario and the proposed network plan.

The average volume/capacity ratio for Sabah is 0.419 at present and the ratio is expected to worsen to 2.0 by the year 2010 under the "Do-Nothing" scenario. By implementing the proposed network, the ratio will recover to a satisfactory level of 0.618. The volume/capacity ratio in Sarawak also indicates that most of the roads will be overcrowded by the year 2010 under the "Do-Nothing" scenario condition, and the proposed highway network will improve the future traffic flow.

The average trip length in Sabah will increase from 75.5 km in 1991 to 81.8 km in 2010 due to detours and congestions under the "Do-Nothing" scenario. The average trip length however will reduce to 63.3 km under the proposed network plan. In the case of Sarawak, the average trip length will increase from 51.8 km in 1991 to 64.3 km in 2010 under the "Do-Nothing" scenario, and will further increase to 65.7 km under the proposed network plan. This is because some of the river transport are replaced by road transport in the proposed network case and there will be an increase in mobility in the state.

The average speed in Sabah is expected to decrease from the present 42.2 kph to 23.0 kph by the year 2010 compared with the present situation if the road network is not improved. The average travel speed however is predicted to increase by about 20% from the present level to 51.0 kph if the proposed network is implemented. Similarly, the average travel speed is predicted to increase from the present 39.8 kph to 53.8 kph by year 2010 in Sarawak with the proposed network plan.

Table 3.11 : Level of Services for Sabah and Sarawak, 1991 & 2010

	Indicators	1991	2010	
			Do-Nothing	Proposed Network
Sabah	Total Road Length (km)	1116.0	1116.0	2005.0
	Average Travel Speed (km/hr)	42.2	23.0	51.0
	Average Trip Length (km/trip)	75.5	81.8	63.3
	Volume/Capacity Ratio	0.419	2.000	0.618
Sarawak	Total Road Length (km)	1213.0	1213.0	2443.0
	Average Travel Speed (km/hr)	39.8	29.0	53.8
	Average Trip Length (km/trip)	51.8	64.3	65.7
	Volume/Capacity Ratio	0.189	1.081	0.376
Sabah & Sarawak	Total Road Length (km)	2329.0	2329.0	4448.0
	Average Travel Speed (km/hr)	41.0	26.2	52.6
	Average Trip Length (km/trip)	70.0	75.8	64.2
	Volume/Capacity Ratio	0.311	1.571	0.504

3.5.3 Economic Evaluation

Economic evaluation is carried out by analyzing the benefits derived from the proposed highway network plans with costs accrued from their implementation using such economic indicators as B/C ratio, IRR and NPV. A "base case" is set up for comparison. This "base case" denotes the existing highway network with the committed road projects. Cost estimates of the proposed network plans exclude the these committed projects since they are under implementation within the framework of the Sixth Malaysia Plan.

Although there are many direct and indirect benefits that can be derived from the implementation of the highway network plans, the two major direct benefits, namely savings in vehicle operating cost and travel time cost are computed for this analysis.

The total projects cost by alternative plans are given in the table below. The financial cost for the three alternative plans in P.Malaysia are estimated at RM40,110.9 million, RM36,051.6 million and RM33,526.7 million respectively. Costs for the proposed network in Sabah and Sarawak are estimated at RM8,092.3 million and RM8,810.0 million respectively.

On the other hand, benefits for the three alternative plans in P.Malaysia are estimated at RM18,670 million, RM20,257 million and RM18,410 million at 2010. Benefits for the proposed plan in Sabah and Sarawak are estimated at RM2,564.4 million and RM1,511.2 million respectively.

Table 3.12 : Total Economic Costs of Alternative Network Plan

(RM million)

Region		Financial Cost	Economic Cost
Peninsular Malaysia	Alternative 1	40,110.9	38,105.4
	Alternative 2	36,051.6	34,249.0
	Alternative 3	33,526.7	31,850.4
Sabah		8,092.3	7,687.7
Sarawak		8,810.0	8,369.5

Table 3.13 : Economic Benefit of Alternative Network Plans in Peninsular Malaysia

(RM million)

Item	Alternative 1		Alternative 2		Alternative 3	
	1999	2010	1999	2010	1999	2010
VOC Savings (Running Cost)	34.6	1,094.6	33.6	1,059.6	29.3	932.9
VOC Savings (Fixed Cost)	217.8	12,147.9	245.8	13,332.6	212.2	12,086.8
Travel Time Savings	68.0	5,427.2	76.4	5,864.8	68.0	5,389.8
Total	320.4	18,669.7	355.8	20,257.0	309.5	18,409.5

Table 3.14: Economic Benefit of Proposed Network Plans in Sabah and Sarawak

(RM million)

Item	Sabah		Sarawak	
	1999	2010	1999	2010
VOC Savings (Running Cost)	5.6	146.9	1.2	154.1
VOC Savings (Fixed Cost)	65.1	1,449.8	20.2	696.6
Saving in River Transport Cost	-	-	1.7	11.9
Travel Time Savings	24.7	967.7	9.7	648.6
Total	95.4	2,564.4	32.8	1,511.2

The total economic benefit and cost streams are compared by each alternative, assuming the discount rate of 12% per annum. The results of the evaluation for P.Malaysia are shown in Table 3.15. The total discounted benefits for all three alternatives are much higher than the total discounted costs, indicating that the alternative plans are economically viable. B/C ratios for the three alternatives are 2.74, 3.34 and 3.24 respectively. IRR are high at 26.4%, 29.8% and 29.2% respectively.

Table 3.15 : Evaluation Indicators of Alternative Network Plans for Peninsular Malaysia

Indicator	Alternative 1	Alternative 2	Alternative 3
Internal Rate of Return (%)	26.4%	29.8%	29.2%
B/C Ratio	2.74	3.34	3.24
Net Present Value (RM million)	17,607.9	21,129.6	18,859.1

Economic evaluation results for Sabah and Sarawak are given in Table 3.16. The B/C ratio for Sabah is calculated at 2.1 and IRR at 23.7%. For Sarawak, the B/C ratio is computed at 1.04 and the IRR at 12.4%. These evaluation results show that the proposed highway network plan for Sabah and Sarawak is economically feasible.

Table 3.16: Evaluation Indicators for Sabah and Sarawak

Indicator	Sabah	Sarawak
IRR (%)	23.7%	12.4%
B/C Ratio	2.11	1.04
NPV (RM million)	2,304.1	87.3

3.5.4 Social and Regional Development Considerations

The road development index is used as a measure of performance of the alternative plans on the promotion of social and regional development.

The road development indices by the three alternative plans for P.Malaysia, and Sabah and Sarawak are given in Table 3.17. The proposed future highway network for P.Malaysia will produce indices of 0.218, 0.202 and 0.186 for Alternative 1 to 3 respectively. Alternative 1 has the highest index since it is the most extensive network plan. Compared with the 1991 level of 0.173, Alternative 1 and 2 show substantial improvements with future indices of more than 0.2 which is comparable to some of the developed countries.

The proposed network for Sabah and Sarawak is expected to improve the road development indices quite substantially from 0.103 in 1991 to 0.141 by 2010 for Sabah and 0.081 in 1991 to 0.131 by 2010 for Sarawak.

Table 3.17: Road Development Index for Inter-urban Highway Network by Alternative Plans

Year	Indicator		P.Malaysia	Sabah	Sarawak	Malaysia
1991	Highway Length (km)		7,690	1,116	1,213	10,019
	Population ('000)		15,084.0	1,592.1	1,814.0	18,490.1
	Area (km^2)		131,598	73,620	124,449	329,667
	Road Develop. Index		0.173	0.103	0.081	0.128
2010	Population ('000)		21,954.6	2,765.9	2,779.9	27,500.4
	Highway Length (km)	Alternative 1	11,740			16,188
		Alternative 2	10,850	2,005	2,443	15,298
		Alternative 3	10,020			14,468
	Road Develop. Index	Alternative 1	0.218			0.170
		Alternative 2	0.202	0.141	0.131	0.161
		Alternative 3	0.186			0.152

3.5.5 Recommended Highway Network Development Plan

As results of the evaluation have shown, Alternative Plan 2 for P.Malaysia consistently emerged as the best alternative plan in terms of economic performance, functional suitability and road development index. As an overall evaluation, therefore, Alternative 2 is recommended as the future highway network development plan for P.Malaysia to year 2010. Table 3.18 summarizes this recommended network plan. Figure 3.22 shows the recommended network plan for P.Malaysia.

Table 3.18 : Summary of Proposed Highway Network for P.Malaysia to 2010

Category		Existing 1991 (km)	Future 2010 (km)
Principal Highway	Expressway	409	1,394
	Major Highway	5,630	4,114
Minor Highway			1,826
Primary Road		1,651	3,516
Total		7,690	10,850

Note : Inter-Urban Highway Network only

The network plan proposed for Sabah and Sarawak is found to be economically viable and functionally suitable. Moreover, the network is able to improve the road development indices significantly in both states. Table 3.19 summarizes this recommended highway network plan for Sabah and Sarawak while Figure 3.23 shows the recommended highway network plan.

Table 3.19 :Summary of Proposed Highway Network in Sabah and Sarawak to 2010

Category	Sabah		Sarawak	
	Existing 1991 (km)	Future 2010 (km)	Existing 1991 (km)	Future 2010 (km)
Principal Highway	759	892	629	972
Minor Highway	-	-		35
Primary Road	357	1,113	584	1436
Total	1116	2005	1213	2443

Note : Inter-Urban Highway Network only

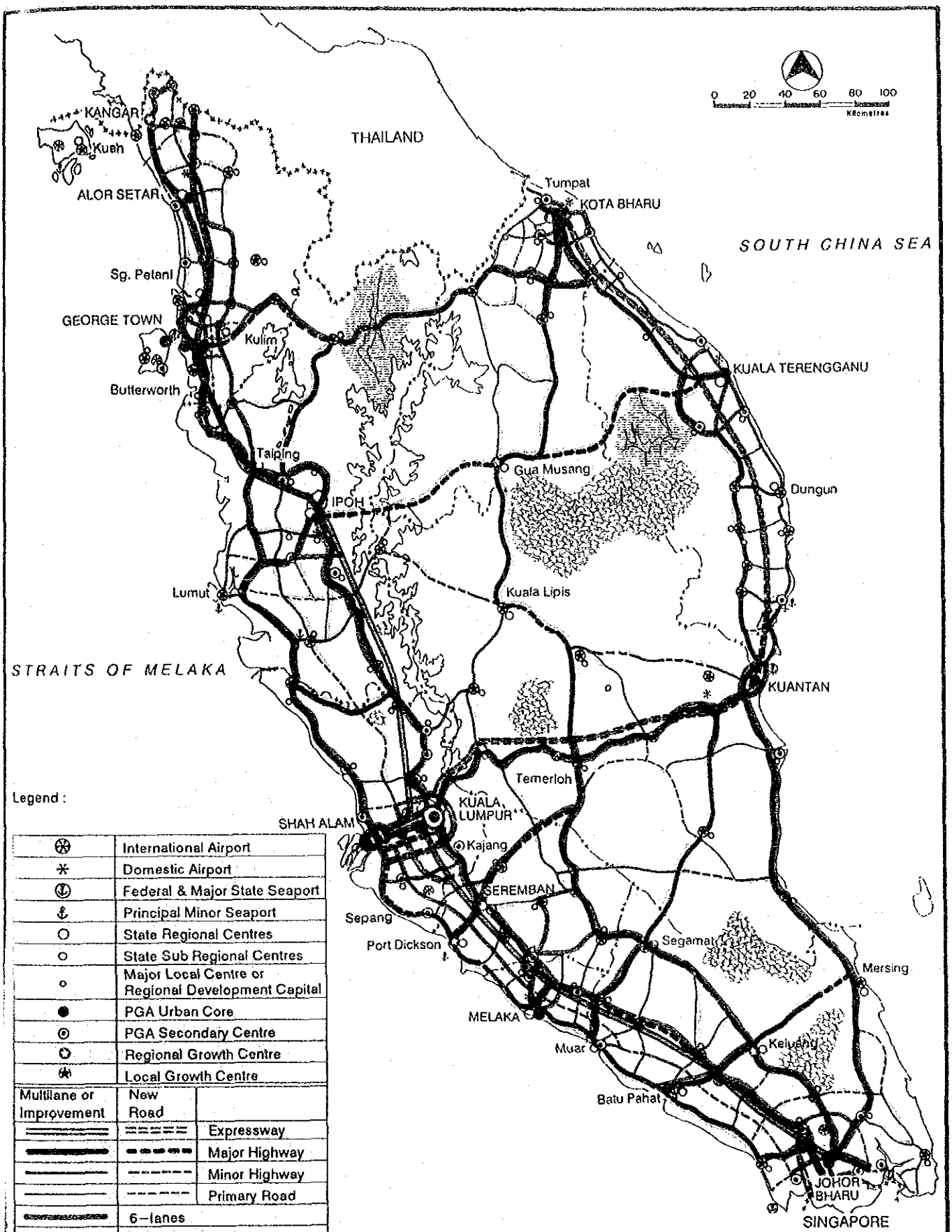


Figure 3.22: Recommended Highway Network Plan for P.Malaysia

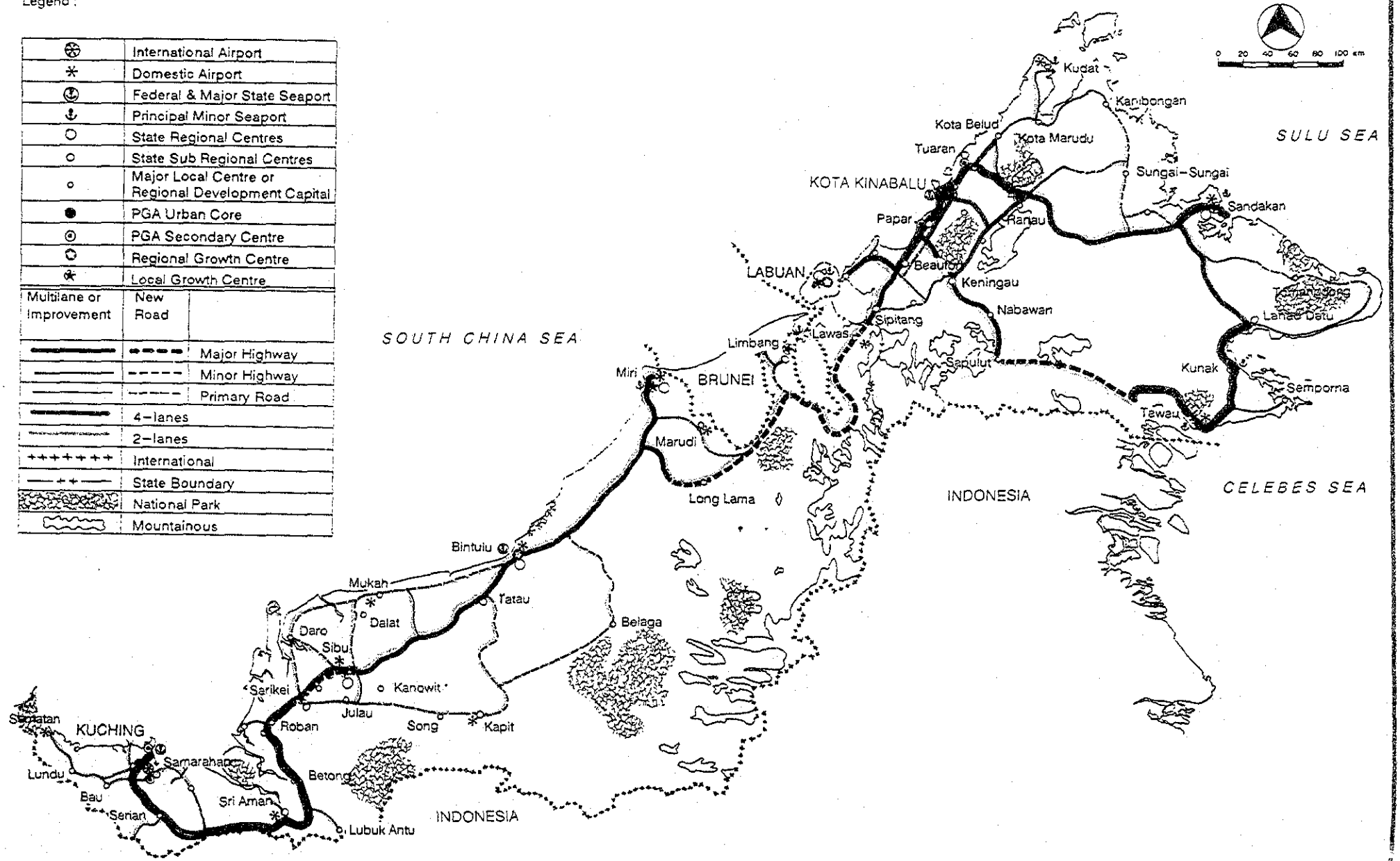


Figure 3.23: Recommended Highway Network Plan for Sabah and Sarawak

3.6 Implementation Plan

3.6.1 Investment Requirements

The total investments required for realizing the recommended highway network plan between 1996 and 2010 are estimated to be approximately RM 53.0 billion. Tables 3.20 and 3.21 show investment requirements for highway development to year 2010 by road function and project type respectively.

Based on the amount of funds allocated for road development since 2nd Malaysia Plan to 6th Malaysia Plan, even if some of the proposed projects are assumed to be implemented by privatization scheme, the investment requirements may not be sufficiently met. Therefore, it is suggested that :-

1. The Government considers allocating a higher highway and bridge development funding in the coming 7MP, 8MP and 9MP plans.

2. A portion of the road user charges (such as road tax, and other users revenue) should be channelled to the development of highways.

Table 3.20 : Investment Requirements for Highway Development by Road Function to Year 2010

(in RM million)

Category	Peninsular	Sabah	Sarawak	Malaysia
Expressways	8,134.1	-	-	8,134.1
Major Highways	14,030.5	4,213.2	3,724.2	21,967.9
Minor Highways	7,022.2	-	118.6	7,140.8
Primary Roads	6,917.0	3,879.1	4,967.2	15,763.3
Total	36,103.8	8,092.3	8,810.0	53,006.1

Table 3.21 : Investment Requirements for Highway Development by Project Type to 2010

(in RM million)

Category	Peninsular	Sabah	Sarawak	Malaysia
New Construction	14,871.3	2,315.5	5,513.9	22,700.7
Improvement	7,048.7	3,302.6	2,065.6	12,416.9
Widening	14,182.8	2,474.3	1,230.5	17,887.6
Total	36,103.8	8,092.3	8,810.0	53,006.1

3.6.2 Ranking of Highway Projects

All the proposed highway projects have to be ranked in an order of priority so as to come up with an efficient implementation program. Highway projects identified in the recommended network plan are examined and compared on their qualitative and quantitative features.

(1) Qualitative Feature

The qualitative feature considered is the network configuration. Projects which are the missing links on the principal highway system are therefore accorded a higher priority.

(2) Quantitative Features

The quantitative features considered are future traffic volume, volume/capacity ratio and cost effectiveness.

Accordingly, the proposed highway projects in P.Malaysia and Sabah, Sarawak are ranked and given Table 3.22.

Possibility of a number of the proposed highway projects to be implemented under the privatization program is also examined. Seven projects amounting to an estimated cost of RM8.71 million are identified as candidate privatization projects. These are also noted in Table 3.22.

3.6.3 Implementation Programme

The recommended highway network is proposed to be implemented in a three phase program as given in Table 3.23.

Table 3.23 : Implementation Programme for Future Highway Development to 2010

(in RM million)

Region	Phase I (1996-2000)	Phase II (2001-2005)	Phase III (2006-2010)
Peninsular Malaysia	8,236.6	11,336.6	16,530.6
Sabah	2,118.0	2,488.0	3,486.3
Sarawak	2,448.0	2,647.3	3,714.7
Total	12,802.6	16,471.9	23,731.6

Figures 3.24 and 3.25 shows the proposed highway projects by phase in P.Malaysia, and Sabah and Sarawak respectively.

Table 3.22: Priority Ranking of Proposed Highway Projects

Rank	Project No.	Project Name	Investment Amount RM Million	Year '95	'00	'05	'10	Note
1	32	Keluang–Gemas Widening	353.805		------			
2	10	KL Outer Ring	853.462		------			P
3	57	Bukit Minyak–K.Batas (Butterworth Bypass)	105.000		------			
4	23	Port Dickson–Shah Alam New Road	328.104		------			
5	25	Klang–Lumut Widening	782.366		------			
6	17	Ipoh Ring Road Wide	92.926		------			
7	9	South Klang Valley Expressway	284.478		------			P
8	72	Kuantan Bypass	101.215		------			
9	22	Melaka–Port Dickson New Road	396.852		------			
10	5	E–W Expressway (KL–Temerloh)	1511.527		------			P
11	29	Changkat Jering–Bukit Mertajam Widening	278.405		------			
12	65	Bt. Seruk–Kg. Petuh New Road (K.Rompin Access)	111.479		------			
13	31	JB–Keluang Widening	527.653		------			
14	6	E–W Expressway (Temerloh–Kuantan)	557.562		------			P
15	48	Melaka–Alor Gajah	36.700		------			
16	44	Tampin–Gemas Widening	127.751		------			
17	58	Telok Air Tawar–Padang Serai New Road (Butterworth Access)	100.000		------			
18	49	Port Dickson–Seremban Widening	105.966		------			P
19	15	Federal Route I Widening (Tanjong Malim–Ipoh)	371.222			------		
20	13	Federal Route I Widening (Melaka–KL)	455.763			------		
21	14	Federal Route I Widening (KL–Tanjong Malim)	254.567			------		
22	11	Federal Route I Widening (JB–Yon Peng)	394.626			------		
23	12	Federal Route I Widening (Yon Peng–Melaka)	685.833			------		
24	47	Melaka–Ayer Keroh Widening	55.050			------		
25	67	Teluk Datuk–Kajang Widening	194.497			------		
26	35	Temerloh–Kuantan Widening Federal Route II	662.514			------		P
27	34	Bentong–Temerloh Widening Federal Route II	251.921			------		P
28	28	Changkat Jering–Lumut Widening	216.820			------		
29	27	KL–Teluk Intan New Road	377.693			------		
30	16	Federal Route I Widening (Ipoh–P.Pinang)	449.877			------		
31	26	Lumut–Ipoh Widening	346.911			------		
32	63	Kota Bharu Coastal Road	441.762			------		
33	43	Muar – Segamat	264.913			------		P
34	7	East Coast Expressway (Kuantan–K.Trengganu)	1790.899			------		P
35	38	Federal Route III Mersing–Kuantan Widening	751.308			------		
36	50	Seremban–Kemayan Road	621.820			------		
37	30	Bukit Mertajam–Thai Border Road	522.474			------		
38	1	N–S Expressway Widening (JB–Yon Peng)	508.567				------	AP
39	2	N–S Expressway Widening (JB–Melaka)	519.269				------	AP
40	3	N–S Expressway Widening (Melaka–Seremban)	336.273				------	AP
41	4	N–S Expressway Widening (Rawang–Ipoh)	839.485				------	AP
42	8	East Coast Expressway (K.Trengganu–Kota Bharu)	1137.574				------	P
43	18	Federal Route I Widening (P.Pinang–Sg. Petani)	169.359				------	
44	19	Federal Route I , VII Widening (Sg. Petani–Kangar)	508.336				------	
45	20	Pontian–Batu Pahat New Road	449.054				------	
46	21	Pagoh–Melaka New Road	340.051				------	
47	24	Port Dickson–Klang Widening	644.505				------	
48	33	Gemas–Temerloh Widening	426.492				------	
49	36	Kuantan–Chukai Widening	162.909				------	
50	37	Federal Route III JB–Mersing Widening	643.981				------	
51	39	K.Trengganu Outer Circle	448.135				------	
52	40	Kulai–Kota Tinggi Widening	115.717				------	

Table 3.22: Priority Ranking of Proposed Highway Projects (cont'd)

Rank	Project No.	Project Name	Investment Amount RM Million	Year '95	'00	'05	'10	Note
53	41	JB–Gelang Patah New Road	276.355				------	
54	42	Batu Pahat–Keluang Widening	318.723				------	
55	45	Tampin–K.Pilah–Bahau Widening	170.335				------	
56	46	Melaka–Jasin Widening	95.500				------	
57	51	Mengkarak–Ibam New Road (Temerloh–K.Rompin Connection)	385.783				------	
58	52	Lumut (Pangkor)–Tapah New Road	290.722				------	
59	53	Perak Tengah–Dipang New Road	82.405				------	
60	54	Kangar–Changlun New Road	104.793				------	
61	55	K.Lipis–Jerantut New Road	215.066				------	
62	56	Jerantut–Lembing (Kuantan) New Road	523.109				------	
63	59	Nerang–Jitra Access	114.168				------	
64	60	Jeli–K.Krai New Road	270.941				------	
65	61	Federal Route IV(Jeli–Pasir Putih) Widening	266.000				------	
66	62	Kota Bharu–Pasir Puteh Widening	231.976				------	
67	64	Pengerang–Kota Tinggi New Road	448.367				------	
68	66	K.Trengganu Coastal Road Widening	219.066				------	
69	68	Sg. Petani–Baling Widening	86.289				------	
70	69	K.Lipis–Cameron Highland New Road	757.368				------	
71	70	K.Krai–Kota Bharu Widening	294.167				------	
72	71	K.Trengganu–K.Berang Widening	154.554				------	
		SUB–TOTAL excluding project with *AP*	**26117.521**					
		SUB–TOTAL	**28321.115**					
1	SB–9	Kg. Segaliud–Sandakan Widening	199.986		------			
2	SB–1	Beaufort–K.Kinabalu–Kota Belud Widening	450.695		------			
3	SB–10	Lahad Datu–Tawau Widening	396.724		------			
4	SB–4	Tamparuli–Ranau	279.979		------			
5	SB–6	Tenom Access Road	378.574			------		
6	SB–3	Beaufort–Papar–K.Kinabalu Road	302.278			------		
7	SB–8	Kanibongan–Kg. Sualong New Road	270.510			------		
8	SB–13	Ranau–Sg. Sungai New Road	479.818			------		
9	SB–2	Mempakul–Beaufort Widening	172.179				------	
10	SB–5	Keningau–Ranau Widening	575.761				------	
11	SB–7	Tambunan–K.Kinabalu Widening	253.020				------	
12	SB–11	Sapulut–Tawau New Road	786.653				------	
13	SB–12	Bukit Garam–Lindungan Buani New Road	243.514				------	
		SUB–TOTAL	**4789.711**					
1	SW–14	Nanga Mendamit–Sabah/Sarawak Border New Road	1195.124		------			
2	SW–19	Kuching Port–Sri Aman Widening	757.151		------			
3	SW–17	Sarikei–Sibu New Road	155.920			------		
4	SW–16	Kanowit–Kapit New Road	634.644			------		
5	SW–18	Sri Aman–Sarikei Widening	518.604			------		
6	SW–20	Samarahan–Simunjan New Road	144.328			------		
7	SW–15	Miri–Long Terawan New Road	532.863			------		
8	SW–21	Kapit–Belaga New Road	911.293				------	
9	SW–22	Sibu–Bintulu Coastal Road	383.319				------	
10	SW–23	Sarikei–Daro–Sibu Road	1111.229				------	
		SUB–TOTAL	**6344.475**					
	Others	Highway Improvement in Peninsular	6956.414		------	------	------	
	Others	Highway Improvement in Sabah	3302.600		------	------	------	
	Others	Highway Improvement in Sarawak	2065.554		------	------	------	
		SUB–TOTAL	**12324.568**					
		GRAND TOTAL excluding projects with *AP*	**223510.24**					
		GRAND TOTAL	**51779.869**					

Note: AP : Projects Already Privatized
P : Possibility to be privatized
The Third Priority Projects (in 2010) is not ranked yet
The continuation projets from 6th Malaysia Plan are excluded

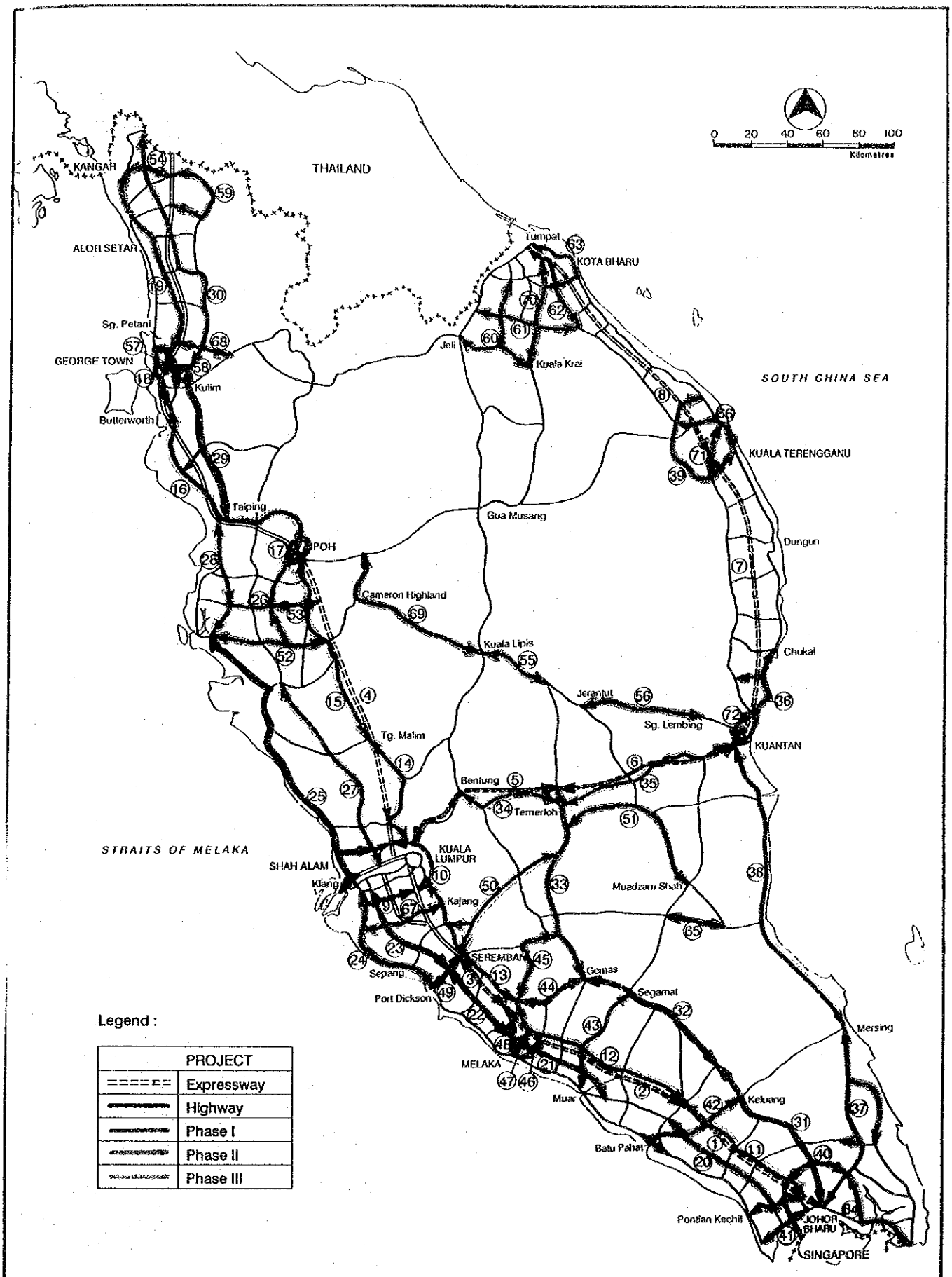


Figure 3.24: Implementation of Proposed Highway Projects by Phase in P.Malaysia

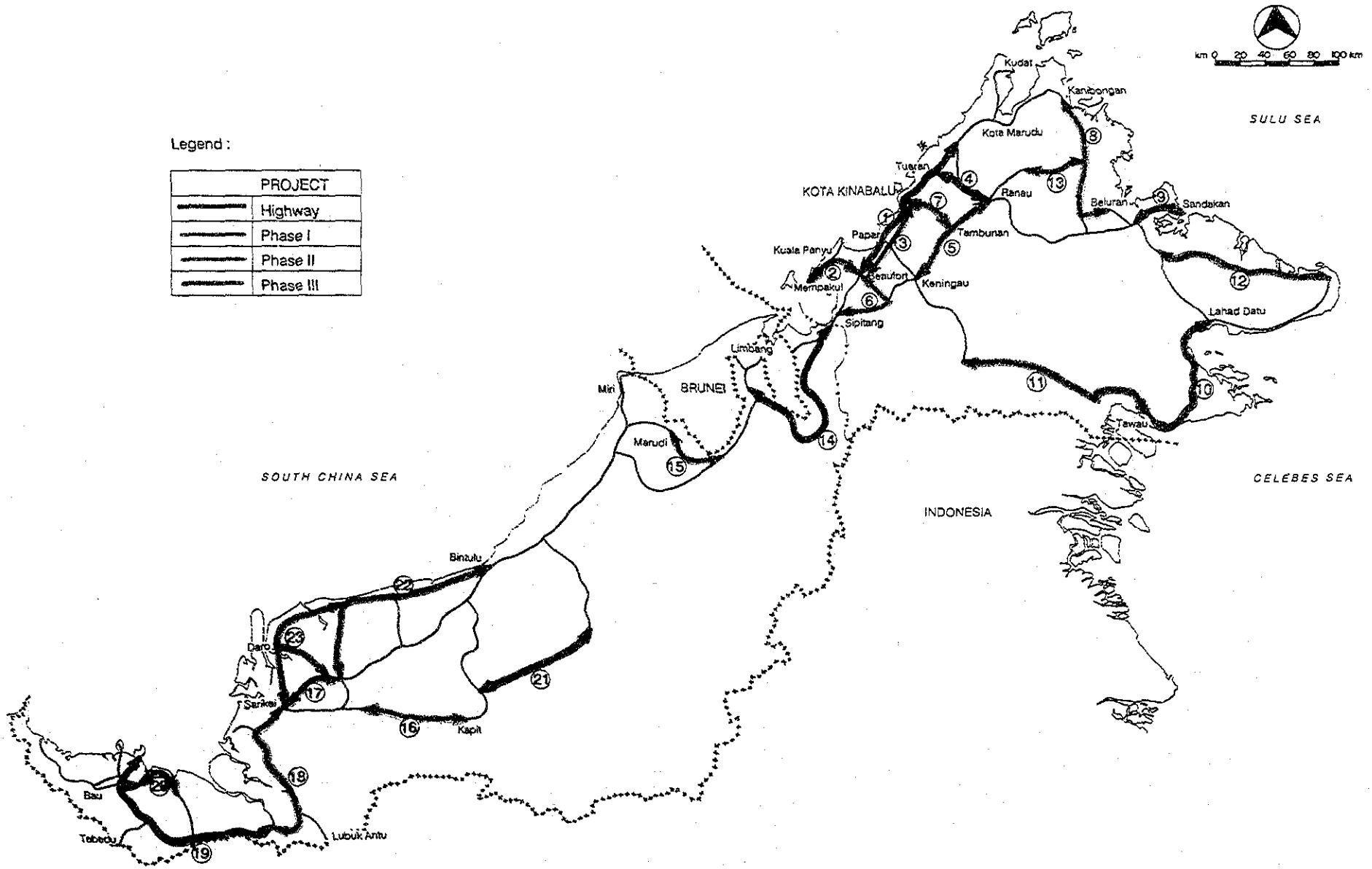


Figure 3.25: Implementation of Proposed Highway Projects by Phase in Sabah and Sarawak

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