LIST OF FIGURES

CHPATER 10 TRANSPORTATION

1. General

The existing major transportation facilities in Peninsular Malaysia are roads, airports, ports and railways. Fig. 10.1 shows the major transport systems in Peninsular Malaysia and Fig. 10.2 shows those in and around the study area.

Out of the major Federal Highway network, Federal Highway Route III and Jerangau-Jabor Highway run north-south through the study area. Route III is along the coast line and was the sole route to reach outside the study area until the opening of the latter Highway in 1980.

The Kuala Terengganu Airport and the Kuantan Airport, being designated as major airports in Peninsular Malaysia, are situated almost the same distance away from the study area, one to the north and the other to the south. Since March 1, 1985 a commercial line has served to Kuala Lumpur using the newly constructed Kerteh Airport. People in the study area can use the airline service at these airports.

The Kuantan Port at Tanjung Gelang, 40 km south of the study area, is the only Federal port in the East Coast capable of handling international marine transportation of 35,000 dwt vessels. The study area is well within its hinterland.

The Dungun and Cukai ports are fundamentally fishing ports and have no prospects of being developed into major coastal ports. The supply base at Tanjung Berhala, currently under construction, will have a capacity to handle 130,000 dwt vessels of the final stage of the programme.

There is no railway line in the study area. The government has decided to construct the East-West railway line. Although a feasibility study of the east-west railway is currently underway, a conclusive implementation schedule has not yet been recommended.

The public transportation modes in the study area are buses and taxis for long distance travel. Trishaws are fundamentally the sole way of intra-city transportation except for school buses and the occasional use of taxis. The bus networks and service are less developed in the study area.

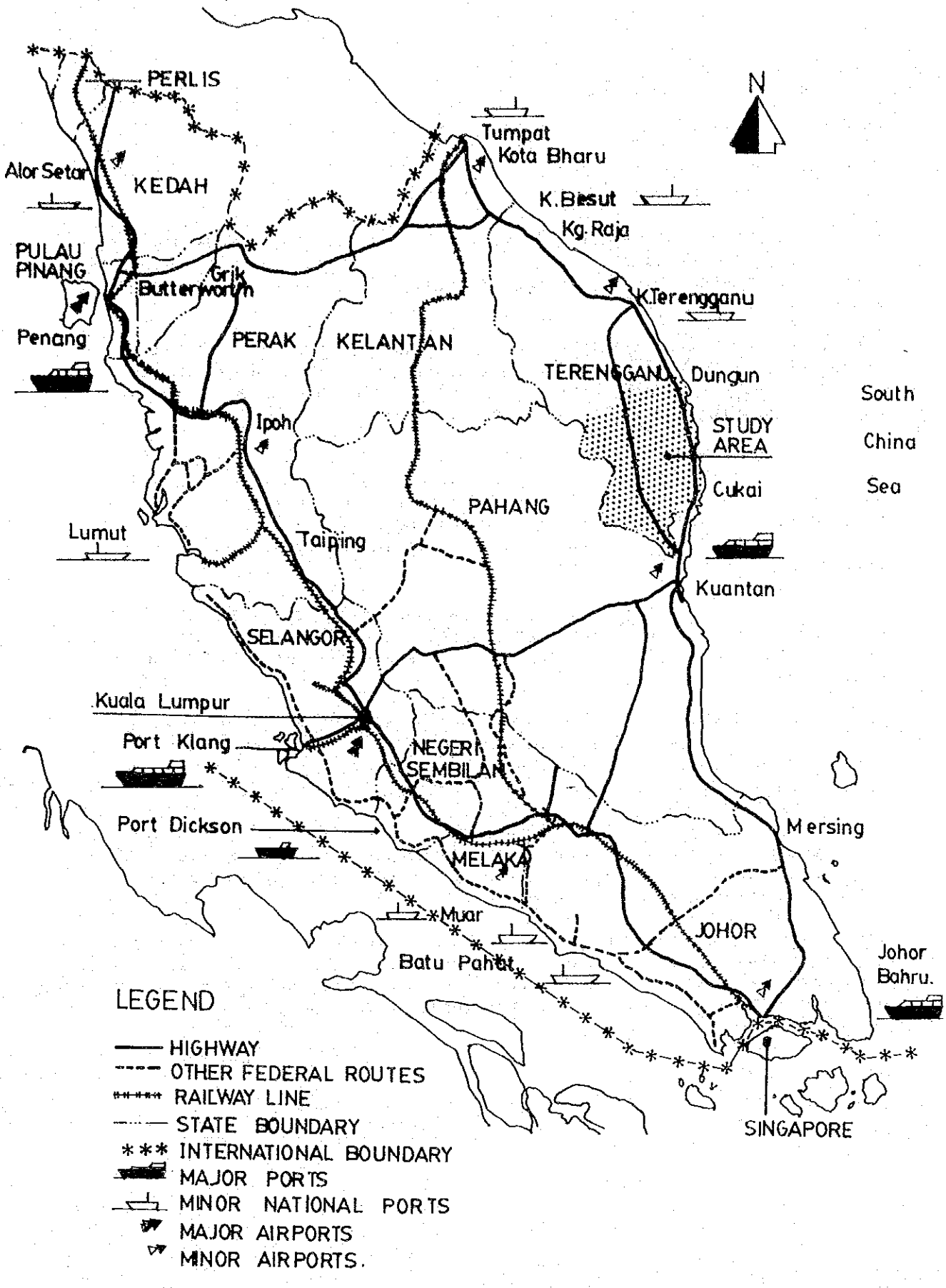


FIG. 10.1 MAJOR TRANSPORT SYSTEMS IN PENINSULAR MALAYSIA

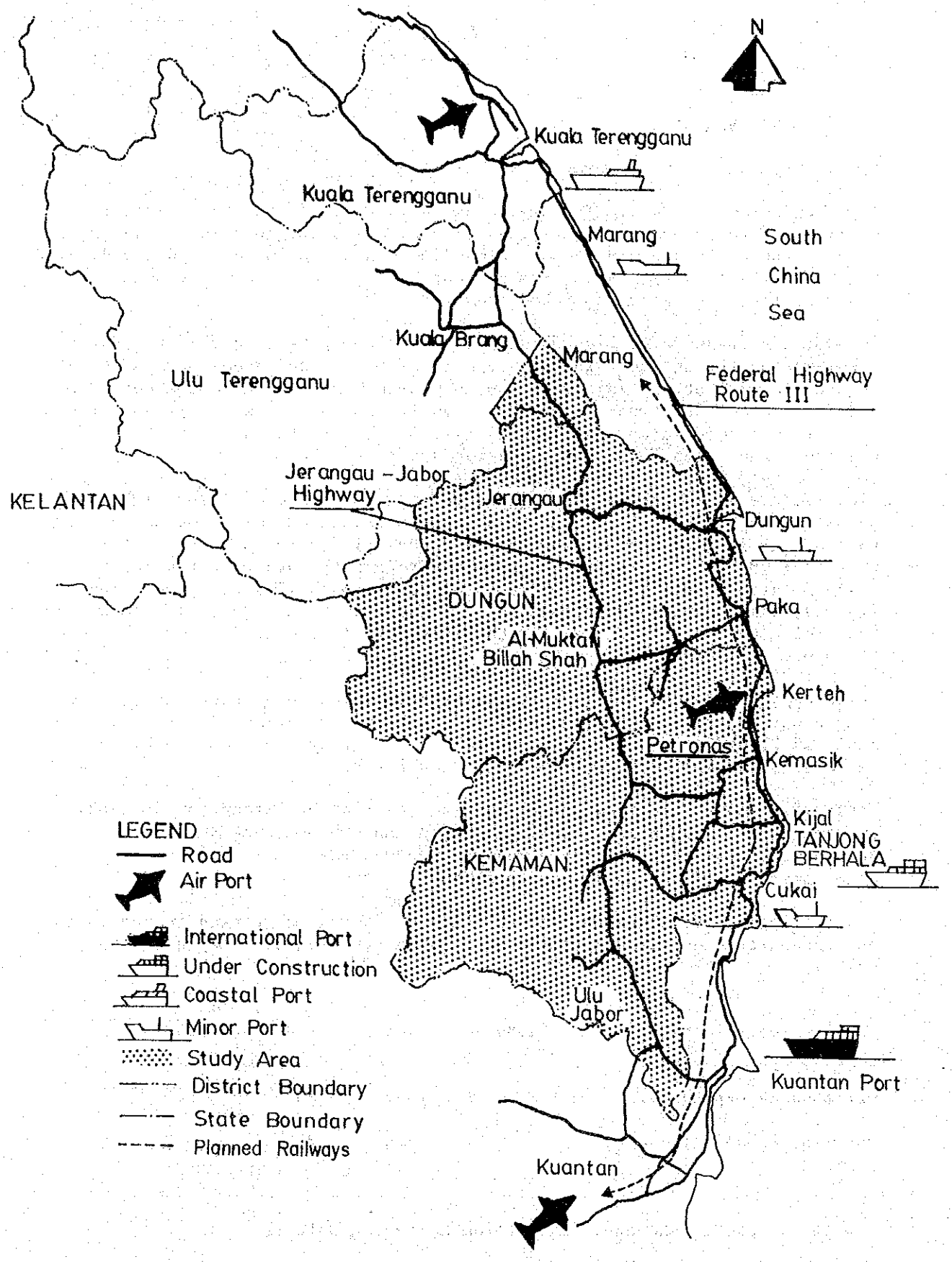


FIG. 10.2 MAJOR TRANSPORT AROUND THE STUDY AREA

2. Roads

2.1 Road System

2.1.1 The existig road network

The road network of South Terengganu had a particular feature in itself until a few years ago. A trunk road of the Federal Highway Route III passed through the north-south direction along the coast linking urban areas of Dungun, Kerteh, Cukai, etc. From this highway, roads were constructed westward into the inner populated areas.

In 1980, Jerangau-Jabor Highway was opened to the public for the purpose of accelerating the agricultural development of the inland areas, the KETENGAH region, forming at the same time another north-south trunk road about 30 km west of the coastal trunk road. As a result, the existing main road network resembles a ladder shape as shown in Fig. 10.3, with two north-south roads and four major east-west connecting roads between them.

Classified road lengths in Terengganu during the period of 1978 - 1982 are shown in Table 10.1. The total road length increased from 1,430 km in 1978 to 1,890 km in 1982 for JKR registered roads. Paved roads covered 86% of the total in 1982. A relatively high figure of coverage with the paved roads is also identified by the ratio of road length (km) per population (1,000), when compared with the table quoted from Ch 4 - Vol. III, TMPS. In the table, the ratio was 3.28 for the State, while it was 2.2 for the whole Peninsula in 1982.

It is apparent by comparing these ratios that Terengganu State has more road length per inhabitant than the average of the whole Peninsula. As shown in Table 10.2, of all districts in the State, the study area has the highest ratio of road length, 5.24 km per 1,000 habitants.

Table 10.2 shows the road length in each district of Terengganu in 1982. The total road length was 310 km in Dungun and 400 km in Kemaman. Furthermore, the ratio of paved road to unpaved road in length was enumerated at 90% versus 10% in these two districts.

The development of the road network as noted above accompanied increases in the expenditure on normal maintenance work on the roads. They are shown below:

Year	1980	1981	1982	1983
Maintenance expenditure	8.4	13.7	20.9	9.5
Pavement Rehabi. Project, Route III	-	0.6	28.2	14.9

Source : JKR, Terengganu. In million Malaysian Dollars

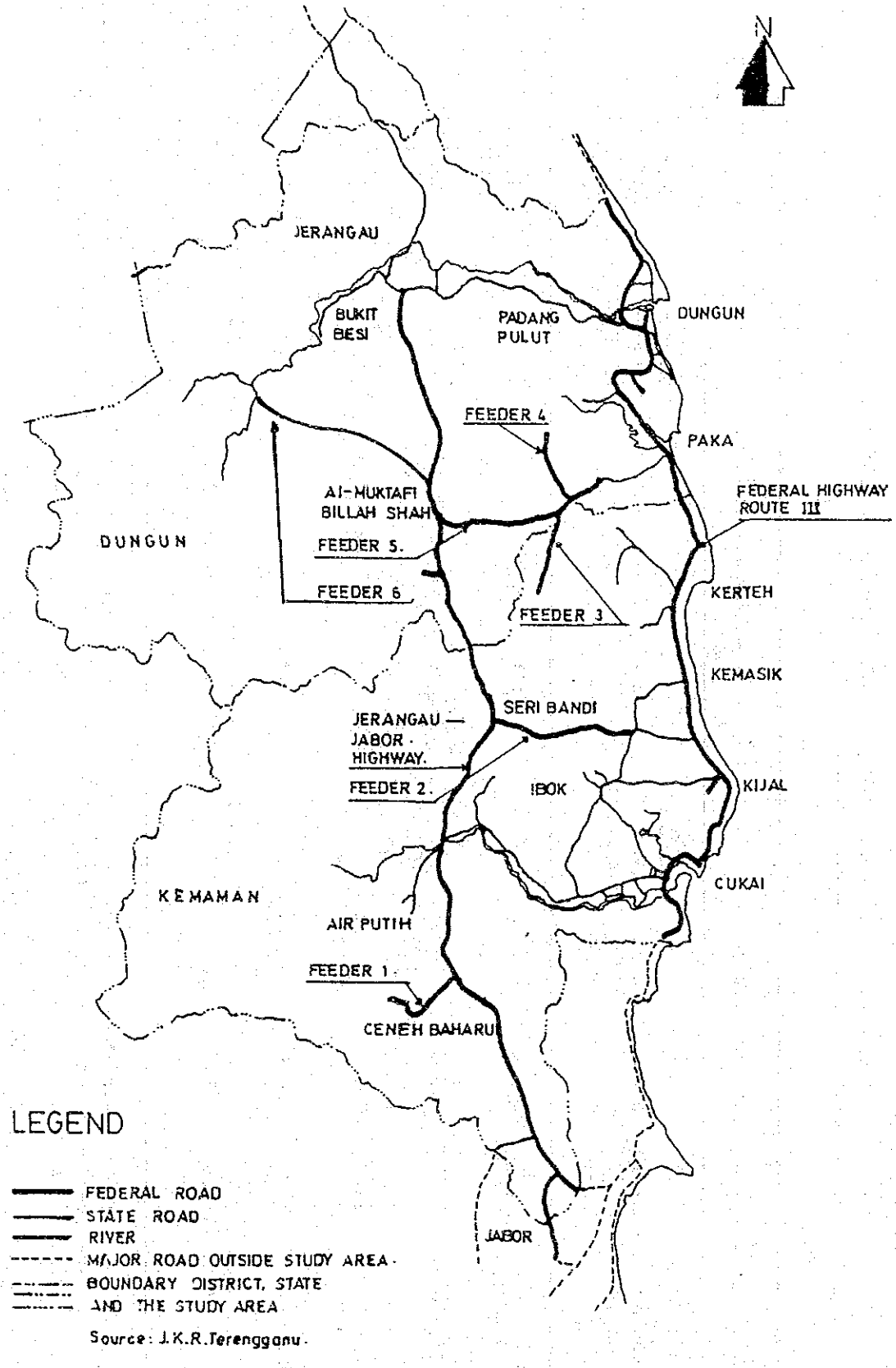


FIG. 10.3 EXISTING ROAD NETWORK IN THE STUDY AREA

Table 10.1 LENGTH OF ROAD IN TERENGGANU FROM 1978 to 1982

Year	Population 1)	Paved Road (km) Federal	State	Total	Annual Increase of Length	Unpaved Road (km) Federal	State	Total	Annual Increase of Length	Total Length of Road (km)	Road km per 1,000 Persons
1978	511,650	342.1	801.8	1,143.9 (80.8)		33.1	252.4	285.5 (20.0)		1,429.4 (100)	2.79
					45.4				-35.1		
1979	526,730	346.0	843.3	1,189.3 (82.6)		30.0	220.4	250.4 (17.4)		1,439.7 (100)	2.73
					287.3				-35.4		
1980	542,280	536.9	939.7	1,476.6 (87.3)		37.6	177.4	215.0 (12.7)		1,691.6 (100)	3.12
					-20.6				-2.2		
1981	558,824	521.6	934.4	1,456.0 (87.2)		36.8	176.0	218.8 (12.6)		1,668.8 (100)	2.99
					175.1				43.5		
1982	575,368	489.6	1,141.5	1,631.1 (86.4)		73.3	183.0	256.3 (13.6)		1,887.4 (100)	3.28

Notes : 1) Population figures before 1980 are estimated by two censuses of 1970 and 1980 and those after 1980 are estimated by using an average annual growth rate of 2.9% to be consistent with the Terengganu Master Plan Study.

2) Roads by District Offices and State Dev. Office are not included.

Source : Jabatan Kerja Raya Terengganu.

Table 10.2 DISTRIBUTION OF ROAD IN TERENGGANU BY DISTRICT IN 1982

District	Population 1)	Paved Road (km)			Unpaved road (km)			Total 2) Length of Road (km)	Share	Km of Road per 1,000 persons
		Federal	State	Total	Federal	State	Total			
Dungun	64,330 (11.2)	130.95	155.33	286.28 (92.6)	22.49	0.42	22.91 (7.4)	309.19 (100)	16.4	4.81
Kemaman	71,710 (12.5)	156.75	201.29	358.04 (88.9)	-	44.75	44.75 (11.1)	402.79 (100)	21.3	5.62
Sub-Total	136,040 (23.7)	287.70	356.62	644.32 (90.5)	22.49	45.17	67.66 (9.5)	711.98 (100)	37.7	5.24
Kuala Terengganu and Marang	284,470 (49.4)	116.02	368.73	484.75 (95.7)	5.28	16.56	21.84 (4.3)	506.59 (100)	26.8	1.78
Besut	106,190 (18.5)	83.70	286.33	370.03 (87.6)	18.29	34.24	52.53 (12.4)	422.56 (100)	22.4	3.98
Hulu Terengganu	48,680 (8.4)	2.13	129.84	131.97 (53.6)	27.28	87.00	114.28 (46.4)	246.25 (100)	13.1	5.06
TOTAL	575,380 (100)	489.55	1,141.52	1,631.07 (86.4)	73.34	182.97	256.31 (13.6)	1,887.38 (100)	100.0	3.28

Note : 1) Population figures are derived from the population forecast by the Terengganu Master Plan Study.
2) Roads by District Offices and State Dev. Office are not included.

Source : Jabatan Kerja Raya Terengganu.

A decline in 1983 is caused by the thrift budget of the Government, postponing several projects into the later years.

Apart from normal maintenance, the Terengganu Pavement Rehabilitation Project was carried out during 1981/1983, funded by the Federal Government with a total allocation of approximately 43.7 million Ringgit out of which about 58% was spent on the roads in the two districts of the study area, according to JKR, Terengganu.

There are a number of other roads, generally called the mukim roads, apart from Federal and State roads. The mukim roads start off from the Federal and State roads to connect kampungs situated away from trunk roads. These roads are only a few kilometers long in most cases, but still are the main life line to the people in the inner area.

Table 10.3 summarizes the improvement work on mukim roads by the funds of the Federal Government which were handed over to the State Development Office. The funds had been used to pave the roads with macadam for a width of 10 feet complying with the Prime Minister's Office Standard. The total improvement for 1981 - 1983 was approximately 36 km in each district of Dungun and Kemaman. The cost of the improvements for the same period was approximately 1.8 million and 1.9 million ringgit respectively in these districts.

The State Government had also been funding District Offices at the same time. The amount for the district of Dungun was approximately 1.3 million ringgit for the improvement of some 127 km long stretch for a period from 1981 - 1983. For Kemaman, the corresponding amount was 0.8 million ringgit for a total length of 27 km. Generally, the improvement by State funds was to improve a stretch either from a mere footpath to a motor vehicle access path or further to a surfaced roadway.

2.1.2 Jurisdiction

The roads in the study area can be classified administratively into four categories as follows:

(1) Federal Roads

These consist of the Federal Highway Route III, the Jerangau - Jabor Highway and those roads which are encircled by federal properties, such as KETENGAH and FELDA.

(2) State Roads

These consist of all other major roads such as the principal urban roads in Dungun, Paka, Kerteh and Cukai. They also include rural roads connecting the towns of Dungun, Jerangau and Ajil, a network covering Kemasik, Meraga, Kijal and Ibok, a road between Cukai and Air Putih and the several short distant roads in the Jabor area.

(3) Mukim Roads

These are generally locally built with varying degrees of structural and geometric criteria. Surfacing and upgrading works are undertaken by District Offices. These roads can also be reclassified into the Federal or State system if they are improved to meet the criteria set by Jabatan Kerja Raya. The major item of the criteria is that right of way be more than 40 feet.

(4) Private Roads and Others

These do not serve the general public. They are built and maintained by estates for cropping and harvesting purposes.

Federal roads are dealt with by Jabatan Kerja Raya Terengganu (SJKR) with funds from the Federal Government. It is noted that most of the rural roads in the State are state roads. Rural road development/upgrading projects approved under the rural road development programme are funded by the Federal Government on a reimbursable basis. Similarly, for those mukim or kampong roads which are included in the kampong road, upgrading programmes are funded by the Federal Government. Federal and State roads are classified and shown in Figure 10.3.

2.1.3 Design Standard

The basic design criteria called "Minimum Geometric Design Criteria for New Roads in Rural Area' are currently applied to all Federal and State roads. The design criteria determine geometric values of six standards, 01 to 06, defined by traffic volumes, and three categories for different terrain conditions, namely flat, rolling and mountainous. The design criteria are shown in Table 10.4.

In the study area, a long time target of upgrading the Federal Highway Route III to the 04 standard is almost complete except some stretches in hilly areas and urban areas. Apart from Route III, most Federal roads in KETENGAH region comply with the 04 standard but the surface width in some parts remains at the 03 standard. The new target for those major Federal roads is now upgraded to the 05 standard.

As for the State roads, important ones such as the Dungun/Jerangau/Ajil road, the Cukai/Air Putih road, etc. are the 03 standard except the surface width which is somewhat in between that of the 02 and the 03 standard. Minor state roads comply with various standards of 01 to 03. The upgrading target is currently set at the 03 standard.

For mukim roads, no precise design criteria exist but the cross sectional structure of surfacing with a formation width of 10 feet is specified by the Prime Minister's Office and is to be applied to the surfacing financed by Federal funds.

Table 10.3 MUKIM ROAD IMPROVEMENT BY THE STATE DEVELOPMENT OFFICE IN 1980 - 1983
(IN CURRENT PRICES)

District	1980		1981		1982		1983		Total 1981 - 1983[2]	
	Cost ($1,000)	Length (km)	Cost ($1,000)	Length (Km)	Cost ($1,000)	Length (Km)	Cost ($1,000)	Length (Km)	Cost ($1,000)	Length (Km)
Dungun	100.3 (18.2)	N.A.[1]	322.0 (12.0)	7.6 (11.3)	884.8 (13.2)	18.5 (15.9)	569.2 (21.0)	9.5 (20.2)	1,776.0 (14.7)	35.6 (15.4)
Kemaman	123.2 (22.3)	N.A.	508.6 (18.9)	13.2 (19.6)	983.7 (14.7)	16.1 (13.9)	418.1 (15.4)	6.7 (14.2)	1,910.4 (15.8)	36.0 (15.6)
Sub-Total	223.5 (40.5)	N.A.	830.6 (30.9)	20.8 (30.9)	1,868.5 (27.9)	34.6 (29.8)	987.3 (36.4)	16.2 (34.4)	3,686.4 (30.5)	71.6 (31.0)
Besut	37.5 (6.8)	N.A.	452.1 (16.8)	11.7 (17.3)	1,251.2 (18.6)	20.3 (17.5)	442.7 (16.3)	9.6 (20.4)	2,146.0 (17.7)	41.6 (18.1)
Kuala Terengganu	178.5 (32.3)	N.A.	686.7 (25.5)	17.7 (26.2)	1,727.7 (25.8)	27.9 (24.1)	598.8 (22.1)	9.0 (19.1)	3,013.2 (24.9)	54.6 (23.7)
Hulu Terengganu	38.9 (7.0)	N.A.	393.4 (14.7)	11.2 (16.6)	1,389.7 (20.7)	23.3 (20.1)	438.3 (16.1)	7.3 (15.5)	2,221.4 (18.3)	41.8 (18.1)
Marang	74.0 (13.4)	N.A.	326.2 (12.1)	6.1 (9.0)	470.6 (7.0)	9.9 (8.5)	247.7 (9.1)	5.0 (10.6)	1,044.5 (8.6)	21.0 (9.1)
TOTAL	552.4 (100)	-	2,689.0 (100)	67.5 (100)	6,707.7 (100)	116.0 (100)	2,714.8 (100)	47.1 (100)	12,111.5 (100)	230.6 (100)

Notes : 1) Date not available.
2) The total shows the accumulated figures from 1981 to 1983.

Source : State Development Office, Kuala Terengganu.

Table 10.4 MINIMUM GEOMETRIC DESIGN CRITERIA FOR NEW ROADS IN RURAL AREAS

Traffic Group		LIGHT									MEDIUM						HEAVY		
		01			02			03			04			05			06		
Terrain		F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
ADT Two Ways	Veh/Day		‡100			100-250			250-400			400-750		-				-	
DHV Two Ways	Veh/HR	-				-		-				100-200			200-800			‡800(8)	
Design Speed	km/h	50	50	30	60	50	40	80	60	50	80	60	50	100	80	60	120	100	80
Pavement Type		-			-			To be determined											
Surface Width	m		4.5			5.0			6.0			7.0			7.5		3.5 3.75	Each Lane desirable	
Usable Shoulder Width-Min.	m	1.25	1.25	1.00	1.25	1.25	1.00	2.00	2.00	1.00	2.50	2.50	1.25	3.00	3.00	1.25	3.00	3.00	1.50
Formation Width (1)	m	8.0	8.0	8.0	8.5	8.5	8.5	11.0	11.0	9.0	13.0	13.0	10.5	14.50	14.50	11.0	24	24	21
Central Reservation	m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Var. 3.00 min.		
Reserve Width-Min.	m		20			20	30		30		40 desirable 30 minimum				40			40	
Max. Gradient	%	7	9	10	6	8	10	4	6	9	4	6	9	3	5	8	3	4	7
Critical Grade Length (2)	m	Not Applicable			Use Lay Byes			350	180	120	350	180	120	500	250	150	560	350	150
Stopping sight Distance-Min. (3)	m	60	60	60	80	60	60	110	80	60	110	80	60	160	110	80	210	160	110
Passing Sight Distance-Min.	m		Use Lay Byes		430	350	350	560	430	350	560	430	350	700	560	430	-	-	-
Min. Radius	m	80	80	30	120	80	50	210	120	80	210	120	80	350	210	120	530	350	210
Transition Curve Min. Length (4)	m		Not Applicable		70	60	60	80	70	60	80	70	60	90	80	70	100	90	80
Widening	m	0.75	1.00	1.50	0.75	1.00		-	1.00	1.25	-	1.00	1.25	-	-	0.75	-	-	-
Superelevation	Ratio		1.10			1.10			1.10			1.10			1.10			1.10	
Camber/Cross Fall	Ratio		1.25			1.30			1.30			1.40			1.40			1.50	
Verticle:																			
Crest-Min. K	m/%	10	10	10	15	10	10	30	15	10	30	15	10	60	30	15	105	60	30
Curve (5)																			
SAG-Min. K	m/%	12	12	8	16	12	10	24	16	12	24	16	12	38	24	16	52	38	24
Access Control	m		None Required			None Required			None Required			None required partial desirable			partial (7)			Limited (6)	
Bridge Over Pass Widths Between Parapets	m		7.0			7.5			8.0			9.0			9.0			18 single opening 2 @ 9 DBL CP.	
Bridge Under Pass Widths Between Abut Walls	m		7.0			7.0			8.5			11.0			16.5			18 single opening 2 @ 10.5 DBL CP	
Verticle Clearance Over Roadways	m		4.50			4.50			4.50			4.50			5.03			5.03	

(1) Formation Width Includes 0.5m each side for rounding.
(2) Use Truck Climbing Lanes if Critical Grade Length is Exceeded.
(3) Stopping Sight Dist. to be Increased on Downgrade.
(4) Values given are for Min. length required for 10% superelevation run-off Spiral should not be less than run-off length.
See A.A.S.H.O. for Min. run-off length of other raddii and superelevation rates.

(5) Minimum length of vertical curve 'L' = KA.
L = Curve length in meter.
A = Alebraic difference of grade in per cent.
(6) Allowing grade crossings with other roads and railroads but no private access.
(7) Access by private property owner at intervals not less than 400m.
(8) Consideration should be given to differed const. of additional lanes where D.H.V. ‡1000 in one direction.

Abbreviations:

m	meter	D.B.L.	Double
D.H.V.	Design Hourly Volume	Des.	Desirable
Var.	Variable	M	Mountainous
R	Rolling	Veh.	Vehicle

Source : Highway Planning Unit, Ministry of Works.

Punca : Unit Perancang Jalan, Kementerian Kerjaraya.

2.1.4 Surfacing

There are five categories to define the type of surfacing of roads, according to SJKR.

A2 : **Bitumen surface**

Approximately 85% of Federal and State roads were under this category according to the data in 1982.

B : **Water bound surface**

There is no road section under this cateogory, gravel road, in the study area.

C : **Hand surface bitumen seal**

Economical version of the A2 type. It is considered to serve for a provisional period. Approximately, 2% of the Federal and 3% of the State roads in the study area were under this category in the 1982 data.

D : **Hard surface water bound**

This type is surfaced by other material than the soil of the road site. The roads with this surface are few in the study area.

E : **Earth**

The most primitive type of surfacing. In total, this covered 13% of Federal roads and 12% of State roads of the study area in the 1982 data.

2.1.5 Road conditions

Most roads in the study area are maintained to a fairly good level status complying with various degrees of the standards. On Federal Highway Route III, it was found that some sections need improvement works from the viewpoints of safety and smoothness of traffic flow. These sections were mostly pointed out in the Terengganu Master Plan Study and TCRS as well. Fig. 10.4 shows the road conditions of the study area.

On Federal Highway Route III from the north, the junction with Jalan Besar at Sura Gate of Dungun, the hilly rolling stretch between MS54 [1)] and 58, another hilly part between MS84 and 87 and a section between MS95 and 99 which is going through the town of Cukai, all seem to be in need of improvement.

Note : 1) MS is the milestone representing the distance from Kuala Terengganu in miles

At the section of Route III between MS47 and MS48 in Dungun town, the traffic is often disturbed by the joining movement of urban traffic as well as the road side activities which occupy part of the road shoulder. The disturbance is severe at the corner where Jalan Besar meets and the road turns almost by 90 degrees.

The hilly sections between MS54 and 58 and MS84 and 87 are recognized to have a reduced road capacity and a larger number of traffic accidents. The section between MS54 and 58 is also known to be flood prone and special consideration will be required for flood mitigation.

The section between MS95 and 99 passing the Cukai town has a similar traffice problem as that in Dungun. Intra-urban movement is mixed with long distance through traffic. A bypass construction plan is prepared by JKR which is stated in the following subsection.

There are three other significant causes of disturbance to the smooth usage of road; namely, the land slide at cut sections, pot-holes and flood prone areas. The former two causes are mainly found along the recently opened Jerangau-Jabor Highway and Feeders 1 to 6. The flood prone sections of road are those located near river and swamp areas.

Land slides are said to be caused mostly by the heavy rain of late 1983. Many fallen roadside slopes along the inland roads have been observed particularly along the newly opened Jerangau-Jabor Highway and the Feeders 1 to 6. Some fundamental stabilisation of slopes should be performed in addition to the current JKR's repair work.

Pot-holes and surface damage are found on Jerangau-Jabor Highway also. They have been caused by heavy trucks, such as those carrying timber, and inadequate designs of the road structure and drainage system. Whichever the cause is, the pot-holes, once they appear, keep growing and become serious hazards to traffic. Restrengthening of subsoil and then surfacing have to be carried out as soon as pot-holes appear. The rehabilitation and strengthening of the road structure is considered necessary.

The flood prone road sections are located close to river and swamp areas. Examples are at the Cukai-Air Putih road and between MS54 and 58 of the Federal Highway Route III. These sections had a flood water level higher by three to ten feet during the monsoon of late 1983. The flood coverage not only damages the road structure but causes much loss to traffic. Unless an effective mean to mitigate flooding is applied immediately, some protective measures have to be taken from the viewpoint of road structure.

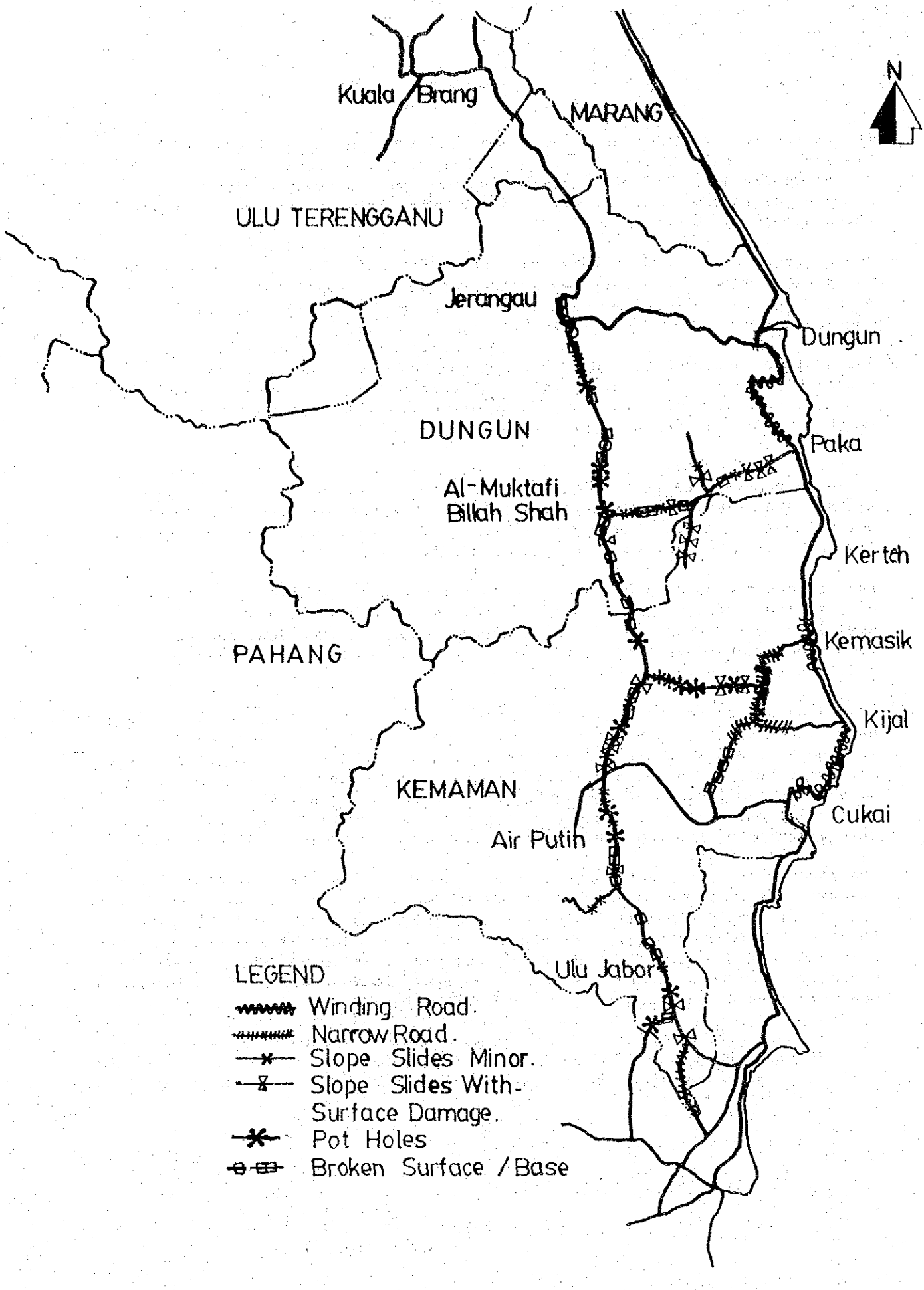


FIG.10.4 ROAD CONDITIONS IN THE STUDY AREA

2.1.6 Current improvement plans

There are programmes of improvement, upgrading, widening, new road construction, etc. currently prepared by both JKR and KETENGAH for the Fourth Malaysia Plan. They are identified and shown in Fig. 10.5 and Table 10.5. Main roads to be constructed and/or improved are stated as follows:

(2) Kuala Jengai - Pasir Raja, 19 km.

(3) Al Muktafi Billah Shah - Pasir Raja, 44 km

Both are development roads serving the new towns of KETENGAH scheduled in Pasir Raja.

(11) Paka - Kerteh - Kemasik, 26 km

Widening to a four-lane dual carriage way which passes through the developing industrial and housing areas.

(10) Telok Kalong Bypass, 14 km.

(12) Cukai Bypass, 13 km.

Both (10) and (12) are new roads a few km away from Cukai town and the Telok Kalong industrial estate.

Roads (2), (6), (15) and (20) in Table 10.5 and Fig. 10.5 are under various stages of construction and are scheduled for completion by 1985 under the rural road programme.

The updated programme for implementation is not finalized. However, most of them, if not implemented in the on-going Fourth Malaysia Plan, will be carried out in the coming 5th 5-year plan, since they are already recommended in TMPS.

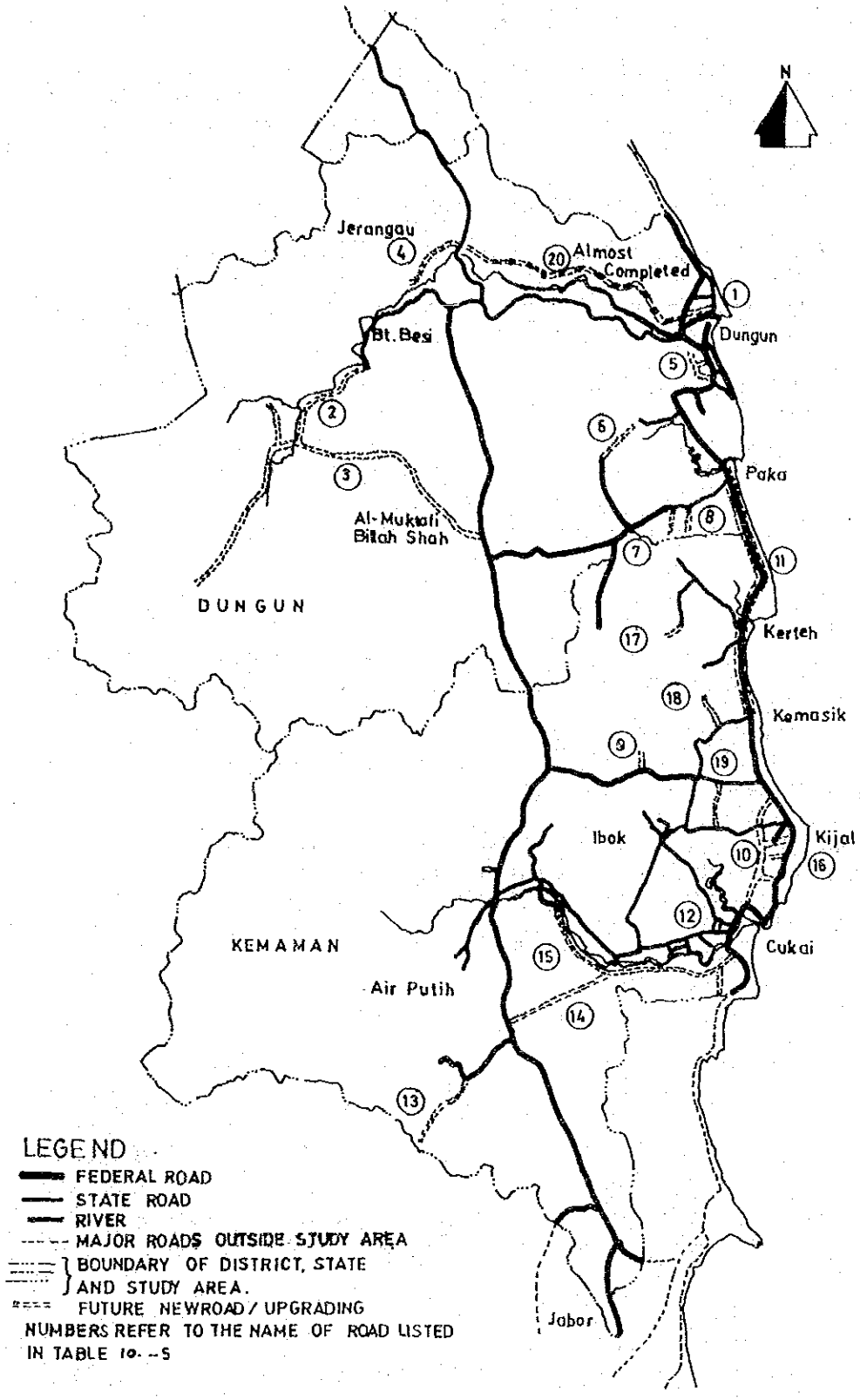


FIG. 10.5 - FUTURE NEW ROAD/UPGRADING PROJECT IN STUDY ARE.

Table 10.5 MAJOR NEW ROAD/UPGRADING PROJECTS IN THE STUDY AREA[3)]
(IN 1983 PRICES)

No.	Name of Project	Length (Km)	Estimated Cost ($'000)
1.	Jalan Seberang Pintasan/Raja Wali/ Pulau Serai	3.7	700
2.	Jalan Kuala Jengai/Pasir Raja	19.3	12,000
3.	Jalan Al Muktafi Bilah Shah/Pasir Raja (Feeder 6)	43.5	62,000
4.	Jalan Tanah ke Rancangan Tanah Pinggir Tepus	8.0	1,750
5.	Upgrading Jalan Kelas C Gong Pasir	9.6	1,500
6.	Jalan Durian Mentangau/Rasau Kerteh	4.8	1,050
7.	Jalan Tanan Santong/Batu Putih	3.2	700
8.	Jalan Tanah ke Rancangan Tanah Pinggir Tanjung Remia	3.5	770
9.	Town D/Ketengah Jaya	2.4	200
10.	Telok Kalong Bypass/Northern Extension	14.0	20,000
11.	Improvement to M.S 61-77 of K.T. Kuantan Route III	25.6	10,000
12.	Cukai Bypass/Southern Extension	12.5	33,400
13.	Extension Feeder I	4.8	3,000
14.	Jalan Kampung Mak Logam/Lubuk Batu/ Ceneh Bahru	20.9	7,250
15.	Jalan Seb. Tayor/Lubok Batu	9.6	N.A.[1)]
16.	Jalan Pancor/Bukit Anak Dara	4.2	1,025
17.	Jalan Rancangan Tanah Pinggir Bagus	6.6	880
18.	Jalan Kg. Cabang/Kg. Kemasek (Bukit Chankkul)	6.0	1,825
19.	Jalan Payoh/Bujal/Padang Kemunting	6.4	1,650
20.	Jalan Jerangau/Tok Kah	26.9	N.A.[1)]
	TOTAL	200.3[2)] (235.5)	149,700

Notes : 1) N.A. means data not available.
2) Total in bracket includes improvements.
3) In 1984 and afterwards.

Source : JKR Terengganu

Apart from these above-mentioned developments, the district offices of Dungun and Kemaman also have plans to improve their mukim roads during the Fourth Malaysia Plan. They are short in length, mostly less than 5 km, but the number of sections to be improved would be more than 40.

2.2 Traffic Volume

2.2.1 Periodic Traffic Survey by Highway Planning Unit

Highway Planning Unit, Ministry of Works and Utilities, Kuala Lumpur (HPU) conducts traffic volume counting survey twice a year, March/April and September/October. There were 421 survey stations as of 1982 in Peninsular Malaysia. At the selected key stations, the counting is conducted for 24 hours, however, in most stations the counting survey is for 16 hours from 6 a.m. to 10 p.m. HPU compiles the results annually, through which trends of changes in the traffic volume can be studied.

In 1983 there were 25 traffic survey stations in the State of Terengganu comprising four in the district of Kemaman, five in Dungun, eight in Kuala Terengganu, three in Hulu Terengganu and five in Besut. Nine stations are located within the study area. In addition, two adjacent stations are taken to study the traffic volume on the major road network. These 11 stations are shown in Fig. 10.6 and the counted volumes including motorcycles for 16 hours from 1973 to 1983 are shown in Table 10.6.

Fig. 10.6 and Table 10.6 show that the main flow of traffic went through stations 93, K13, K17, 92 and 91 which are all on Federal Highway Route III.

The data in 1983 indicate the volume on Route III will be in the range of 3,500 - 4,500 vehicles, except in the urban areas of Dungun and Cukai. In these urban areas the volume will be 8,000 - 9,000 vehicles because of the additional short distant intra-urban traffic. The traffic volume on Jerangau-Jabor Highway (J-J Road) was shown by two stations of No. 87 and No. 88 indicating 1,200 - 1,300 vehicles. Traffic volume on other roads linking Route III and J-J Road was mostly similar to that on J-J Road.

Average growth rates per annum at these stations in these ten years are calculated as shown in Table 10.6. Although the figures vary considerably, it can be identified that the study area had an overall growth rate of 13% during the five years from 1978 to 1983, while it would be 15% for the five years from 1973 to 178.

The above assessments of the overall average growth rate are consistent with the average growth rate of Terengganu State shown in Table 10.7 which was derived from the data of HPU. In this table, Terengganu had an average annual rate of 13.6% in the period of 1973 - 1982.

The composition of vehicles at major traffic survey stations on the federal roads for the years 1978, 1980 and 1982 is shown in Fig. 10.7. On Federal Highway Route III, the diagrams for stations 93, 92 and 91 show a larger percent share of cars and taxis. The shares of this category at these stations in 1982 are 58, 50 and 43 percent respectively with modest changes from earlier years.

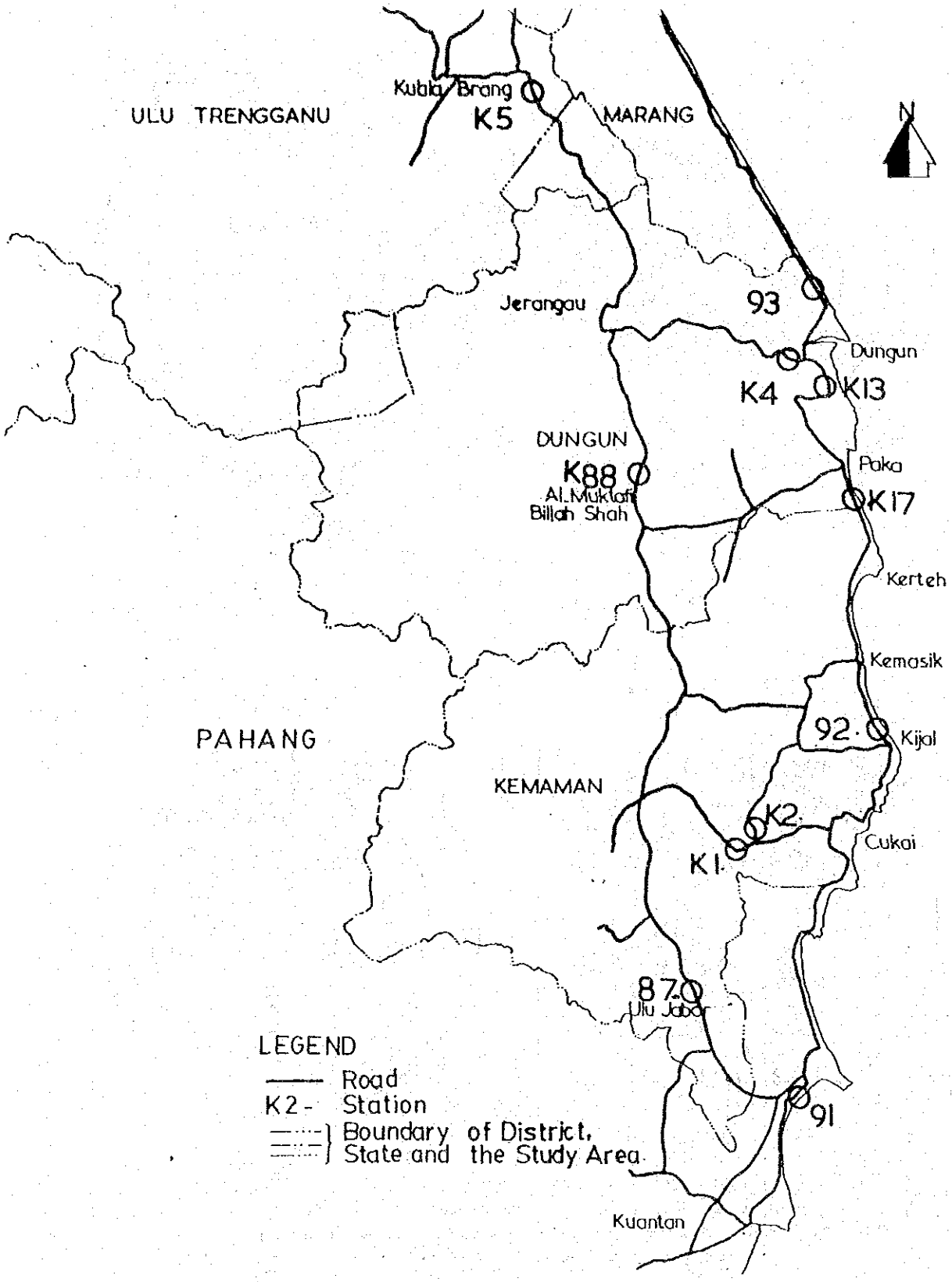
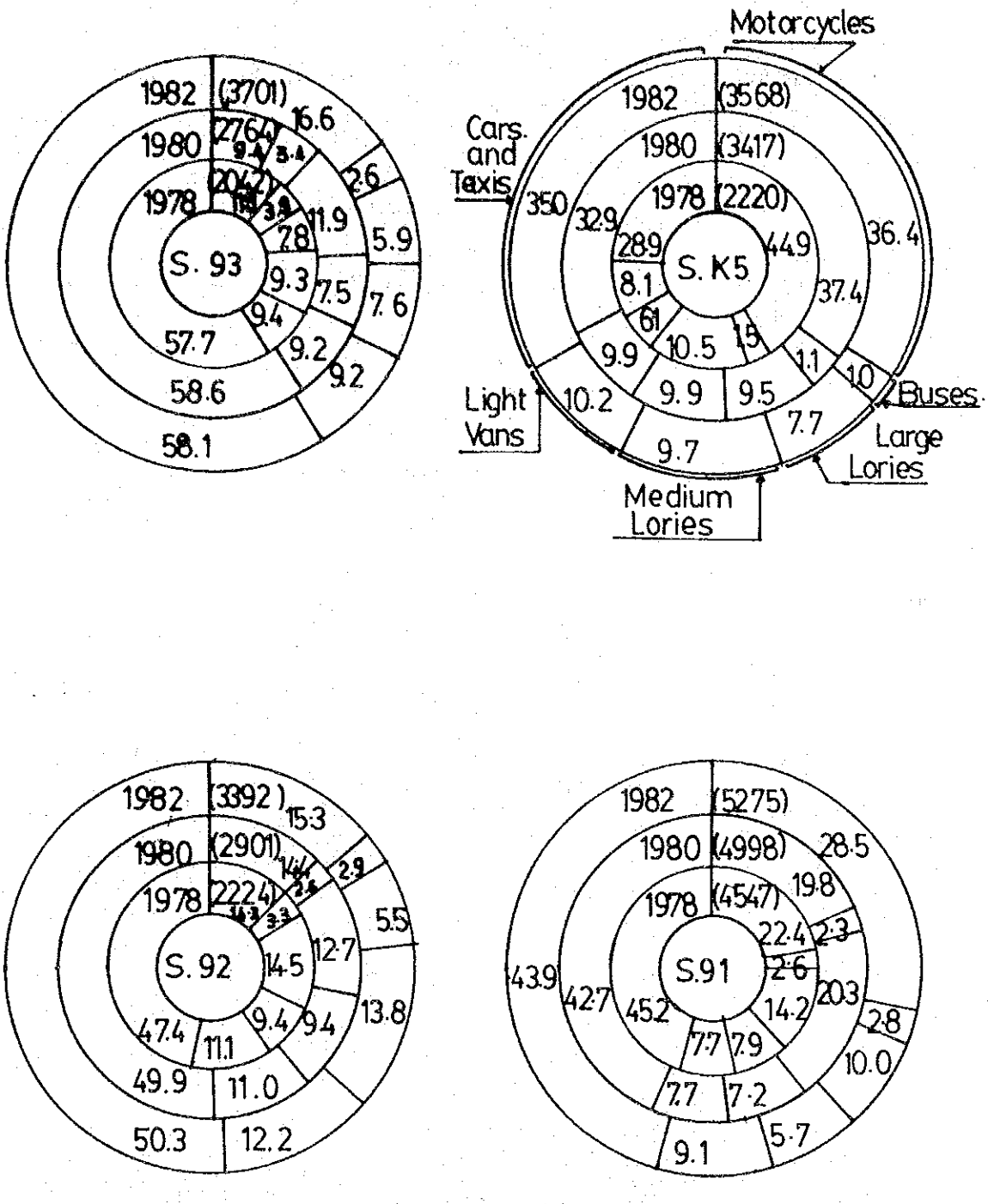


FIG. 10.6 TRAFFIC VOLUME SURVEY STATION



Note: The percentage of vehicle composition for the year 1978, 1980 and 1982 are shown from the inner to outer ring. The figure in [ ] is the total number of vehicles.

Source: Derived from the data provided by Highway Planning Unit Composition of Vehicle in 1978, 1980 and 1982.

FIG. 10.7 PERCENT COMPOSITION OF VEHICLE TYPES

Table 10.6 TRAFFIC VOLUME IN BOTH DIRECTIONS IN 16 HOURS, 1973 - 1983

District	Station	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Average Annual Growth Rate (%) 1973-78	1978-83 (March)	1973-83 (March)
Hulu TERENGGANU	K 5	1,149	1,339 (16.54)	1,422 (6.20)	1,564 (9.99)	1,727 (10.42)	2,220 (28.55)	2,531 (14.01)	3,137 (23.94)	N.A. (6.6 per anum)	3,567 (4.54)	3,729	14.1	10.9	12.5
DUNGUN	93	1,106	1,560 (41.05)	1,272 (-18.46)	1,342 (5.50)	2,006 (49.47)	2,042 (1.84)	2,260 (10.68)	2,764 (22.31)	2,863 (3.58)	3,701 (29.27)	3,494 (-5.59)	13.0	11.3	12.2
	K13	1,893	2,246 (18,65)	1,780 (-20.75)	2,245 (26.12)	2,632 (17.24)	2,987 (13.49)	3,167 (6.03)	4,674 (47.58)	3,977 (-14.91)	6,040 (51.87)	7,339 (21.51)	9.6	19.7	14.5
	K 4	678	631 (-6.93)	674 (6.81)	734 (8.90)	736 (0.27)	917 (24.59)	1,087 (18.54)	1,216 (11.87)	1,345 (10.61)	1,598 (18.81)	2,109 (31.98)	6.2	18.1	12.0
	K17	----------	----------	N.A.	----------	----------	----------	----------	640	724 (13.13)	813 (12.45)	1,031 (26.81)	1,694 (64.31)	-	27.6	-
	88	----------	----------	N.A.	----------	----------	----------	----------	----------	----------	939	1,512 (61.02)	1,253 (-17.13)	-	15.5	-
KEMAMAN	92	1,247	1,485 (19.09)	1,569 (5.66)	1,826 (16.38)	1,895 (3.78)	2,224 (17.36)	2,494 (12.14)	2,901 (16.32)	2,829 (-2.48)	3,392 (19.90)	4,263 (25.68)	12.2	13.8	13.0
	K 2	316	239 (-24.37)	194 (-18.83)	208 (7.22)	221 (6.25)	507 (29.41)	339 (-33.14)	362 (6.78)	426 (17.68)	393 (-7.75)	459 (16.79)	9.9	9.8	3.8
	K 1	988	897 (-9.21)	1,028 (14.60)	1,122 (9.14)	1,353 (20.59)	1,533 (13.30)	1,566 (2.15)	1,470 (-6.13)	1,684 (14.56)	1,584 (-5.94)	1,446 (-8.71)	9.1	9.4	3.8
	87	----------	----------	----------	N.A.	----------	----------	----------	----------	----------	1,114	1,359 (21.99)	1,200 (-11.70)	-	3.8	-
KUANTAN (PAHANG)	91	1,943	2,331 (19.97)	2,513 (7.81)	3,686 (46.68)	4,011 (8.82)	4,547 (13.36)	4,368 (-3.94)	4,998 (14.42)	4,305 (-13.87)	5,275 (22.53)	4,482 (-15.03)	18.5	-0.1	8.7
Average[1]		1,165	1,341 (15.11)	1,307 (-2.54)	1,591 (21.73)	1,823 (14.58)	2,122 (16.40)	2,227 (4.95)	2,690 (20.79)	2,490 (-7.43)	3,194 (28.27)	3,415 (6.92)	12.7	9.9	11.4

Notes: 1) Average figures do not include stations K17, 88 and 87.

Source: Highway Planning Unit, Ministry of Works.

At these stations, the percent shares of motorcycles and lorries show a larger change without a constant trend. At station K5 between Jerangau and Kuala Brang, the share of cars and taxis increased while the share of motorcycles decreased in these years. The former was 35% and the latter 36% in 1982.

Table 10.7 AVERAGE ANNUAL NORMAL GROWTH BY HPU

Peninsular Malaysia	Traffic Survey Stations[1)]	Average Normal Growth (%/year)
Johor	62	9.60
Melaka	30	9.66
Negeri Sembilan	52	7.84
Selangor	58	8.87
Wilayah Persekutuan	6	9.80
Perak	60	9.06
Pulau Pinang	26	10.43
Kedah	31	9.44
Perlis	7	9.35
Pahang	35	11.25
Terengganu	24	13.61
Kelantan	25	15.03
Average of the Peninsular Malaysia		9.95

Notes : 1) Some stations excluded due to abnormal statistics.

Source : Highway Planning Unit, Ministry of Works and Utilities, Kuala Lumpur

2.2.2 Vehicle Plate Number Survey

The vehicle plate number survey was carried out to clarify the volume of traffic passing through, terminating at and generating from the study area. Scopes of the survey are shown below.

Locations: (Fig. 10.8)

At the northern boundary:

(1) On the Federal Highway Route III, at the northern side of the bridge over Sungai Dungun, near Dungun town;

(2) On the Jerangau Jabor Road, at the northern side of the bridge over Sungai Dungun near Jerangau;

At the southern boundary:

(3) On the Federal Highway Route III, at the southern side of the bridge over Sungai Kemaman, near Cukai town;

(4) On the Jerangau-Jabor Road at the southern side of the bridge over Sungai Kemaman, near Air Putih.

Direction:

South bound traffic.

Survey date and hours:

February 21 (Tuesday), 1984

9 hours from 9.00 to 18.00 at (1) and (2)
from 10.00 to 19.00 at (3) and (4)

Recording

The plate number of vehicles was recorded together with the time of observation.

All of the recorded data were compiled to identify the same numbers between the location of (1), (2) and (3), (4).

Results

Fig. 10.9 shows the vehicle movement results of the survey. Table 10.8 shows the travel time distribution with the classification by vehicle type. There were 1,178 vehicles counted at (1) Dungun. 328 of them or 28% passed through at (3) Cukai and 17 or 1.4% at (4) Air Putih, while 37 vehicles or 16% of 227 vehicles counted at (2) Jerangau were found passing through at (4) Air Putih and 16 or 7% at (3) Cukai. Accordingly, 71% of those passing southbound at (1) Dungun and 77% of those at (2) Jerangau terminated in the study area.

On the southern boundary, at (3) Cukai 16% came from (1) Dungun and less than 1% from (2) Jerangau. At (4) Air Putih, 326 vehicles were counted, including 5% from (1) Dungun and 11% from (2) Jerangau. The vehicle trips generated southbound from the study area corresponded to 84% at (3) Cukai and 83% at (4) Air Putih.

It seems that vehicles diverting to J-J Highway from Route III is small in number. Only 10% is using J-J Highway in the case of passing through traffic.

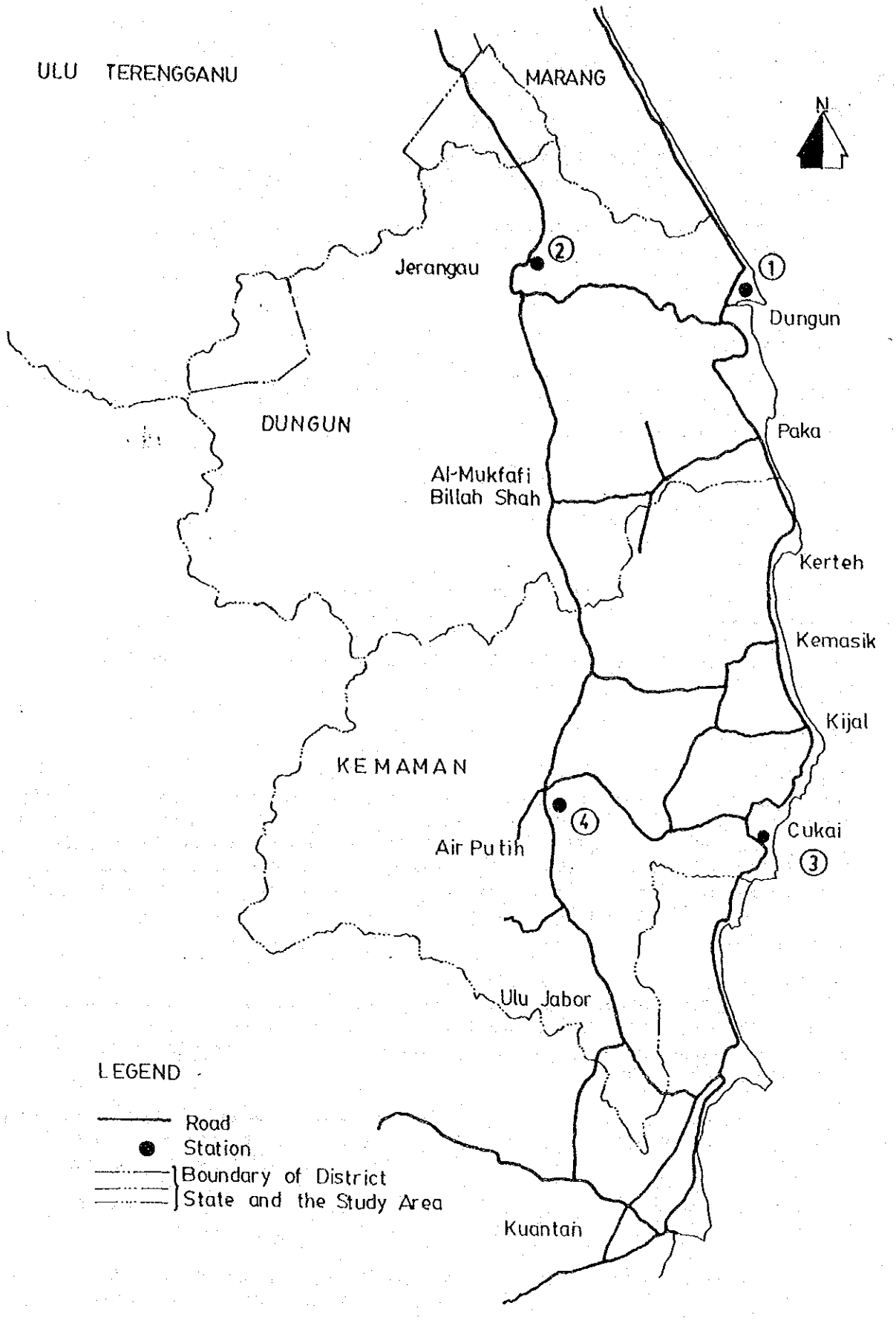
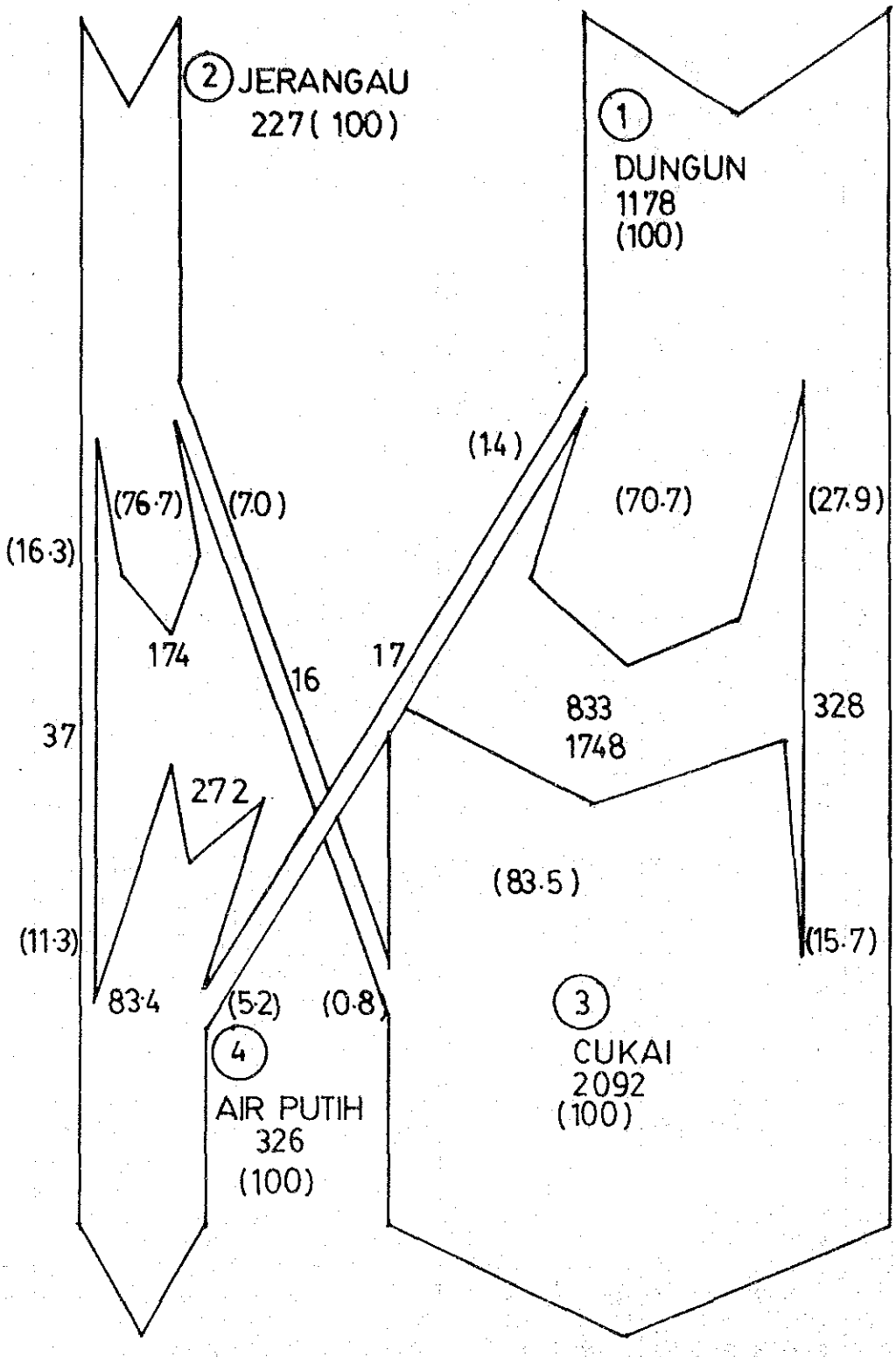


FIG. 10.8 VEHICLE NUMBER PLATE SURVEY STATION



Note: Figures are the number of vehicles and in brackets are the percentage. The number plate survey was carried out on the south bound traffic for 9 hours during daytime.

FIG. 10.9 TRAFFIC FLOW: THE SURVEY RESULTS

Table 10.8 SUMMARY OF TRAVEL TIME OF THROUGH TRAFFIC

Through Route	Vehicle Type	0 Hour 40	0 Hour 50	1 Hour 10	1 Hour 20	1 Hour 30	1 Hour 40	1 Hour 50	2 Hour 10	2 Hour 20	2 Hour 30	2 Hour 40	2 Hour 50	3 Hour 10	3 Hour 20	3 Hour 30	3 Hour 40	3 Hour 50	Over	Total
1 Dungun	Passenger-Car		1 2 7	11 21 18	10 8	9 8	4 8	2 10 3	7 3 5	6 2 6	4 2 1	3 3 1		3 2 2 1		1 2	2		22	200
	Taxi	1		2 6 1	1 2	3 1												1		18
—	Small Van			1	2 2	1	1 1	1							2					11
3 Cukai	Lorry		1	3 3	6 6	7 10	4 6	1 5 1	3 9 1	1	3 2	1 1 1			1 1		1		5	83
	Bus			2	4 1	1	3	2 2	1											16
	Total	1	1 2 8	14 30 24	23 19	21 19	12 17	5 15 5	10 13	6 7	2 9	6 3	2 4 3 1	3 2	2 1 3	1 1	2 1	2 1	27	328
2 Jerangau	Passenger-Car		2	2 2	1 1	2	1	1	1										2	15
	Taxi																			0
—	Small Van			1														1		2
4 Air Putih	Lorry			1	3	1	2	1	1	2 2 1		2 1								17
	Bus				2 1															3
	Total		2	4 2	3 5	3	1	2 2	1	3 2 1		2 1						1	2	37
1 Dungun	Passenger-Car			1 1		1 1				2 1		1	1		1 1				1	12
	Taxi																			0
—	Small Van												2							2
4 Air Putih	Lorry														2				1	3
	Bus																			0
	Total			1 1		1 1				2 1		1	3		3 1				2	17
2 Jarangau	Passenger-Car						2 1		1	1					2				3	10
	Taxi																		1	1
—	Small Van									1				1					1	3
3 Cukai	Lorry												1 1							2
	Bus																			0
	Total						2 1		1	2			1 1	1	2				5	16

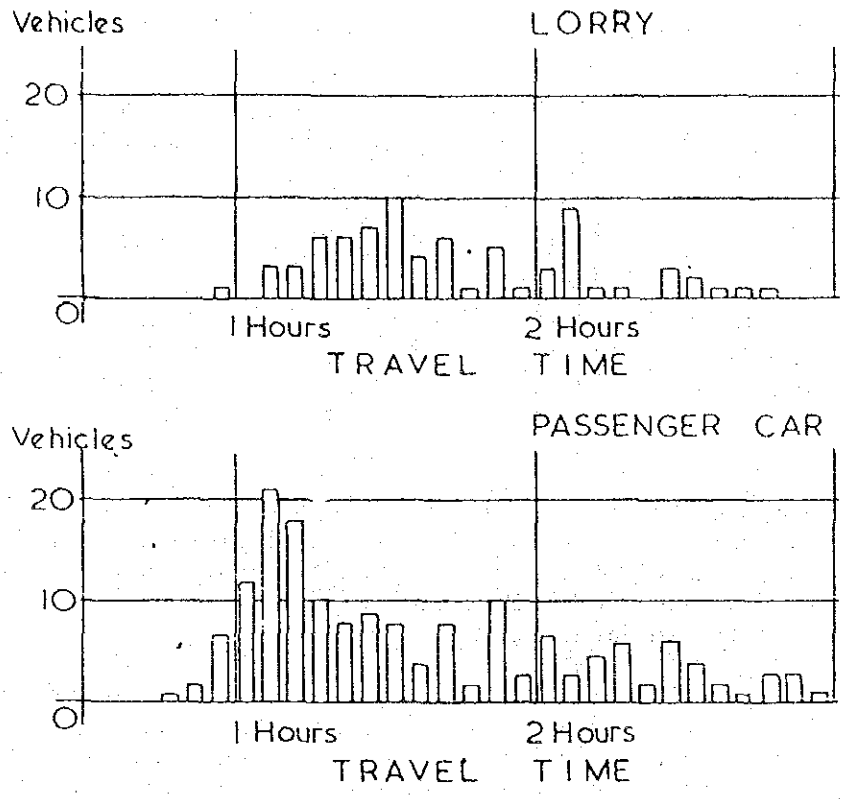


FIG. 10.10 TRAVEL TIME DISTRIBUTION OF DUNGUN-CUKAI TRAFFIC

2.2.3 Registered Vehicles

Vehicles registration together with the issue of driving permits are managed by the Registration Office Terengganu, Road Transport Department, MOT. In reality, some of those living in the study area register at the Registration Office Kuantan for their convenience. Accordingly, the actual number of vehicles located in Terengganu State would be slightly larger than those on the statistical data.

Table 10.9 and Fig. 10.11 present the figures of vehicles registered in Peninsular Malaysia for the period 1970 - 1983. The total registered vehicles in the Peninsular increased from 670 thousand in 1970 to 3.57 million in 1983 with an average growth rate of 13.7% per annum. The largest share in registration was motorcycles, which counted 350 thousand or 52% of the total in 1970 and 2.0 million or 56% in 1983 with the growth rate of 14% per annum during this period. Approximately 32% of the total had been shared by cars which grew by 13% per annum from 231 thousand in 1970 to 1.15 million in 1983.

The rest of the registration in 1983 was shared by lorries and vans (7%), others (3%) and taxis and buses (1.1%).

The registration of 3.57 million and the population of 11.70 million in 1983 indicate that every 3.3 persons had a motorcycle or other types of vehicles. In case of passenger cars alone, every 10.2 persons had a car in 1983.

The registered vehicles during the years of 1970 - 1983 in Terengganu State are shown in Table 10.10. Average growth rates per annum for every five years are calculated as follows:

	1770-75	1775-80	1773-78	1778-83
Motorcycles	13.8%	18.8%	17.4%	18.5%
Cars	10.5%	15.6%	15.6%	14.6%
Lorries and others	10.0%	15.6%	10.5%	17.5%
Total	12.4%	17.6%	17.6%	17.5%
Total w/o mc	10.3%	15.6%	13.1%	15.6%

The above average growth rates indicate that motorcycles had a larger rate of increase than cars and others. The rate of increase has gradually decreased for all vehicle types in the past few years, being shown in Table 10.10. However, motorcycles still hold the predominant figure in registration and growth rates.

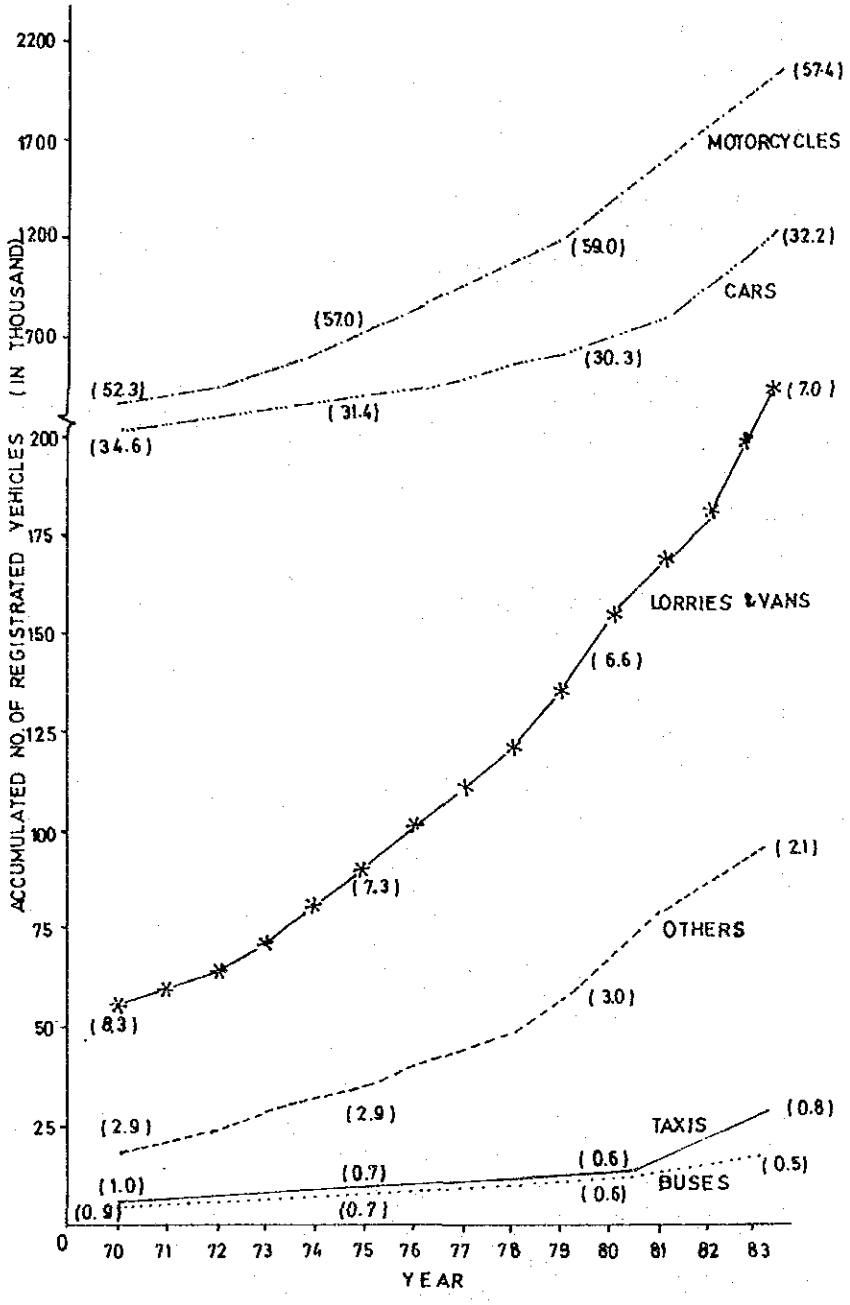
By using the number of registered vehicles, 76,000, and the estimated population of 575,000 in 1982, it is calculated that every 7.5 persons had one vehicle including motorcycles. If passenger cars are taken into account, the ratio is 34.7 persons per car. The figures show less prevalence of vehicles than the Peninsular average. This means a possibility of substantial increase in the prevalence of car ownership in the coming years.

Table 10.9 MOTOR VEHICLE REGISTRATION - PENINSULAR MALAYSIA 1970 - 1982

Year / Veh. Type	Motor Cycles	Cars	Taxis and Hires	Buses	Lorries and Vans	Others	Trailers	Total
1970	350,049	231,539	6,827	5,932	55,823	12,255	6,869	669,294
1971	398,133	253,491	7,377	6,447	60,447	13,878	8,296	739,165
1972	435,334	279,300	7,427	6,839	64,979	15,676	9,102	818,657
1973	507,096	316,894	7,562	7,274	72,164	18,658	10,303	939,951
1974	611,822	357,910	8,150	7,733	81,584	21,679	11,352	1,100,280
1975	722,309	398,014	9,239	8,688	92,207	24,524	12,138	1,267,119
1976	830,834	436,939	10,432	9,735	101,610	27,236	13,059	1,429,845
1977	951,080	491,933	11,285	10,545	111,755	30,609	13,794	1,621,001
1978	1,077,874	555,450	12,058	11,596	122,520	34,698	14,624	1,828,820
1979	1,195,997	612,199	12,705	12,276	135,682	40,280	16,199	2,025,338
1980	1,391,899	714,742	14,347	13,079	154,532	49,851	18,935	2,357,386
1981	1,556,516	797,143	17,106	13,898	167,432	59,425	20,428	2,631,948
1982	1,744,433	881,923	17,406	15,199	180,882	68,402	20,856	2,930,101
1983[1)]	2,030,000	1,150,000	26,270	18,000	250,000	74,000	22,000	3,570,000
Av. Growth Rate (%) 1970/1975	15.6	11.4	6.1	7.9	10.6	14.9	12.1	13.6
Av. Growth Rate (%) 1975/1980	14.0	12.4	8.7	8.5	10.9	15.2	9.3	13.2
Av. Growth Rate (%) 1975/1983	13.8	14.2	14.0	9.5	13.3	14.8	9.7	13.8
Av. Growth Rate (%) 1970/1983	14.5	13.1	10.9	8.9	12.2	14.8	9.4	13.7

Notes : 1) Provisional

Source : Road Transport Department.



Note: Figures in brackets are the composition in percent.
Source: Highway planning unit, Ministry of Work and Utilities.

FIG. 10.11 MOTOR VEHICLE REGISTRATION - PENINSULAR MALAYSIA 1970 - 1983

Table 10.10 VEHICLE REGISTRATION IN TERENGGANU, 1970 TO 1983

Year	Population*	Car Registration			Motor Cycle Registration			Bus Registration			Taxis			Total (with Lorries and Others)		
		No.	Annual Growth Rate (%)	No. per 1,000 pop.	No.	Annual Growth Rate (%)	No. per 1,000 pop.	No.	Annual Growth Rate (%)	No. per 1,000 pop.	No.	Annual Growth Rate (%)	No. per 1,000 pop.	No.	Annual Growth Rate (%)	No. per 1,000 pop.
1970	405,540	3,694	-	9.11	7,926	-	19.54	142	-	0.35	179	-	0.44	13,773	-	33.96
1972	417,490	3,931	6.42	9.42	8,682	9.54	20.80	144	1.41	0.35	181	1.12	0.43	14,921	8.34	35.74
1972	429,800	4,244	6.96	9.87	9,649	11.14	22.45	152	5.56	0.35	182	0.55	0.42	16,399	9.91	38.15
1973	442,470	4,672	10.08	10.56	11,097	15.01	25.08	153	0.66	0.35	180	-1.10	0.41	18,609	13.48	42.06
1974	445,515	5,458	16.82	11.98	13,321	20.04	29.24	164	7.19	0.36	168	-6.67	0.37	22,015	18.30	48.33
1975	468,940	6,077	11.34	12.96	15,149	13.72	32.30	180	9.76	0.38	165	-1.79	0.35	24,691	12.16	52.65
1976	482,765	6,776	11.50	14.04	18,041	19.09	37.37	202	12.22	0.42	174	5.45	0.36	28,629	15.95	59.30
1977	497,000	7,871	16.16	15.84	21,265	17.87	42.79	235	16.34	0.47	180	3.45	0.36	33,347	16.48	67.10
1978	511,650	9,246	17.47	18.07	24,750	16.39	48.37	261	11.06	0.51	183	1.67	0.36	38,668	15.96	75.58
1979	526,730	10,858	17.43	20.61	28,593	15.53	54.28	281	7.66	0.53	299	63.39	0.57	45,190	16.87	85.79
1980	542,280	12,554	15.62	23.15	35,816	25.26	66.05	308	9.61	0.57	365	22.07	0.67	55,520	22.86	102.38
1981	558,824	15,053	19.91	26.96	42,781	19.45	76.63	340	10.39	0.61	443	21.37	0.79	65,853	18.61	117.84
1982	575,368	16,577	10.12	28.81	50,237	17.43	87.31	372	9.41	0.65	526	18.74	0.91	76,387	16.00	132.76
1983	591,912	18,289	10.32	30.90	57,771	15.00	97.60	422	13.44	0.71	552	4.95	0.93	86,521	13.27	146.17

Note : * The population figures between 1970 and 1980 are estimated based on the annual growth rate of 2.948 percent, which is the average annual population growth rate between 1970 and 1980. The figures after 1980 are estimated using 2.9 percent per annum to be consistent with the Terengganu Master Plan Study, Terengganu.

Source: JPJ Office, Kuala Terengganu.

2.3 Growth Prospects

2.3.1 Vehicle registration

Changes in car and motorcycle registration in Japan for the period after 1955 are illustrated in Table 10.11 and Fig, 10.12 in terms of per capita ownership. Per capita motorcycle ownership exceeded car ownership up to the early 1970s. After that point, however, per capita motorcycle ownership continued to increase although the rate of increase was not as high as that of per capita car ownership.

Changes in per capita ownership of these vehicle types in Peninsular Malaysia and Terengganu were studied as in Fig. 10.12 and Table 10.12. During the years from 1970 to 1982, motorcycles and cars had shown a continuous and a similar trend of increase in terms of per capita figures both in Peninsular Malaysia and Terengganu. It is found that during this period motorcycles had a larger rate of increase (11.8%) than cars (9.3%) in terms of per capita figures in Peninsular Malaysia. In Terengganu, the increase of motorcycles after 1980 did not taper off.

Forecast of the increasing tendency for the coming years requires studies in the growth of the economy, income levels, prices, a relationship of substitution and/or complement between the car and the motorcycle, and other related matters. In addition, there remain uncertain influencing factors.

It is assumed that in Terengganu State, as a whole, the increasing trends of car and motorcycle ownership continue with a tapering off trend, slightly different from each other. They are shown in the annual rates: one up to 1990 and the other at a lower rate afterwards. This assumption results in the estimates of vehicle increase of the State as shown in Table 10.13.

In the case of trucks (lorries, vans and trailers), changes in registration are considered better to be associated with Gross Regional Domestic Product (GRDP) rather than with per capita ownership. The relationship is shown as a regression line with a high coefficient of correlation. It is shown in Table 10.14 and Fig. 10.13.

By using this relationship and the assumption that GRDP of Terengganu increases at 8% per annum, it is estimated that registered trucks, including small trucks, lorries and trailers, increase at an average rate of 8% per annum. It may taper off slightly to 7% or 6% per annum beyond 1990.

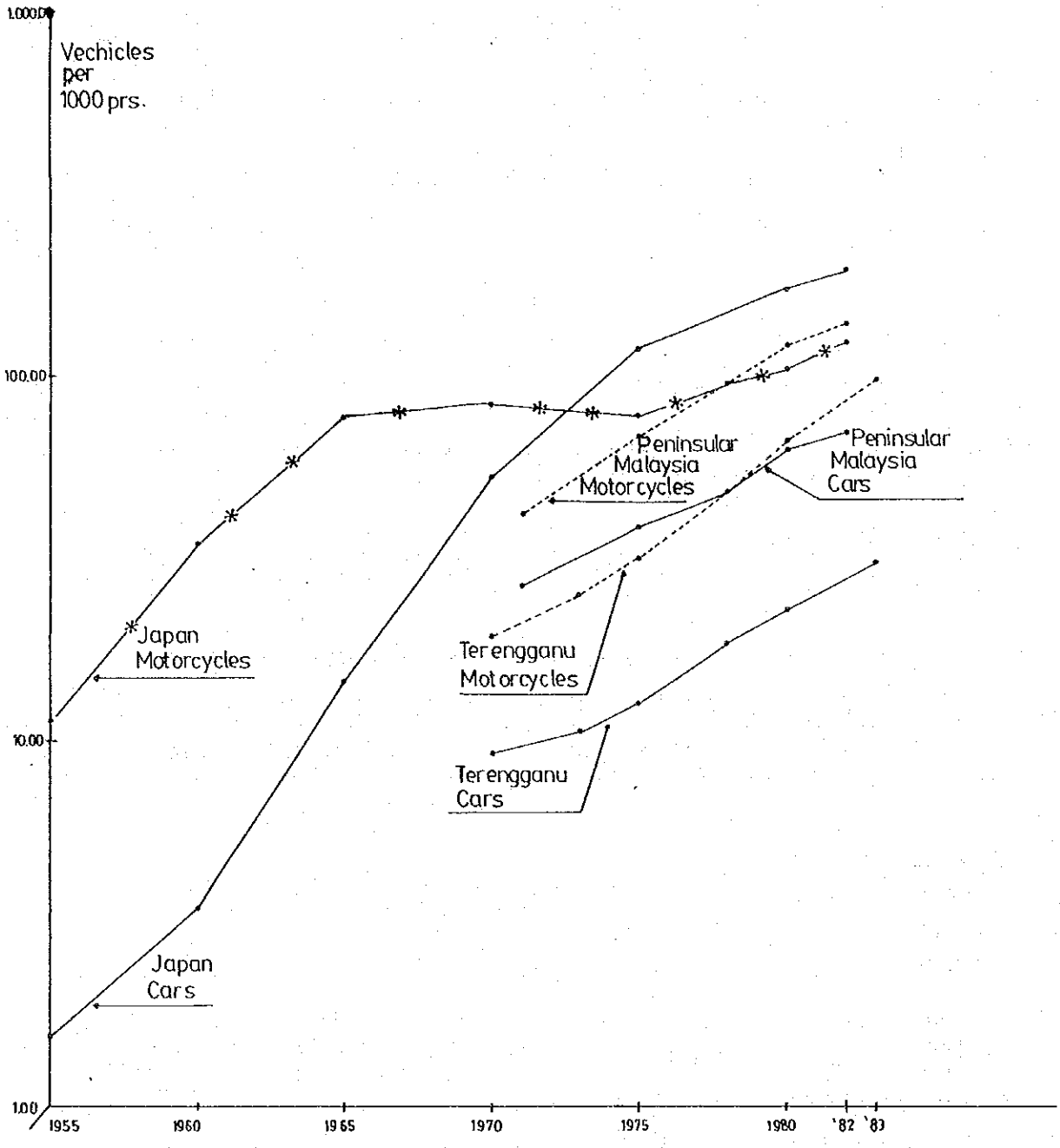


FIG. 10.12 MOTORCYCLE AND CAR OWNERSHIP: PENINSULAR MALAYSIA TERENGGANU AND JAPAN (1970 - 1983)

Table 10.11 CARS AND MOTORCYCLES IN JAPAN

	1955	1960	1965	1970	1975	1980	1982
Population[1] (million)	89.3	93.4	99.5	103.5	110.9	116.2	117.8
Cars[2] ('000)	139	331	1,462	5,512	13,207	20,559	22,515
Motorcycles[2] ('000)	1,028	3,038	7,672	8,852	8,753	11,966	14,558
Cars/Pop. of '000	1.6	3.5	14.7	53.2	119.0	176.9	191.2
Mc/Pop. of '000	89.3	32.5	77.1	85.5	78.9	103.0	123.6

Source : 1) Population census (1955 and 1960) and Population and Household Surveys (1965 and afterwards).

2) Annual Reports of Land Transport Statistics for the respective years. Registered three classes were summed up.

Table 10.12 CARS AND MOTORCYCLES IN PENINSULAR MALAYSIA

	1970	1971	1975	1978	1980	1982
Peninsula						
Population[1] ('000)		9,405	10,434	11,262	11,426	12,284
Cars[2] ('000)	232	253	398	555	715	882
Motorcycles[2] ('000)	350	389	722	1,078	1,392	1,744
Per Population of 1,000						
Cars/Pop.		26.9	38.3	49.1	62.7	71.7
Mc/Pop.		41.4	69.4	95.4	122.1	141.8

Source : 1) Population census and Five-Year Development Plans, DOS.
2) Road Transport Department, 1983.

Table 10.13 CARS AND MOTORCYCLES IN TERENGGANU STATE 1980, 1990 AND 2000

	1980		1990		2000
Population[1] ('000)	542		722		930
Car/'000 persons[2]	23.1	9.9%	59.4	6.9%	116
Mc/'000 persons[3]	66.1	6.0%	118.4	3.9%	174
Cars registered ('000)	12.5	13.1%	43	9.6%	108
Mc registered ('000)	35.8	9.0%	85	6.7%	162

Source : 1) Terengganu Master Plan Study

2) An average from 1970 to 1983 of 9.9% p.a. is used. For 1990 - 2000, 9.9 x 0.7 = 6.9% is assumed.

3) In 1990, MC is assumed at two times larger than cars, and in 2000, larger by 50% than cars in the registration.

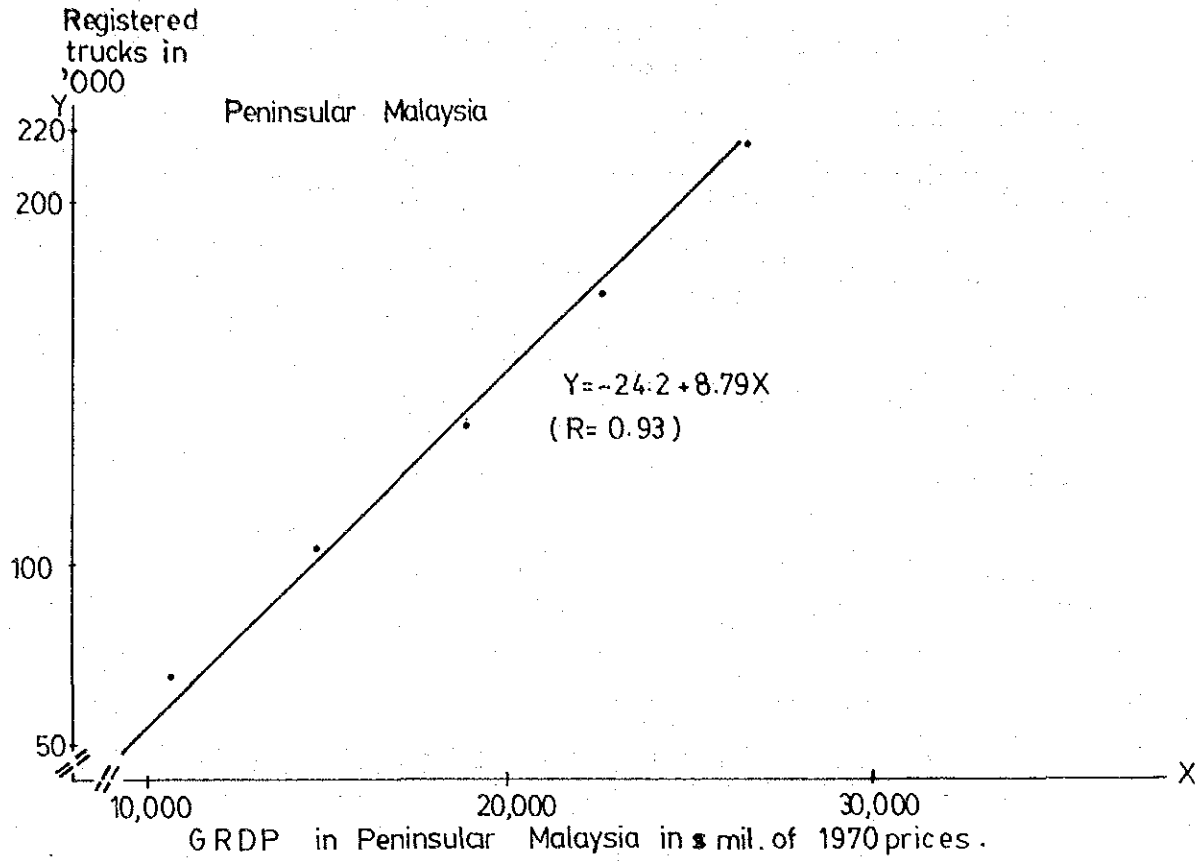
Table 10.14 TRUCKS AND GRDP (GRDP IN 1970 PRICES)

	1971	1975	1978	1980	1983
Peninsular Malaysia					
GRDP (mil.)[1]	10,888	14,930	18,934	22,116	26,661
Registered Trucks[2]	68,839	104,345	137,144	173,467	217,500
Terengganu					
GRDP (mil.)[1]	261	358	529	734	1,065
Registered Trucks[3]	1,832	3,120	4,228	6,477	9,487

Source : 1) The 3rd and 4th Five-Year Development Plans.

2) Road Transport Department, Kuala Lumpur.

3) Road Transport Department, Kuala Lumpur.



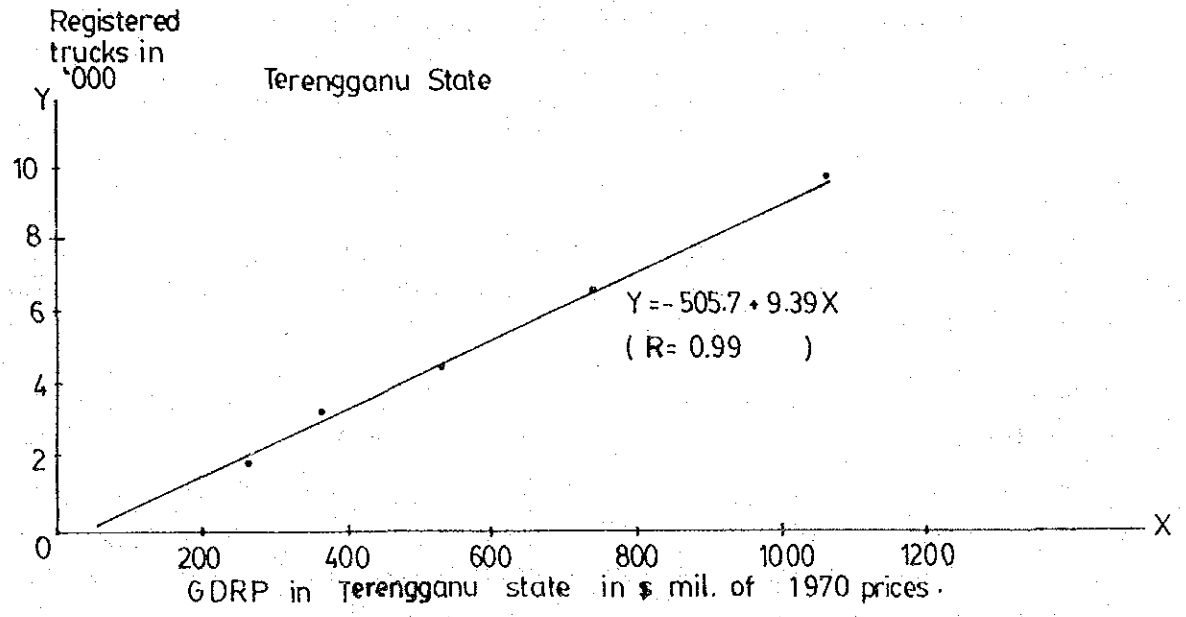


FIG. 10.13 REGISTERED TRUCKS AND GRDP

2.3.2 Projection by TMPS

Fig. 10.14 shows the future traffic growth projected by the Terengganu Master Plan Study (TMPS) up to the year 2000 and Table 10.15 summarizes the projection in the study area. The projection by TMPS was made by distributing the estimated volume through a gravity model formula. Peninsular Malaysia was divided into ten zones; four zones in the northern part of Terengganu and four in the area of this study. The projection also took into account the shift of a certain percentage of traffic to the proposed new rail service which was assumed to commence operation in 1990.

The traffic volume at Marang-Dungun section, as shown in Table 10.15, is forecast to grow from 3,634 in 1982 to 12,000 by the year 2000. The traffic volume between Dungun and Kerteh, and Kerteh and Cukai is estimated at 14,000 and 19,000 respectively in 2000. Thus, the average annual growth rate at the Kerteh-Cukai section between the year 1982 and 2000 is estimated at 10.9%, including effects of the development of industry and township.

As shown in Fig.10.14 and Table 10.15 two sections on Jerangau-Jabor Highway will have a traffic volume of approximately 8,000 by the year 2000.

The annual average growth rate is different from section to section. The overall average growth rate between the years 1982 and 2000 is estimated to be 8% in the study area (the southern part of Terengganu) according to TMPS.

2.3.3 Trend Extrapolation

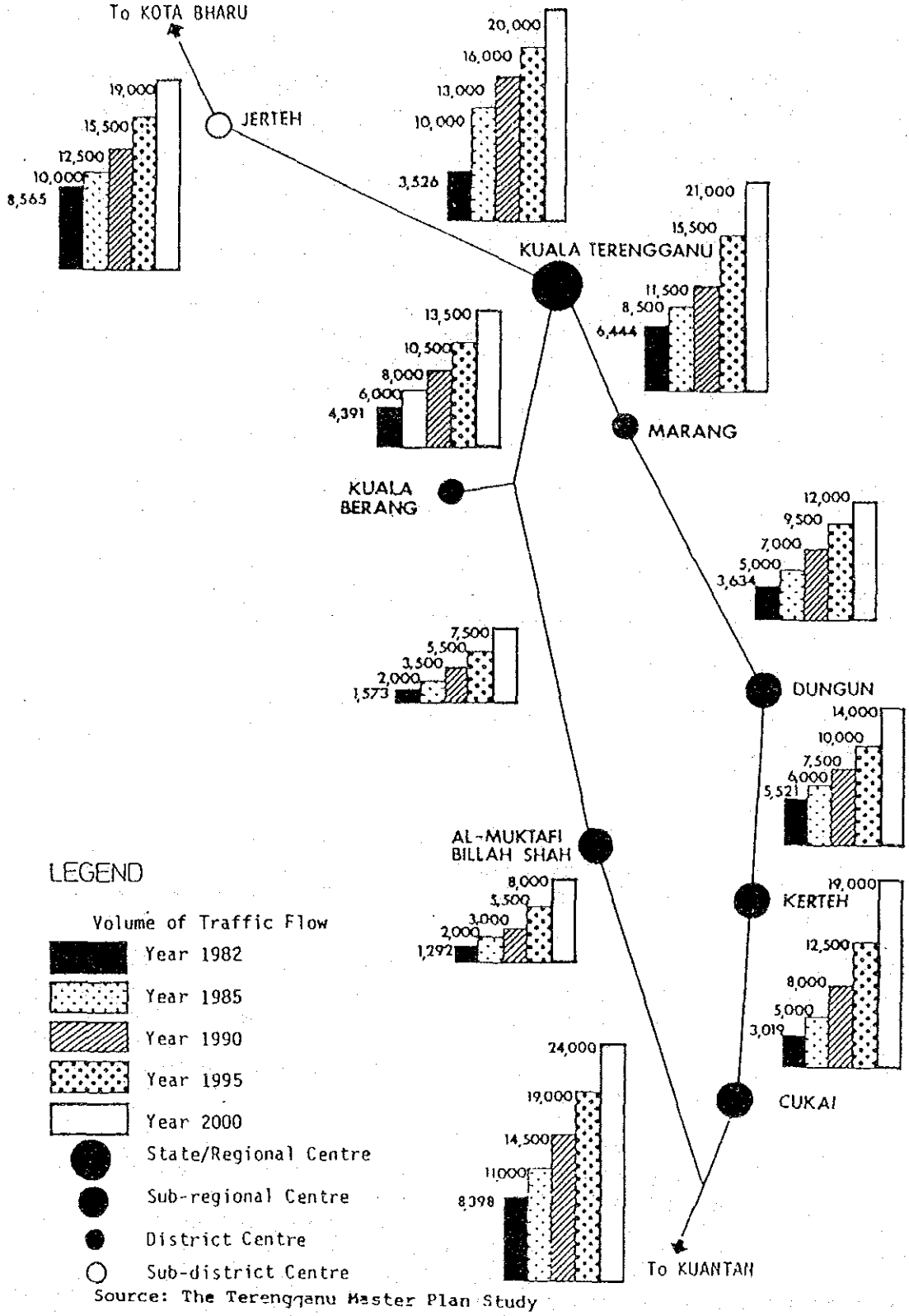
The average annual growth rate for the traffic in the study area, derived from the Highway Planning Unit statistics, is 13% for the period between 1973 and 1978 and 10% for the period of 1978 - 1983 as observed in Table 10.6.

On the other hand, the average annual growth rate of vehicle registration for the State of Terengganu, as shown in Table 10.10, is much higher (17.5%) for the period between 1973 and 1983. However, the annual rate began to decrease in 1980.

As shown in Table 10.13, registered cars are expected to increase at 13% per annum, motorcycles at 9% per annum and lorries 8% per anum up to 1990. Traffic, in general, will increase at a lower rate than the above registered figures since the vehicle's annual mileage decreases when the ownership ratio increases substantially. Owners tend to use vehicles less intensively when the ownership prevails much more.

The decreasing trend of the annual growth rate in the recent past suggests that the overall average annual growth rate would be 11% for the coming years from 1983 through 1990. Ongoing development projects in the coastal area and the new township development project in KETENGAH would support the continuation of this high rate of increase (11%) up to 1990.

Thus, the future traffic volume in the study area projected through trend extrapolation and vehicle registration forecast is summarized in Table 10.16. The estimated traffic volumes are similar with those projected by TMPS shown in Table 10.15.



Source: The Terengganu Master Plan Study

FIG. 10.14 PROJECTED AVERAGE DAILY TRAFFIC ALONG FEDERAL ROUTE III AND JERANGAU - JABOR HIGHWAY

Table 10.15 SUMMARY OF TRAFFIC FORECAST BY THE TERENGGANU MASTER PLAN STUDY

Section	1982	1985	1990	1995	2000	Average Annual Growth Rate (%)		
						1982-2000	1990-2000	1982-2000
Marang - Dungun	3,634 (11.2)	5,000 (6.9)	7,000 (6.3)	9,500 (4.8)	12,000	8.5	5.6	6.9
Dungun - Kerteh	5,521 (2.8)	6,000 (4.6)	7,500 (5.9)	10,000 (7.0)	14,000	3.9	6.5	5.3
Kerteh - Cukai	3,019 (18.4)	5,000 (9.9)	8,000 (9.5)	12,500 (8.7)	19,000	13.1	9.1	10.9
Cukai - Kuantan	8,398 (9.4)	11,000 (5.0)	14,500 (5.5)	19,000 (4.8)	24,000	6.7	5.2	5.9
Kuala Berang - Al-Muktafi Billah Shah	1,573 (8.3)	2,000 (11.8)	3,500 (9.5)	5,500 (6.4)	7,500	10.5	8.0	9.1
Al-Muktafi Billah Shah - Kuantan	1,292 (15.7)	2,000 (8.5)	3,000 (12.9)	5,500 (7.8)	8,000	11.2	10.4	10.7
Average	(11.0)	(7.8)	(8.3)	(6.6)		9.0	7.5	8.1

Notes : Figures in brackets are the annual growth rates.

Source : Terengganu Master Plan Study.

Table 10.16 FUTURE TRAFFIC VOLUME[1)]

District & Survey Station		1982	1985	1990	1995	2000
Annual Growth Rate (%)			11.0	11.0	9.0	7.0
Route III	Marang-Dungun (93)	3,701	5,000	8,500	13,000	18,500
	Dungun-Kerteh (K13, K17)	3,540	5,000	8,250	12,500	17,500
	Kerteh-Cukai (92)	3,392	4,500	8,000	12,000	17,000
	Cukai-Kuantan (91)	5,275	7,000	12,000	18,500	26,000
Jerangau-Jabor Highway	(K5)	3,567	5,000	8,000	12,500	17,500
	(88)	1,512	2,000	3,500	5,500	7,500
	(87)	1,359	2,000	3,000	5,000	7,000

Source : Study Team

Note: 1) Including motor cycles

2.4 Road Capacity and Improvement Plans

The road capacity determination depends on the parameters applied, such as the service level, road conditions, traffic characteristics, travelling speed and road side friction.

TMPS estimated a 17,500 vehicles per day capacity for the maximum average daily traffic that can be accommodated on a two-way, two-lane rural highway. TMPS estimation was based on the Highway Capacity Manual, Highway Research Board, Washington D.C. (1965), applying the service level of D which had the maximum service volume of 1,700 vehicles per hour in both directions of a two-lane highway with a design speed of 60-70 km per hour. Some local conditions were taken into account in determining the parameters.

On the other hand, the Highway Planning Unit, Kuala Lumpur, has shown in its publication, Traffic Volume Peninsular Malaysia, November, 1983, the hourly peak capacity of major roads by each section. Those figures on the roads of the study area are shown in Table 10.17. The methodology of estimation would be quite similar with that of TMPS. TMPS applied a rate of 73% to obtain the average hourly flow from the peak hour flow. About 1,500 vehicles per hour (17,500 - 16 - 0.73) can therefore be derived consistent with the estimation by HPU.

Accordingly, the HPU estimation is considered reasonable and the average daily (16 hours) capacity is then derived by multiplying 16 hours and a factor of 0.73. The calculated capacity and traffic forecast are shown in Table 10.18.

From Table 10.18, the road sections containing the survey stations No. 93 northward outside of Dungun will need a new proposal to increase the capacity in the late 1990s. The station K13 is in the Dungun town area. The widening or a bypass will be necessary. This point will be studied in the urban planning of Dungun of this study. But the rest of the road seems to have enough capacity as long as the current development programs of Table 10.5 and Fig. 10.5 are carried out in due course. Jeragau-Jabor Highway will not require widening work before 2000.

Table 10.19 summarizes the road development plans by TMPS, JKR and the recommendation of this study.

Table 10.17 ROAD TRAFFIC CAPACITY BY HPU

Road Segment Federal Highway Route III Kuala Terengganu/Kuantan	Average Width (ft)	Existing Capacity (Vehicles per hour)	Traffic Volume Survey Station
m/s 28.0 - m/s 47.0	20	1,455	No. 93-m/s 40.8
m/s 47.0 - m/s 49.0 (Dungun m/s 49.0)	21	1,488	No.K13-m/s 49.0
m/s 49.0 - m/s 61.0 (Paka m/s 61.0)	20	1,311	
m/s 61.0 - m/s 77.0 (Kemasek m/s 77.0)	20	1,444	No.K17-m/s 64.5
m/s 77.0 - m/s 98.82 (Cukai m/s 96.0) (Terengganu/Pahang Border m/s 98.82)	18	1,252	No. 92-m/s 83.2
Ajil - Jerangau State Road	18	1,250	No. K5
Jerangau - Jabor Highway	20	1,450	No. 88, 87

Source : HPU for Federal Highway Route III.

Table 10.18 ESTIMATED ROAD CAPACITY AND TRAFFIC IN 2000

Road Section	Road Structure	Capacity	Volume	Vol./Cap.	Remarks
Federal High Route III:					
Survey Station No. 93	Existing T/L, TW, W-20 ft	17,000	18,500	1.1	Upgrade necessary recommended
Survey Station No. K13	Existing T/L, T/W, W-21 ft	17,400	30,000	0.8	
	Bypass T/L, T/W, W-20 ft	17,000			To be recommended
Survey Station No. K17	After widening, Dual 2 + 2, W-11 ft/lane	34,000	5,000	0.7	Now planning
Survey Station No. 92	Existing T/L, T/W, W-20 ft	17,000	17,000	0.5	Now planning
	Bypass T/L, T/W, W-20 ft	17,000			
Jerangau-Jabor Highway	T/L, T/W, W-20 ft	17,000	7,500	0.4	

Notes : T/L = Two Lane, T/W = Two Way, Dual 2 + 2 = Four Lane Dual Carriageway.

Capacity is obtained by multiplying 16 hours and 0.73 to the figure in Table 12 - 18 which is a conversion ratio from peak hour volume to the average daily volume. Volume is for 16 hours in 2000.

Traffic data of K17 should be reviewed. It should be at the level of Nos. 93 and 92.

Table 10.19 PROPOSALS ON ROAD TRANSPORTATION DEVELOPMENT PROGRAMME

	Up to 1985 (4th Malaysia Plan)	1986 - 1990 (5th Malaysia Plan)	1991 - 1995 (6th Malaysia Plan)	1996 - 2000 (7th Malaysia Plan)
TMPS Recommendation	o Continue to implement the planned road improvement and expansion program.	o Complete all road improvement and expansion programs earmarked under the Fourth Malaysia Plan.	o Carry out feasibility study on the development of the Kuala Berang-Sg. Siput Highway followed by preliminary and detailed engineering if the project is found to be economically viable.	o Commence construction of Kuala Berang - Sg. Siput Highway if project has been determined to be viable.
	o Implement traffic management schemes at conflict junctions.	o Continue to implement traffic management schemes.	o Study the need to upgrade Federal Route III (from Kuantan to Kota Bharu) into a dual-carriage way.	o Either upgrade Federal Route III (from Kuantan to Kota Bharu) into a dual-carriageway or expand state road network according to recommendations of study.
Major JKR Scheme	o Kuala Jengai - Pasin Raja New Road o Extension Feeder 6 o Dual Carriageway of Route III between Paka & Kemasik o Telok Kalong Bypass and Northern Extension o Cukai Bypass and Southern Extension o Cukai - Ceneh Baharu New Road		N.A.	
Recommendation by this Study	o Complete JKR Schemes by the Fifth Malaysia Plan. o Implement traffic safety managements. o Study the need of Dungun Bypass and construct if viable. o Study the flood prevention on roads. o Study the rehabilitation of inland highways. o Study the dual carriageway of the whole Route III.		o Continue implementations of traffic safety management. o Commence the flood prevention projects on roads. o Continue the rehabilitation of inland highways. o Commence the upgrading of Route III if found viable.	

2.5 Recommendations

(1) JKR of Terengganu has performed maintenance and repair works well. This performance should be strengthened and continued in the coming years because increasing traffic will depreciate the road structure much more than in the past.

(2) Road improvement plans as summarized in Table 10.5 and Fig. 10.5 should be implemented during the Fourth and Fifth Malaysia Plan periods. These improvement plans are proposed by JKR of Terengganu in order to strengthen the road system of the area. The major points of the program are widening of Route III, development roads such as to Pasir Raja, a bypass plan of Cukai, etc. In addition, a bypass plan is recommended for Dungun from the viewpoint of urban road network planning of this study.

(3) Jerangau-Jabor Highway and other inland roads have a number of damaged sections although they were constructed only a few years ago. The damages observed are pot-holes, slope deterioration, shoulder damages, etc. There are several causes of the damages, including the heavier truck loading than intended and the application of inadequate structural and surface design standards. Substantial rehabilitation work is recommended. JKR of Terengganu recognizes the necessity for rehabilitation beyond the normal maintenance work.

(4) Some sections of the roads in the study area are covered by floods in rainy seasons. Flood prone sections should be improved in order to be free from traffic distruption and structural damage. This matter was simultaneously studied from the viewpoint of river and drainage planning. Actions for (a) increasing the elevation of the road, (b) the improvement of river drainage, and (c) combined works of (a) and (b) should be studied and implemented. The most damaged sections are as fllows:

- Between Dugun and Paka of Route III, along Paka river.
- Between Air Putih and Cukai, along Kemaman river.

(5) It is expected to see urbanization development in the towns along Route III. However, Route III has no provision for separating the speedy traffic and the slow movement of bicycles and pedestrians. For the safety of these flows, an additional width of 5.0 m on both sides with a barrier/fence and a stablized surface is recommended.

(6) For the safety of traffic movement and pedestrians, traffic signals are required. Particularly in the urban areas, signals should be installed at major junctions.

3. Public Transport Service

The public transport system in the area is divided into bus lines, taxis, school buses, and trishaws. Of these services long distance inter-regional services are provided by buses and taxis, while short distance intra-urban services are provided by taxis, school buses and trishaws. In KETENGAH, some school buses circulate among new townships.

3.1 Inter-Regional Service

There are two types of public transport services available in the study area, namely buses and taxis. There is no railway service.

In the state of Terengganu, there was 19 bus companies registered with total of 198 buses as of January 1984[1]. According to the 1982 Year Book of Transport Statistics, Ministry of Transport, there were 16 bus companies with a total fleet of 151 buses providing transport services to 64 routes for a total length of some 5,300 km. Those companies are mostly based at Kuala Terengganu but some at Dungun and Cukai. The bus routes are all, except school buses, extended to connect cities and towns. The inter-regional bus services, connecting the study area with outside areas, have a terminal at Dungun and Cukai.

There are many other express buses passing through the study area, connecting the northern cities of Kuala Terengganu and Kota Bahru with the southern cities of Kuantan, Kuala Lumpur and Johor Bahru/Singapore. Most of them stop at Dungun and Cukai. These routes and trips are shown in Fig. 10.15.

There are bus services connecting inland KETENGAH townships to Kuala Terengganu, Dungun, Cukai and Kuantan. Frequency of the service is low, generally in 90 - 180 minute headways. At the moment there are no buses circulating between the five townships of KETENGAH.

Taxi service fundamentally provides a complementary function in the regional public transport service of buses.

> Taxis provide rather for long distance travel than for travel within the town. They operate from stations within each of the towns: Dungun and Cukai, and may be hired to any outlying location. No fixed routes are prescribed and taxis may convey passengers anywhere within Malaysia but the base station is the district in which the permit was issued[2].

Two types of permits are issued. Only those in (b) are operating in the study area.

a) Kereta teksi- where passengers pay the fare shown on the meter; and

b) Kereta Sewa - which operates on a car-hire basis where passengers pay a pre-agreed fare.

Source : 1) Road Transport Dept. (JPJ) Terengganu, 1984.
2) Ch. 10. Volume III, TCRS.

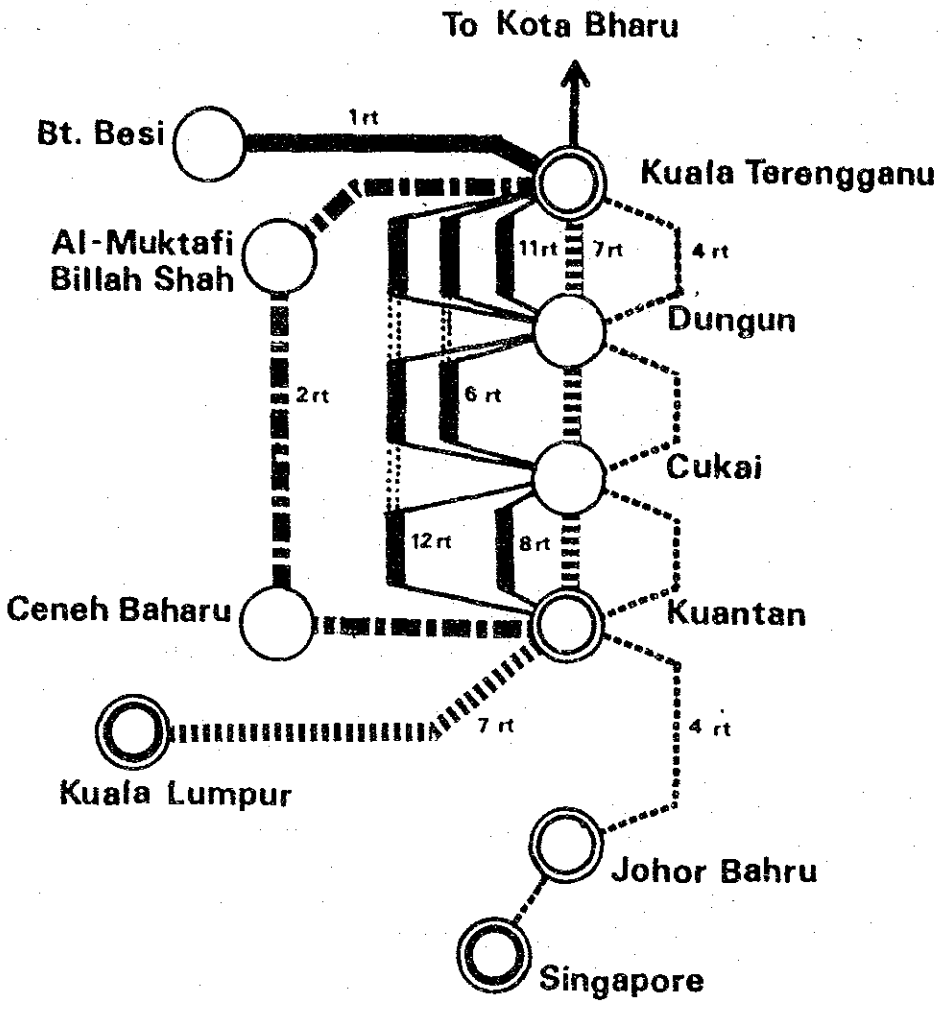


FIG. 10.15 BUS ROUTES AND ROUND TRIPS

Table 10.20 shows the allocation of taxis and hired vehicles in each district of the state of Terengganu. Kuala Terengganu district has the largest number of taxis, however, the ratio of taxis to the population is the highest in Besut followed by Marang, while Kuala Terengganu became the fourth in 1983. In comparison to other districts, Dungun and Kemaman have the lowest ratio of taxis per capita in 1983. The growth rates of taxis, by number as well as by the ratio to population, are the lowest in these two districts in the State of Terengganu.

3.2 Intra-Urban Service

Public transport services available in the urban areas are taxis, school buses and trishaws.

Taxis which are mentioned in the previous sub-section as serving long distance travel actually provide service to short distance travel in and around the urban area with the fare negotiated.

There is no ordinary bus network within Dungun and Cukai, but there is a regularly serviced school bus system which carries all classes of students. There are 34 registered school buses in the State out of which 16 belong to a company in Kemaman as of January 1984[3)]. The school bus routes start from various schools and go through the main roads in the town.

Trishaws or rickshaws fundamentally provide the public transport service in the populated towns. There are only two towns in the study area where trishaws exist: Dungun and Cukai. The approximate number of trishaws are 150 each according to the District Offices. There is a total of some 2,000 licensed trishaw operators in Terengganu.

Terengganu Coastal Regional Study recommends the introduction of small motorized rickshaws of the bemo type, because manually powered rickshaw not only has limitations of distance and travel time, but also has frequent conflicts with the faster moving traffic streams resulting in accidents and congestion. There are some applications at present to the District Offices for the use of motorized trishaws.

But the District Offices as well as the Road Transport Department, Ministry of Transport which is in charge of licensing any type of motorized vehicles have not decided if they will accept or reject these applications.

Source : 3) Road Transport Department, Kuala Terengganu

Table 10.20 TAXIS AND HIRED VEHICLES

	Item	Besut	Kuala Terengganu	Hulu Terengganu	Marang	Dungun	Kemaman	Total
1975	Population (1,000)[1]	89.0	208.6	39.6	22.1	52.4	52.7	469.0
	Number of Taxis[2]	61	94	31	17	28	36	267
	Taxis/1,000 pop.	0.69	0.45	0.78	0.77	0.53	0.63	0.57
1980	Population (1,000)	103.0	241.3	45.8	25.5	60.5	66.2	542.3
	Number of Taxis	103	177	48	20	35	51	434
	Taxis/1,000 pop.	1.0	0.73	1.05	0.78	0.58	0.77	0.80
1981	Population (1,000)	104.5	249.0	47.2	26.2	62.3	68.8	558.0
	Number of Taxis	145	230	47	21	42	55	540
	Taxis/1,000 pop.	1.39	0.92	1.0	0.80	0.67	0.80	0.97
1982	Population (1,000)	106.1	257.0	48.6	26.9	64.1	71.5	574.2
	Number of Taxis	170	260	60	28	47	57	622
	Taxis/1,000 pop.	1.60	1.01	1.23	1.04	0.73	0.80	1.08
1983	Population (1,000)	107.7	265.2	50.1	27.6	66.0	74.2	590.8
	Number of Taxis	195	285	66	30	51	60	687
	Taxis/1,000 pop.	1.81	1.07	1.32	1.09	0.77	0.81	1.16
Taxis Average Annual Growth Rate 1975/1983		15.6	14.9	9.9	7.4	7.8	6.6	12.5
Taxis/1,000 pop. Av. Annl. Growth Rate 1975/1983		12.8	11.4	6.8	4.4	4.8	3.2	9.3

Source : 1 - Population in 1980 is obtained from the Preliminary Field Count of the 1980 Census. The ones in other years are estimated by TMPS.

2 - The JRJ Office in Kuala Trengganu.

3.3 Recommendations

Bus service in the study area should be established to link the settlements and to provide intra-urban service in major urban areas. Due to the scarce population distribution and the growth in ownership of cars and motorcycles, the demand and revenue will not be sufficient to cover the cost of operation of the bus service.

Subsidizing part of the cost is recommended since public buses usually serve for those in low income classes having no vehicles and those in rural areas in which some urban services are not provided. Subsidizing is a social cost. Network, frequency, fare, operation system, amount of subsidy, etc. as well as transport demand should be examined at the earliest date. A conceptual pattern of bus service in the area is shown in Fig. 10.16.

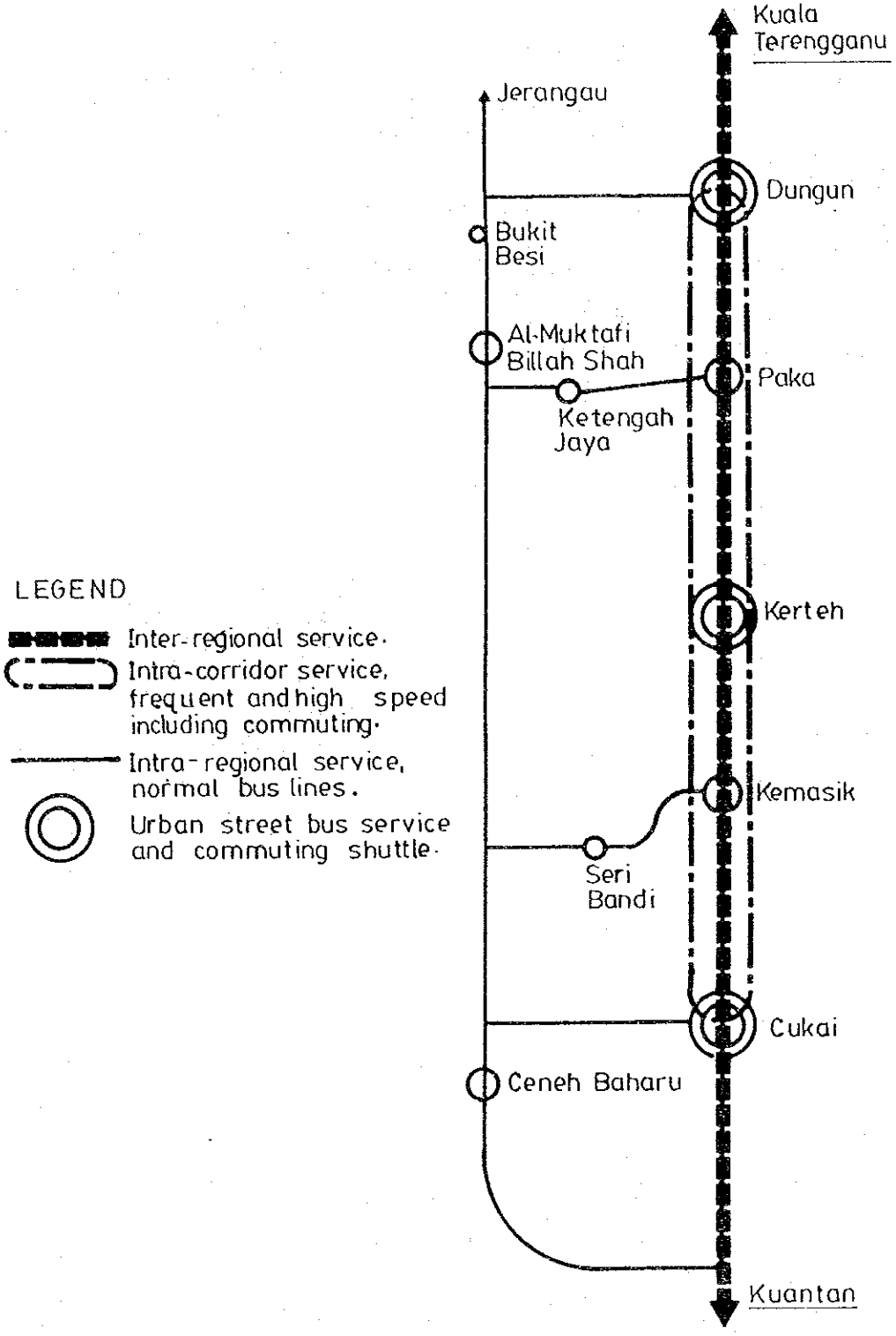


FIG. 10.16 CONCEPTUAL PATTERN OF BUS SERVICE

4. Airports

4.1 Existing Facilities and Services

There are 22 existing airports and airfields in Peninsular Malaysia incorporated in the National Airport System Plan, 1981 (NASP). Dungun airfield, currently not used, is located in the study area, some 7 km south of the city center. Nearby airports outside of the study area are the Kuala Terengganu airport, approximately 100 km north of Dungun, and the Kuantan airport approximately 70 km south of Cukai. Table 10.21 presents the existing facilities of these three airports/airfields. The domestic network of Malaysian Airline System (MAS) in 1984 is shown in Fig. 10.17.

Kerteh Airport, being constructed to support the PETRONAS petrol and gas production, has also began commercial service to Kuala Lumpur since March 1, 1985. The service is by Malaysian Air Charter with its small sized aircrafts in two or three round trips a day.

4.1.1 Kuala Terengganu Airport

The Kuala Terengganu airport, being classified as C3, is one of nine designated major airports in Peninsular Malaysia, according to NASP. It is located 20 km north by road from Kuala Terengganu and provides services of regular commercial flights, oil field supporting helicopters and fixed wing aircrafts and private flights.

The airport had been under an expansion programme which was completed recently. With the completion the airport will fall into the B4 category with the new facilities of a longer runway of 46 m x 2,012 m, stronger runway surface, larger apron and a terminal building. The night landing facility has been delayed until the relocation work of the Esso hangar is completed.

The Malaysian Airline System (MAS) had operated F27 aircraft from Kuala Terengganu to Kuala Lumpur, four flights daily on Tuesday, Wednesday, Friday and Sunday and three flights daily on Monday, Thursday and Saturday, as well as one flight each on Monday, Wednesday and Saturday to Penang and vice versa.

From June, 1984, MAS replaced the F27 flights with B737 aircraft three times a week. However, the schedule will be revised after observing the performance of the jet service.

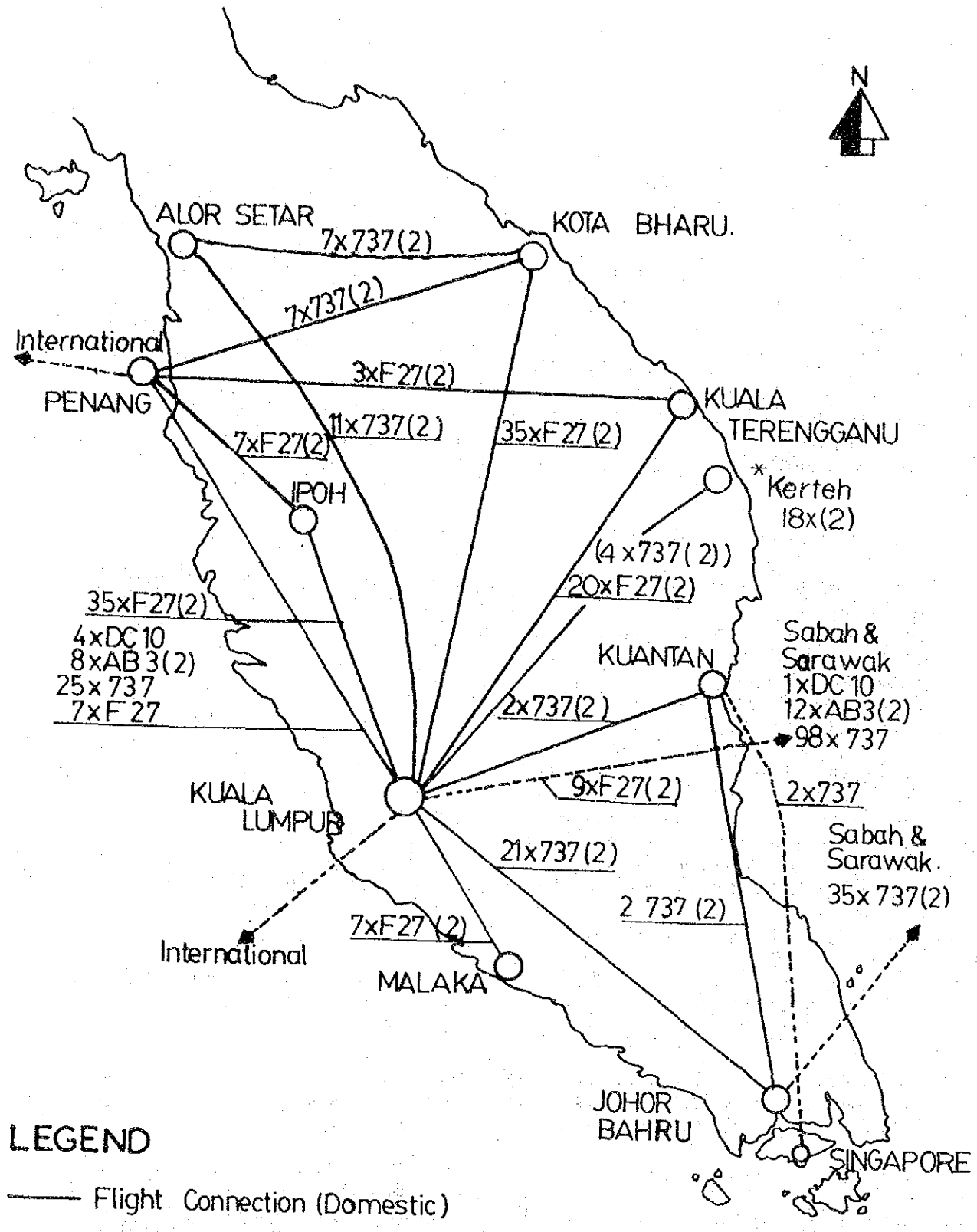
The airport currently serves helicopter transport to and from the offshore oil exploitation sites and PETRONAS complex in Kerteh as well. However, State Economic Development Cooperation (SEDC) has constructing an airfield in Kerteh for the exclusive use of the PETRONAS oil and gas exploitation. Since it was completed, some of these PETRONAS related flights have been transferred to the new Kerteh airfield.

Table 10.21 AIRPORT/AIRFIELD FACILITIES

City	Code	Runway				Operation	Terminal	Navigational Aids	Maximum Landing Capacity
		Length	Width	Stopway	Surface Strength				
Kuala Terengganu									
- Existing	TGG	1,371	36	61/61	Tarmac LCN28	DAY (NIGHT)	(New Terminal) 100-200 persons/h per one way flow	TWR, RS, L	F 27
- After expansion	TGG	1,920	46	61/64	Tarmac LCN50	DAY NIGHT	- ditto -	TWR, RS, NDB	B 737
Dungun	-	366	23	91	Grass (Clay)	DAY	Nil	Nil	Helicopter (Fixed wing not allowed)
Kuantan	KUA	2,804	46	91/61	Tarmac LCN50	DAY NIGHT	100-200 persons/h per one way flow	TWR, APP	B 737

Source : Department of Civil Aviation, Aeronautical Information Service, 24th November, 1983.

Notes : Kuala Terengganu Airport development is nearly complete. Regular flights by B 737 starts from July, 1984.



LEGEND

——— Flight Connection (Domestic)

----➔ Flight Connection (International.)

(2) Indicates Two-way Connection, i.e. Departure & Arrival

Source: Timetable 1984—Malaysian Airline System.

* by Malaysian Air Charter since March 1985.

FIG. 10.17 DOMESTIC FLIGHT NETWORK FOR PENINSULAR MALAYSIA IN 1984

4.1.2 Dungun Airfield

Dungun airfield is designated as one of the ten rural airstrips in Peninsular Malaysia by NASP. But the airfield is at present closed due to hazardous obstruction, according to the Aeronautical Information Service (AIS) of Department of Civil Aviation (DCA), because of restricted approaches due to hills to the south and west. The obstruction mentioned by AIS is a hill at which a quarry site is in operation. In addition, the buildings of the newly constructed Mara Technical Institute close to the southern end of the runway is another obstruction.

Dungun airfield, with only a clay topped 366m x 30 m runway falls into the FO category under the NASP classification system which means it is suitable for the aviation of less than a 10 seater aircraft. There is no terminal building.

4.1.3 Kuantan Airport

The Kuantan airport is also one of the nine major airports in Peninsular Malaysia as designated by NASP. But unlike the Kuala Terengganu airport whose operation is managed by DCA, the Kuantan airport is jointly operated by DCA and Royal Malaysian Air Force. DCA owns the civilian facilities, such as the terminal building, parking apron, etc. The facility of the airport currently falls into the A4 category under the NASP classification system with a runway of 2,804 m x 46 m. B737 or a similar sized aircraft are able to use it. DCA has no plan to carry out further extensions of their facilities, at least for the time being.

MAS is currently operating domestic flight from Kuantan to Kuala Lumpur twice daily and a round trip on Friday and Sunday to Johor Bahru. Most of these flights are made by F27. There are two round trips per week between Singapore by B727 aircraft or a similar type jet flights.

4.1.4 Kerteh PETRONAS Airfield

In addition to these three existing airports/airfields, the PETRONAS is building for its own use a new airport/heliport at Kerteh with cooperation from the State Economic Development Corporation (SEDC).

The main purpose of the Kerteh airport is to support the oil producing activities at about 150 - 200 km offshore of the study area. At present the support operation is from the Kuala Terengganu airport.

The Kerteh airport, completed in September, 1984 as scheduled for Phase A, has a runway 1,100 m long and 30 m wide, a 48 m long parking apron, taxiway, helicopter parking, fixed wing apron, terminal buildings, hangars, fire station, fueling facilities, control tower, etc., according to SEDC.

A regular flight service by Malaysian Air Charter starts in March 1985 with 36 or 28 seat planes for two or three trips a day between Kerteh and Kuala Lumpur.

In Phase B, the runway is to be extended by 300 m. When Phase C, the last phase is completed, the airport will have a 2,000 m runway. The land has already been acquired for this with space for a possible future commercial terminal building. But the exact schedule to commence Phase B and C is not yet fixed.

4.2 Air Transport Statistics

Table 10.22 summarizes the air transport movement of the Kuala Terengganu and Kuantan airports as well as all airports in Peninsular Malaysia. There were both international and domestic flights at each of these two airports. But while most of the domestic flights were scheduled ones, all the international flights are irregular chartered ones. A regular service to Singapore from Kuantan has started early in 1984.

At the Kuala Terengganu airport, the number of passengers on the domestic lines grew by an average of 36% per annum from the figure of 9,680 in 1973 to 155,000 in 1982. The growth rate for the latter half of this period was approximately 10% higher at 42% than the former half of 32%. At the Kuantan airport, the same category grew at an average rate of 13% per annum from 12,000 in 1973 to 37,000 in 1982.

The domestic cargo and mail transport did not grow as steadily as the passenger traffic. In 1982, the cargo transport was 60,000 kg and the mail was 95,000 kg at the Kuala Terengganu airport. The figures at the Kuantan airport were 52,000 kg and 64,000 kg, respectively.

Relatively lower volumes of demand for service at Kuantan than those of Kuala Terengganu comes from the fact that the distance to Kuala Lumpur is only 270 km from Kuantan by road. Savings in travel time at this distance compared to the road travelling is modest. The road distance from Kuala Terengganu is 500 km.

In comparison with the above statistics, the total passengers was found in Peninsular Malaysia of 1982 was 5.2 million out of which the Kuala Terengganu airport shared 3% and the Kuantan airport 0.8%. The passenger vlume increased at an average rate of 12.4% per annum from 1973 to 1982 in Peninsula.

4.3 The National Airport System Plan 1981 (NASP)

NASP covered almost all the airports in Malaysia to study the existing service level and future prospects and recommended the development of each airport up to the year 2000. Table 10.23 presents the summary of NASP recommendations for the Kuala Terengganu, Kuantan airports and the Dungun airfield.

For both of the Kuala Terengganu and the Kuantan airports, the NASP recommendations strongly suggest the introduction of A300 aircraft operation, although they are supposed to remain as domestic airports throughout the forecast period by the NASP (Volume I). However, a regular flight of two trips per week between Singapore by Singapore Airlines started in March, 1984. It is an indication of the direct opening to international airline network from the study area.

Table 10.22 AIR TRANSPORT MOVEMENT AT KUALA TERENGGANU AND KUANTAN AIRPORTS AND IN PENINSULAR MALAYSIA IN 1973 - 1982

Year	Kuala Terengganu Airport								Kuantan Airport								Peninsular Malaysia			
	Aircraft		Passenger		Cargo (1,000 kg)		Mail (1,000 kg)		Aircraft		Passenger		Cargo (1,000 kg)		Mail (1,000 kg)		Air Craft	Pas-senger (1,000)	Cargo (1,000 kg)	Mail (1,000 kg)
	Int.	Dom.	Int.	Dom.	Int.	Dom.	Int.	Dom.	Int.	Dom.	Int.	Dom.	Int.	Dom.	Int.	Dom.				
1973	640	1,376	-	9,680	-	18.4	-	29.8	239	1,102	71	11,988	1.8	27.7	-	21.3	56,546	1,795	8,825	1,864
1974	494	2,788	-	14,466	-	22.6	-	33.7	276	1,212	411	10,924	-	33.1	-	43.3	63,842	2,072	13,999	2,656
1975	N.A.	1,830	257	14,580	-	15.4	1.1	37.3	60	980	452	10,137	-	26.2	-	41.9	63,324	2,194	16,759	2,343
1976	N.A.	744	201	14,091	-	18.1	1.0	42.5	2	852	508	13,126	-	32.9	-	43.9	64,806	2,387	24,002	2,360
1977	N.A.	1,522	324	23,608	-	27.5	1.0	48.2	8	790	159	15,508	9.2	35.7	-	48.1	66,092	2,555	31,184	2,498
1978	N.A.	2,072	257	38,080	-	37.5	1.0	65.3	8	742	254	13,652	-	47.3	-	78.9	69,379	2,806	34,772	3,318
1979	N.A.	2,582	149	31,407	-	40.3	1.0	67.4	8	614	351	10,478	-	34.1	1.0	55.6	76,638	3,153	30,248	3,292
1980	8	7,338	727	54,168	-	49.5	1.1	79.7	2	788	1,536	17,801	-	47.6	0.7	77.2	90,530	3,940	37,512	3,472
1981	8	8,032	766	121,066	-	48.4	1.2	86.5	2	938	4,960	21,273	4.9	37.4	-	70.6	99,448	4,885	38,497	5,474
1982	12	10,446	599	155,043	-	60.4	0.7	94.9	N.A.	1,076	4,715	37,191	6.0	52.2	-	64.4	99,940	5,160	41,627	5,800
1983																				
Average 1973/78	-	8.5	-	31.5	-	15.3	-	17.0	-	-7.6	29.0	2.6	-	11.2	-	29.9	4.2	9.3	31.6	12.2
Annual 1978/82	-	49.8	23.6	42.0	-	12.7	-8.5	9.8	-	9.7	107.6	28.5	-	2.5	-	-4.9	9.6	16.5	4.6	15.0
Growth Rate (%) 1973/82	-	25,3	-	36.1	-	14.1	-	13.7	-	-0.3	59.4	13.4	-	7.3	-	13.1	6.5	12.4	18.8	13.4

Source: Department of Civil Aviation, MOT, Kuala Lumpur.

Table 10.23 APPROVED AND RECOMMENDED DEVELOPMENT PROGRAMMES FOR KUALA TERENGGANU, DUNGUN AND KUANTAN AIRPORTS

Airport	1981 - 1985	1986 - 1990	1991 - 1995	1996 - 2000
Kuala Terengganu				
Expansion Program	o New terminal construction. Runway widening and extension and provision of approach and runway lighting. DVOR/DME and ATC equipment for B737 operations being provided.	o Completion of new terminal and other works.		
	* Installation of ILS on extended runway for B737 operations. Consideration to be given to possible future A300 operations.		* Improvement to building layout and additional terminal capacity required.	
Development Cost ($M)	* 16.5	* 13.6	* 33.3	* 3.7
Dungun				
Expansion Program	* Build new tarmac runway of 854 m x 30 m plus 30 m stopway at each end to cater for F27 operation. Build new terminal building and facilities to handle 0 - 200 pas/hr one way flow passengers.			
Development Cost ($M)	* 2.8			
Kuantan	o Terminal extension in progress.			
Expansion Program	* Early installation of ILS for B737 operations. Consideration to be given to possible future A300 operations.	* Runway strengthening required if A300 operations develop.	* Further extension to terminal building required.	
Development Cost ($M)	* 47.5	* 0.2	* 3.9	* 0.4

Notes: o Current planning proposals or developments in hand.

* NASP's recommendation.

Source: The National Airport System Plan, Vol. 1.

4.4 Recommendations

(1) In order to support the industrial development of the study area, international services at Kuala Terengganu and Kuantan airports are indispensable. The service should be realized in the first half of the 1990s.

(2) The Kerteh airport was orginally designated to serve PETRONAS offshore production activities. Common civil aviation service has been proposed by Malaysian Air Charter from Kuala Lumpur two/three trips daily since March, 1985. The prospect of demand for the service is hard to confirm, but the commercial service should be maintained for the benefit of local people and the support of industrial development of the study area.

5. Ports

5.1 Existing Facilities

Along the coast of the study area, there are a number of small estuaries and river mouths, some of which are used as fishing and local ports. Out of these places, the ports in Dungun and Cukai are major ones, although their services are poor because of sedimentation and the river mouth bar formation.

There are two other ports, outside the study area, which have larger facilities; namely, the port of Kuala Terengganu, one of seven minor ports in Peninsular Malaysia, and the port of Kuantan, one of four Federal ports in Peninsular Malaysia.

Table 10.24 represents the major characteristics of these four ports and Table 10.25 summarizes the vessel movements in 1983.

Table 10.24 MAJOR CHARACTERISTICS OF EXISTING PORTS

Port	Accommodation Limit	Operational Period	Present Operations	Cargo
Kuala Terengganu[1)]	Vessels to 2,000 DWT	Year-round	Regular traffic	Oil, oil products, sawn timber, and fish
Cukai[1)]	Vessels to 500 DWT	Year-round (with occasional drift)	Regular traffic	Timber, palm oil crude & products
Dungun[1)]	Vessels to 100 DWT	Non-monsoon	Small fishing vessels	Fish, palm oil, and logs
Kuantan[2)]	Vessels to 35,000 DWT	Year-round	Regular traffic including ocean-going vessels	General commercial goods as a major international port

Source : 1) Terengganu Coastal Regional Study.
2) The Port of Kuantan Authority.

Table 10.25

VESSEL MOVEMENT AT THE PORTS OF KUALA TERENGGANU, DUNGUN, CUKAI AND KUANTAN IN 1983 (1/2)

Port	Type[2]	1983											
		January		February		March		April		May		June	
		V[2]	T[2]	V	T	V	T	V	T	V	T	V	T
Kuala[3] Terengganu and Oil Rig.	1	18	551.6	23	864.2	16	502.5	29	916.7	55	1,411.2	63	980.1
	2												
	3	53	15.0	63	18.3	56	16.2	76	27.8	95	74.5	82	24.6
	4	6	0.1	10	0.1	14	0.1	28	1.2	22	0.1	13	0.6
	5							3	0.1	4	0.1	2	0
	Total	77	566.7	96	882.6	86	518.8	136	945.8	176	1,485.9	160	1,005.3
Dungun and Kerteh Oil Jetty	1									18	3,7	4	88.7
	2												
	3	6	1.0	6	1.0	6	1.0	6	1.7	7	1.0	6	1.0
	4							6	0				
	5												
	Total	6	1.0	6	1.0	6	1.0	12	1.7	25	4.7	10	89.7
Cukai and Tanjong Berhala Supply Base	1									6	32.1	2	6.0
	2	36	30.2	34	17.2	77	24.3	72	22.5	80	39.1	75	22.3
	3												
	4											6	0.1
	5			6	0.2	4	0						
	Total	36	30.2	40	17.4	81	24.3	72	22.5	86	71.2	83	28.4
Kuantan (Tanjong Gelang)	1	20	56.3	20	93.3	25	85.2	26	108.1	24	83.7	18	88.7
	2												
	3	48	25.3	47	12.7	64	26.6	57	31.0	59	23.1	41	17.6
	4	19	0.2	23	0.4	20	0.3	29	0.7	28	0.1	16	0.3
	Total	87	81.8	90	106.4	109	112.1	112	139.8	111	106.9	75	106.6
Gross Total:		206	679.7	232	1,007.4	282	656.2	332	1,109.8	398	1,668.7	328	1,230.0

Notes : 1 - The table shows the total of entering and leaving vessels by type 1 : Foreign Going, 2: Home Trade, 3: Local Trade, 4: Less than 75 ton, and 5: Native Craft.

2 - V represents the total number of entering and leaving vessels and T represents the total tonnage of those vessels in 1,000 tons.

3 - All vessel movements at the offshore oil rig are included.

Talbe 10.25

VESSEL MOVEMENT AT THE PORTS OF KUALA TERENGGANU, DUNGUN, CUKAI AND KUANTAN IN 1983 (2/2)

Port	Type[1]	1983												Grand Total	
		July		August		September		October		November		December			
		V[2]	T[2]	V	T	V	T	V	T	V	T	V	T	V	T
Kuala[3] Terengganu and oil Rig.	1	42	791.3	36	886.2	47	654.6	45	908.8	17	488.8	4	117.7	395	9,073.7
	2														
	3	76	27.3	104	20.3	68	24.3	64	20.0	54	15.7	50	12.6	841	296.6
	4	23	0.8	26	0.5	31	14.4	24	0.2	14	0	2	0	213	18.1
	5							5	0.1					14	0.3
	Total	141	819.4	166	907.0	146	693.3	138	929.1	85	504.5	56	130.3	1,463	9,388.7
Dungun and Kerteh Oil Jetty	1	6	1.6	8	1.8	10	0.2	18	3.8	16	390.0	12	351.5	92	841.3
	2														
	3	6	1.0											43	7.7
	4													6	0
	5														
	Total	12	2.6	8	1.8	10	0.2	18	3.8	16	390.0	12	351.5	141	849.0
Cukai and Tanjong Berhala	1	6	49.5			20	37.3	63	24.4	32	33.4	14	20.8	143	203.5
	2	79	28.9	97	50.5	91	45.3	16	11.4	75	16.3	74	18.6	806	326.6
	3														
	4							22	0.1					28	0.2
	5	2	0							2	0			14	0.2
	Total	87	78.4	97	50.5	111	82.6	101	35.9	109	49.7	88	39.4	991	530.5
Kuantan (Tanjong Gelang)	1	35	277.7	13	53.0	37	107.0	24	108.0	31	137.7	22	69.4	295	1,268.1
	2														
	3	44	16.3	45	20.4	44	16.3	63	30.1	58	24.5	33	11.6	603	255.5
	4	15	0.2	22	0.3	24	0.2	30	0.3	14	0.4	14	0.6	254	4.0
	5											1	0	1	0
	Total	94	294.2	80	73.7	105	123.5	117	138.4	103	162.6	70	81.6	1,153	1,527.6
Gross Total:		334	1,194.6	351	1,033.0	372	899.6	374	1,107.2	313	1,106.8	226	602.8	3,748	12,295.8

Notes : 1 - The table shows the total of entering and leaving vessels by type 1: Foreign Going, 2: Home Trade, 3: Local Trade, 4: Less than 75 ton, and 5: Native Craft.
2 - V represents the total number of entering and leaving vessels and T represents the total tonnage of those vessels in 1,000 tons.
3 - All vessel movements at the offshore oil rig are included.

Source : Harbour Master, Kuala Terengganu, Monthly Report of Marine East Coast'.

The port of Dungun is located at the south bank of the Sungai Dungun and is a typical river mouth port. The port serves at present for the landing of fish which are locally consumed. In addition, there is a small movement of lightering logs to ocean going vessels. But activities are reducing during the monsoon season as is apparent in Table 10.25.

The port of Cukai is located at the south bank of the river mouth where Sungai Cukai meets with Sungai Kemaman. As shown in Table 10.24, the serviceability of the port is larger than Dungun. Dungun Port faces a similar sedimentation problem as in other ports of the study area.

The port of Cukai is operational all year round due to good natural protection, except occasional drift restrictions at the river mouth, according to TCRS. The vessel movement of the port of Cukai is approximately seven times larger than that of the port of Dungun. The reduced activities during the monsoon season are shown in Table 10.25.

The port of Kuantan which is situated some 30 km south of the study area started providing service in 1983 with a capacity of catering for vessels of up to 35,000 dwt. It has a quaywall of 725 meters long consisting of three conventional berths, one container berth 250 meters long and a tanker berth completed in 1984. The port basin is well protected by a north-south break water and has a draught of 11.5 meters at low tide, according to the Port of Kuantan Authority. Being designated as one of four Federal ports, this port is expected to play an important role in the international trade of the east coast.

The port of Kuala Terengganu, designated as one of seven minor ports in Peninsular Malaysia, has a capacity to serve vessels up to 2,000 dwt. The port is situated at the river mouth and the south bank of Sungai Terengganu and is facing a serious sedimentation and entrance bar problem. A draught of 3.5 meters at high tide was cleared by the dredging service of the Maritime Division, Ministry of Transport. The harbour office in Terengganu completed a capital dredging of 750,000 cubic meters and is carrying out maintenance dredging of 300,000 cubic meters per annum. The Maritime Division is constructing another dredger to service the east coast.

5.2 On-going Development

There is a significant development carried out at present the Tanjong Berhala Port, approximately ten kilometres north of Cukai. It has three berths which are the supply base, the east wharf and the LPG jetty. The supply base has a 300 meters quaywall and a turning basin of 400 meters diameter with a draught of nine meters serving vessels up to 35,000 dwt. It has already started providing services to the support activities for offshore oil rigs and, in the meantime, it is used for the landing of construction materials in the development of the nearby Telok Kalong industrial estate.

The east wharf, mostly completed by the end of 1984, will be used for the import of iron ore to be consumed by Perwaja steel billet mill. The capacity of Phase I will be 60,000 dwt with a draught of 16 meters, while it is planned in Phase II to serve for 130,000 dwt with a draught of 19 meters.

A channel is to be built at an initial cost of 70 million Ringgit to approach the port with the expected annual maintenance dredging of 150,000 cubic metres[4].

The LPG jetty will be used by PETRONAS for the export of LPG. It will be a 290 meters long jetty and 1,300 meters long breakwater and will have a draught of 14 meters for vessels of up to 40,000 dwt.

The total cost of construction is expected to be in the order of 330 million Ringgit[5]. The port covers a total area of approximately 20 hectares. When enlarged to the capacity of 130,000 dwt, it will become the largest port in the country.

5.3 Recommendations

(1) In considering the facilities in the ports of Kuala Terengganu, Tanjong Berhala and Kuantan, there will be no need to construct a new port for ocean-going vessels. These ports will meet the requirements of the economy of the study area. In the case of the Tanjong Berhala Port, the request by some plants located in Telok Kalong to use it will be raised sometime in the future, although it is a purpose built port. The port should meet these requests because its service is a prerequisite for the development of the Telok Kalong Industrial Estate.

(2) The ports of Cukai, Dungun and other small ones, mostly serve the fishing industry and a small amount of cargo movement. The development of road network and lorry service have shown an advantageous service for cargo movement when compared with the coastal marine transport system, which has problems such as siltation, monsoon, and inadequate port facilities.

It is considered that the ports in the study area should be maintained with proper dredging and river improvement. In addition, jetties and/or wharves should be constructed for fishery service and other minimum necessities. However, the requirement for extensive investment in these ports will not arise in the near future, as far as the recommended functions, shown in Table 10.26 can be maintained properly.

Source : 4) The Dredging Requirement within Peninsular Malaysia, 1982, Maritime Department.

5) By SEDC.

Table 10.26 RECOMMENDED FUNCTIONS OF MAJOR PORTS

Ports	Accommodation Limit (dwt) of largest Vessel	Operational Period	Recommended Functions	Major Cargoes
Tanjung Berhala	130,000 (after Phase II)	Year-round	Restricted port for petroleum supply, iron ore landing and LPG storage and shipping.[1)]	Oil and oil products, raw materials for heavy industries.[1)]
Cukai	500	Year-round but with occasional draft restrictions.	Localized port.	Fish, timber, log, etc.
Dungun	100	Non-monsoon	Localized port.	Fish and logs.

Notes : 1) The service should be widened to export/import by ocean going vessels from the Telok Kalong Industrial Estate and the study area.

6. Railways

The east-West railway line expected to go through the study area is now under planning by the Malaysian Government. However, the plan and programms are not concrete enough to be incorporated in the sub-regional plan. Therefore, the railway plan and its impact on the study area are shown in conceptual aspects.

A feasibility study has been undertaken by the Malaya Railway Authority and a JICA study team on the east-west lines passing through the area. The final results of the viability is said to be shown in late-1985. However, the Malaysian Government has decided a railway construction plan as follows (according to the letter of EPU on September 14, 1984):

(1) The initial phase of implementation would connect
Port Kelang == Kuala Lumpur == Janda Baik - Temerloh
Kuantan - Cukai - Paka

(2) The schedule of implementation has not been decided yet.

(3) A provisional alingment was discussed between the Malaya Railways Authority (MRA) and the Terengganu State on which the feasibility study is being carried on.

The provisional alignment is shown in Fig. 10.2 of this chapter. The rilway is proposed to run along the western side of Route III, with railway stations of Cukai, Kerteh Paka and Dungun, and a branch line to Telok Kalong industrial estate. If may also provide cargo service station in the Kerteh industrial estate.

Railway station at Cukai and Dungun will be located a few kilometre away from the town centre. The location has a close relationship with the urban development plan in the following aspects.

- Land use
- Urban road network
- Infrastructure plans, particularly in drainage system
- Access services in transport and communication

The above aspects were studied in the conceptual urban structure plan in chapter 9 of Technical papers and in the main report.

CHAPTER 11

FLOOD CONTROL AND DRAINAGE

CHAPTER 11 FLOOD CONTROL AND DRAINAGE

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CHAPTER 11 FLOOD CONTROL AND DRAINAGE

1. Scope of the Study

1.1 Purpose of the Study

The south Terengganu area is exposed to heavy rainfalls during the monsoon season. The downstream areas of the River basins are low and flat. Under these natural conditions, development of agriculture, forestry, industries, etc. have been carried out and also planned for both upstream and downstream areas of the rivers.

River flow will be affected by the developments, which will be affected by the river flow, especially in the case of the low and flat areas. Whilst the river improvement or water resources development takes a long time, developments occur rapidly. Therefore, problems especially of flooding become serious as developments grow.

In the study area, the flood problem is more serious than that of water use because of large volume of low flow rates in the rivers, and natural conditions described above.

Methods of solution to the flood problems in relation to the developments are the main thrust of studies in order to minimize flood damage.

1.2 Study Items

(1) Water Use

- Countermeasures against salinity intrusion at the intakes.

(2) Flood

- Information for landuse, such as, necessary land requirements for river improvements in the future, and land classification from the viewpoint of potential flooding.
- A master plan for long and short ranges in mitigating flood damage.
- Sedimentation in the rivers

The river mouth sedimentation problem is to be included in the river improvement study. Beach erosion at dungun is to be studied together with the river mouth study of the river.

1.3 Reports and Data

(1) Locations

The area concerned with the studies for water resources and flooding are the river basin areas lying between Sungai Dungun and Sungai Kemaman. The beach erosion problem at Dungun is included in this study. Locations of the rivers are shown in Fig. 11.1.

(2) Previous Study Reports

Major studies concerning water use, flood, estuary and coast have been performed by various agencies, which reports are shown below:

1) Terengganu Master Plan Study, 1983 - TMPS

2) National Water Resources Study Malaysia, 1982 - NWRSM

3) Water Resources Development for Domestic and Industrial Water Uses in the South Terengganu Region, 1981 - SCTWR

4) Terengganu Coastal Region Study, 1980 - TCRS

For studies on the rivers and coastal areas, these reports include the following contents:-

- Natural features of the study area - (4)
- River mouth sedimentation of the rivers and beach erosion at Dungun - (4)
- Prediction of water requirements - (1),(2),(3)
- Problems of water supply - (1),(2),(3)
- Landuse, etc. - (1),(4)
- Water use including ground water - (2),(3)
- Profiles of the rivers - (2),(3),(4)
- Flood damage and flood prone areas - (2),(3)
- Overall study and recommendations for water resources development, flood mitigation and the costs - (1),(2),(3)
- Water quality - (2),(3)
- Drainage - (1),(3),(4)
- Overall hydrological analysis - (2),(3)
- Other general information - (1),(4)

(3) Available Data

1) One inch to a mile topographic map, 1972

2) Rainfall intensity duration curves, DID

3) Daily rainfall in the study area, 1959-1979, DID

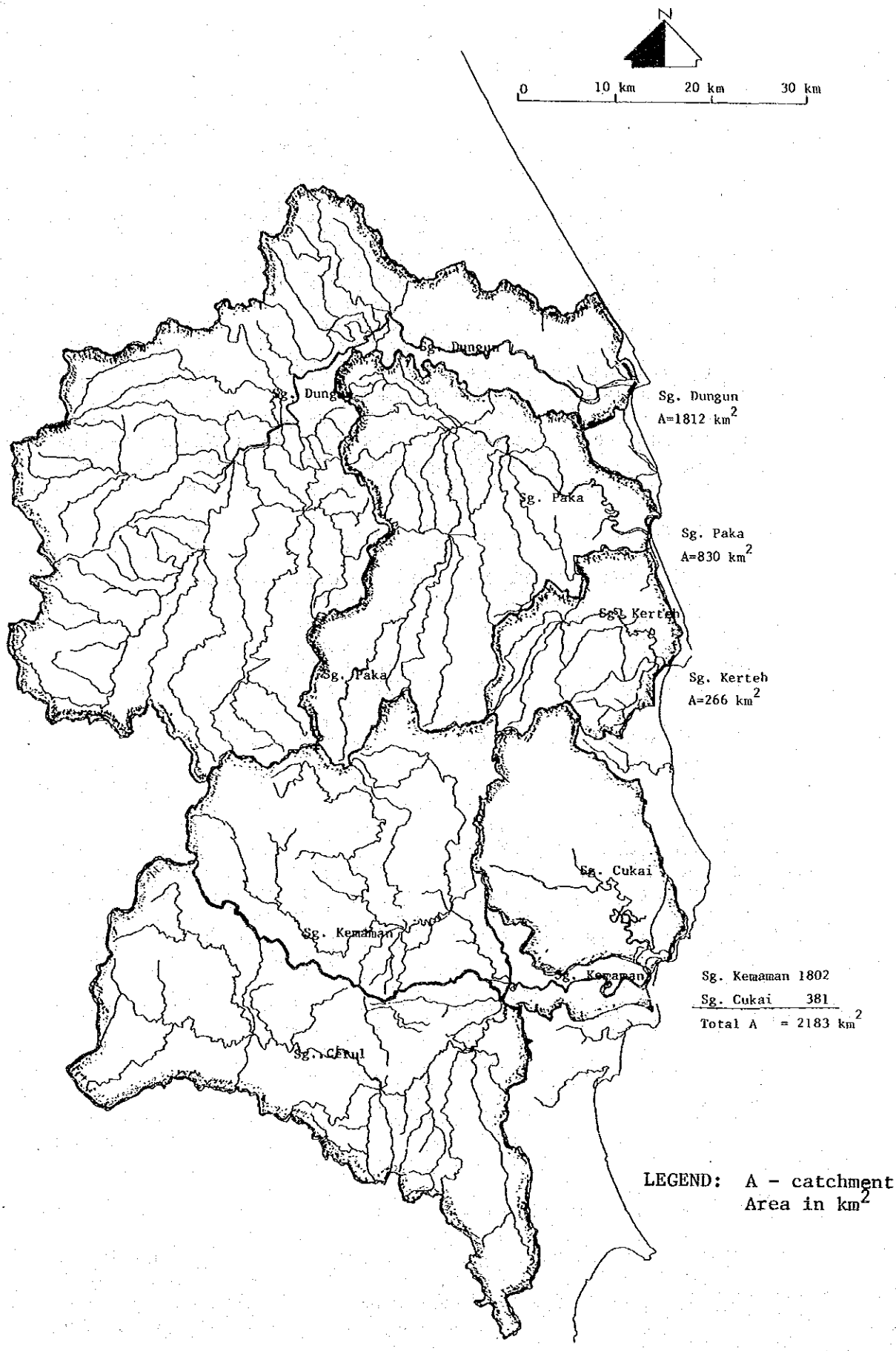


FIG. 11.1 LOCATIONS OF THE RIVERS

4) Daily discharge of Sungai Dungun and Sungai Kemaman, 1975-1981, DID

5) Results of hydrological analysis (Hydrological Procedure No. 1, 4, 11 etc.), DID

6) KETENGAH Area Landuse Plan, KETENGAH Headquarters

7) Marine Charts, London, Published by the Admiralty

8) Wind and wave data, Kuantan and Kuala Terengganu Ports, analyzed by the Meteorological Dept.

9) One inch to three miles Landuse Map, National Mapping.

10) Tide Table, 1984, Port Authority Terengganu, Marine Dept.

11) Cukai Flood Mitigation Study, 1978, DID

12) Lapuran Banjil 1983 Untuk Negeri Terengganu, DID

2. Existing River Conditions

2.1 The River Basins

Existing conditions of the rivers were have been explained in the reports (1) - (4). Main characteristics of the river basins in relation to the river planning are summarized below based on the reports, data and the field reconnaissance.

(1) Topography and Geology

The western half of the study area are mountainous with the highest eastern ridge of Mt. Andi Angin (EL. 1,460m). The eastern half is featured by low hills, rolling plains and swamps. Major geological members are carboniferous and granitic rocks in the hilly or mountainous area, and alluviums in the low area along the coast.

(2) Catchment Area

The River	Catchment Area (km^2)
Sungai Dungun	1,812
Sungai Paka	830
Sungai Kerteh	266
Sungai Kemaman and Cukai	2,183

Source: Measured from the 1 inch to a mile map.

(3) Landuse

The total forest area decreased from 10,093 sq.km or 78% of the whole State in 1966 to 6,608 sq.km or 51% in 1979 by forest exploitation not only for logging purpose but also for execution of agricultural land development schemes. Major landuse patterns in 1979 were forests of 6,608 sq.km, grassland of 280 sq.km, annual and perennial crop land of 1,777 sq.km, swamp of 1,080 sq.km and miscellaneous land of 3,218 sq.km in the State.[1)]

The towns of Dungun, Paka, Kerteh, Kemasik, Kijal and Cukai are located along the coastal area.

(4) Run-off

Climate is usually hot and wet. Average annual rainfall is high of 2,500mm - 3,000mm, of which 50% occurs in November to January, being strongly affected by the northeast monsoon.

Run-off in rivers wholly or partially located in the State of Terengganu is estimated based on the 1961 - 1979 records at the hydrological station No. 5130432 in the Terengganu river.[2)] The surface run-off is 25 billion cu.m/y or 58% of the rainfall of 43 billion cu.m/y. Evapotranspiration is 16 billion cu.m/y and groundwater recharge is 2 billion cu.m/y.

Source: 1) and 2) State Report Vol. 7, NWRSM.

2.2 River Channels

Longitudinal profiles for the Dungun and Kemaman Rivers are shown in NWRSM. River conditions and cross-sections for the Dungun, Paka and Kemaman Rivers are contained in SCTWR.

According to these data, downstream reaches of about 20km from the river mouth are almost flat with riverbed slope of about 1/5000.

Cross-section of the Rivers

Downstream[3)]

River	Width (m)	Depth (m)
Dungun	150 - 240	6 - 9
Paka	90 - 100	6 - 9
Kemaman	130 - 150	4.5 - 6
Cukai	140 - 145	8

Riverbed materials are mostly sand. High concentrations of suspended solids inflow to the rivers are seen during rainfall from developed and developing areas and the deteriorated portion of fill and cut along the roads.

2.3 River Usage

Usage of the rivers in the Study Area are summarized as follows:

- Navigation and ports are mainly for fishing in the river mouth.
- Navigation by small boats for transportation from kampung to kampung in the upstream reaches.
- Intakes for domestic and industrial water supply.
- Washing (laundry and bathing)
- Recreation (swimming, sport, fishing, etc.)

2.4 Flood Damage

Floods in the Terengganu State, during the past twenty years, have occurred about once every two years and once every three years with heavier damage. Flood damage has increased in proportion with the development in agricultural and urban areas. Landuse in the flooded areas by river basin are shown in a previous study which are summarized in Tables 11.1 and 11.2.

Source: 3) SCTWR

Since water depths during the floods are deep and last for more than several days, all human activities are greatly affected. During the Deember 1983 flood, traffic on the road from Kuantan to Kuala Terengganu was suspended for about two weeks. Though studies on flood have been carried out, countermeasures (such as storage of flood water, river improvement, etc.) have not been implemented except for some flood warning facilities. Main reasons for flooding are considered as follows:

- Back water from the main stream
- Inadequate drainage
- Development in the flood prone areas
- Deposition of silt in the river due to soil inflow from developing areas
- River mouth sedimentation
- Heavy rainfall and flat topography
- Effects of development in the hilly area on run-off

Table 11.1 LANDUSES IN THE RIVER BASINS

River Basin(s)	Paka	Dungun	Kemaman, Kemasik, Kerteh
Landuse (1000 ha)			
- Urban Area	-	-	0.1
- Mining	-	-	0.2
- Mixed Horticulture	-	0.4	1.4
- Rubber	0.5	1.0	1.6
- Oil Palm	-	0.7	0.2
- Coconut	0.1	-	0.1
- Other Crops	-	-	-
- Pady	0.1	1.3	0.8
- Pasture/Grassland	0.2	0.3	0.2
- Forest Land	1.6	10.0	6.2
- Swamp	4.2	7.8	20.7
- Unused Land	-	-	-
- Total Flood Area	6.7	21.5	31.5
Road in Flood Area (km)	2	11	34.0
No. of People (10^3) Affected by Flooding	0.5	7.9	26.8

Source: State Report Vol. 7, NWRSM

Table 11.2 FLOODED AREA BY RECORDED MAXIMUM FLOOD IN TERENGGANU

River Basin	Year	Flood Area (km^2)	Population 1980 (10^3)	Estimated Damage at 1980 Condition (M$$10^6$)
Kemaman	1972	265	25	3.7
Kemasik	1972	11	-	0.1
Kerteh	1973	59	1	0.1
Paka	1973	47	1	0.1
Dungun	1973	220	8	1.3
Total:		602	35	5.3

Source: State Report Vol. 7, NWRSM

3. Flood Study

3.1 Flood Characteristics

According to the flood level data of the Dungun and Kemaman Rivers, the highest flood levels are from five to ten metres above ordinary water levels. In the low areas along the rivers, ground elevations are only two or three metres above ordinary water levels. Therefore, flood depths in the low areas are large, and in addition flood durations are long. (Refer to Figs. 11.2 - 11.13)

These phenomena are attributable to the factors described below:

- Total rainfall in monsoon season is large and incessant.
- Storage volume of flood waters is large because of the vast forest coverage and swamps in the river basins.
- Flood flow capacities of the channels are limited by river widths because of the trees and grass on the river banks. (Refer to Fig. 11.5.)
- Topography (gentle slope)
- Other obstacles against flood flow such as narrow bridges, flotsam, houses, etc.
- River mouth sedimentation.

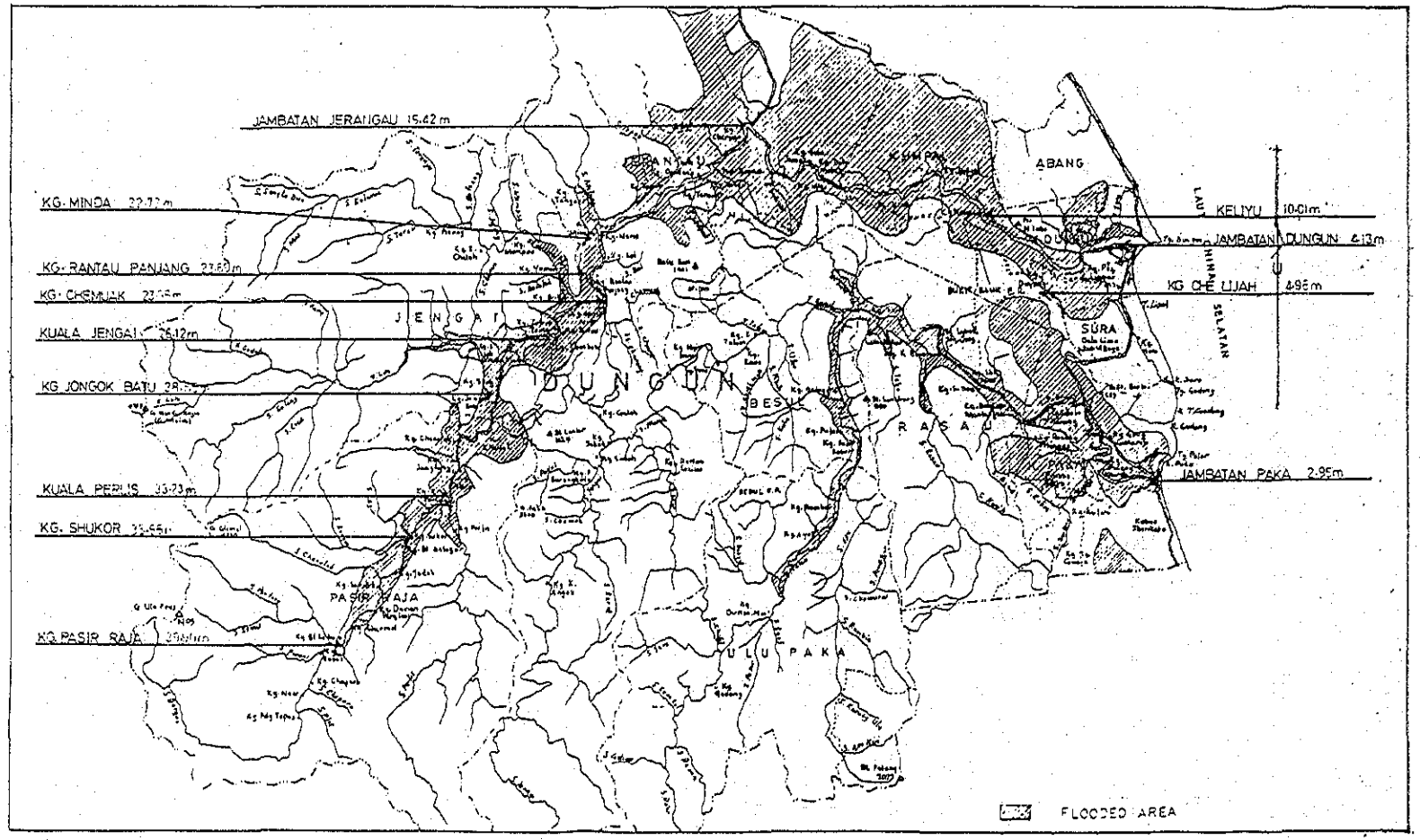


FIG. 11.2 FLOODED AREA, DUNGUN DECEMBER 1983

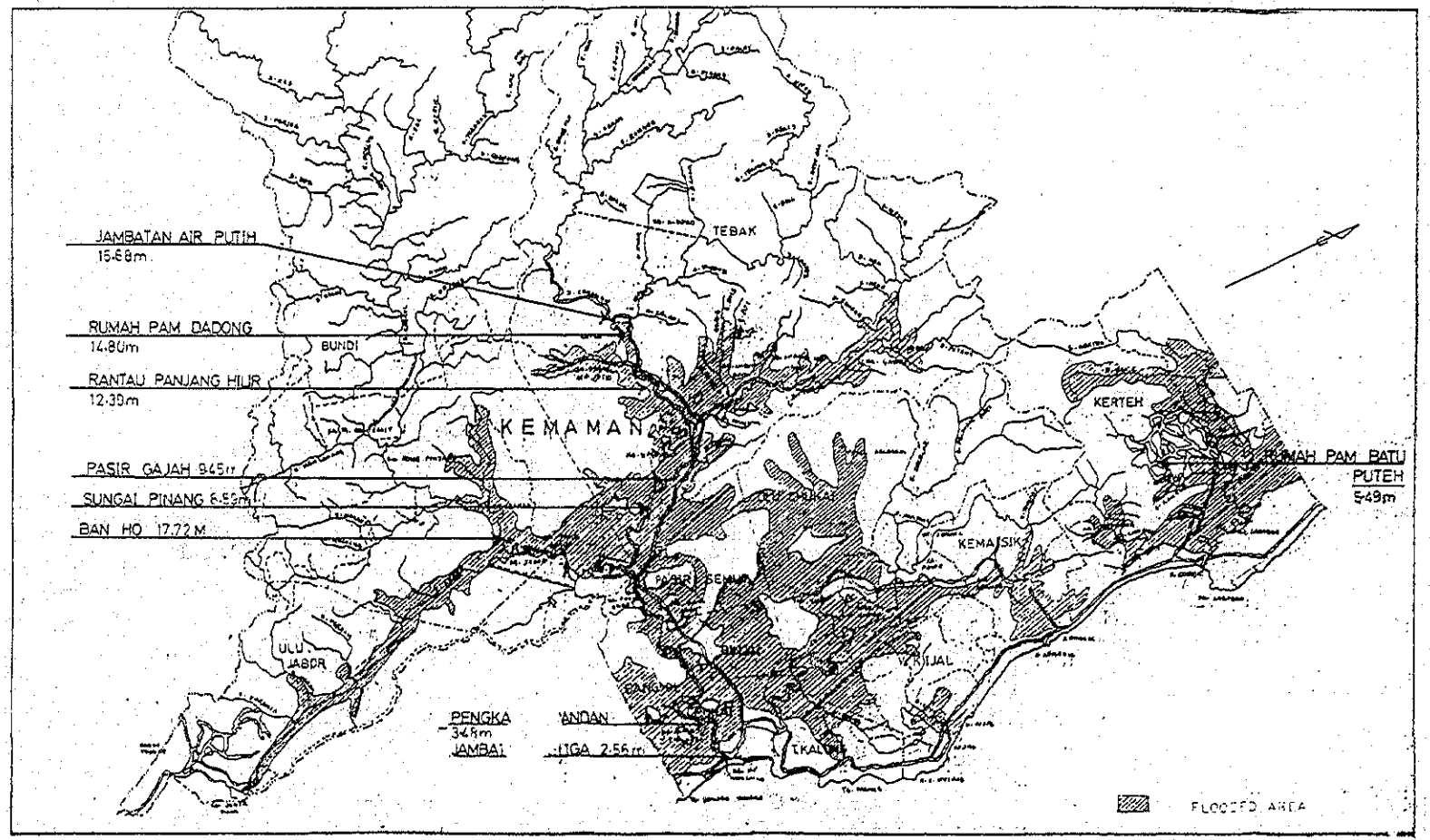
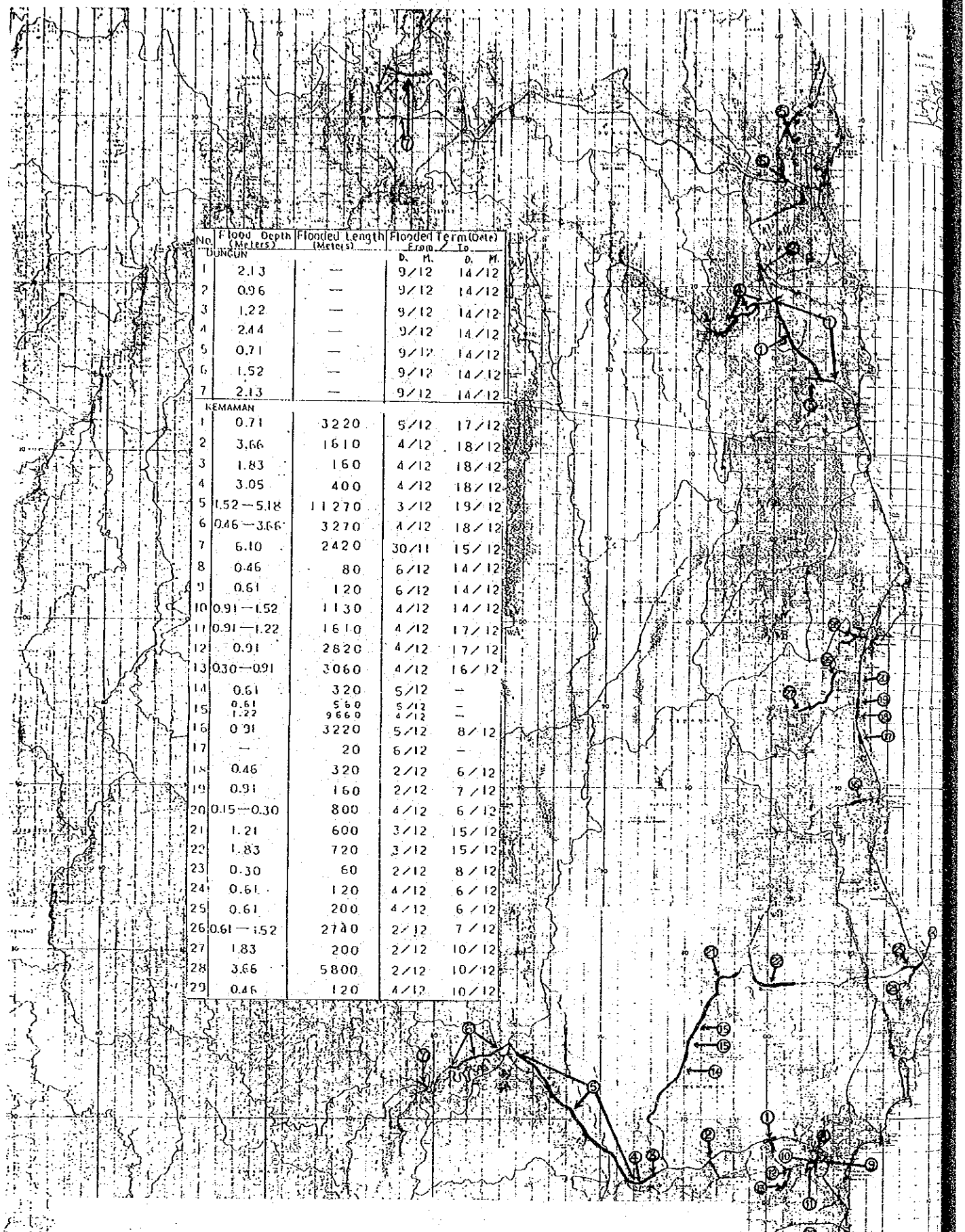
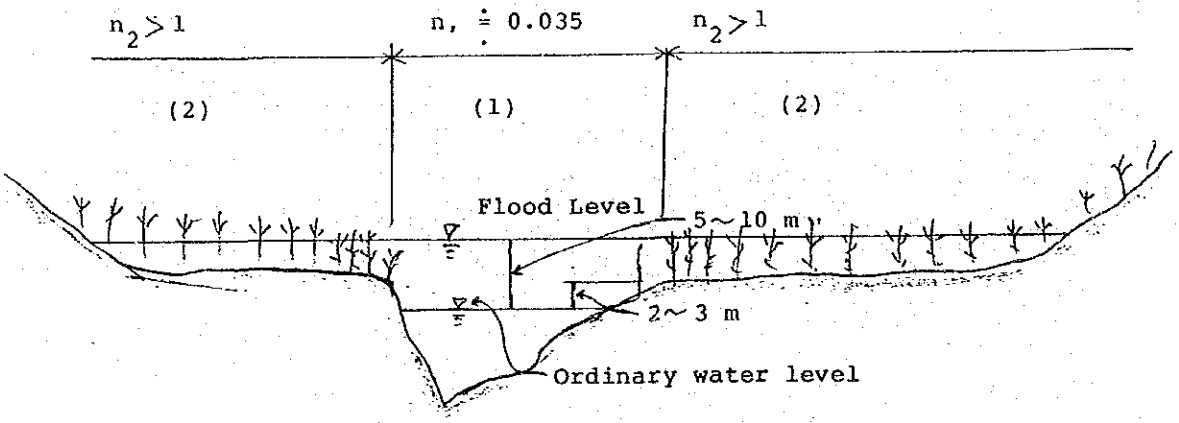


FIG. 11.3 FLOODED AREA, KEMAMAN DECEMBER 1983



No.	Flood Depth (Meters)	Flooded Length (Meters)	Flooded Term (Date) From D. M.	To D. M.
DUNGUN				
1	2.13	—	9/12	14/12
2	0.96	—	9/12	14/12
3	1.22	—	9/12	14/12
4	2.44	—	9/12	14/12
5	0.71	—	9/12	14/12
6	1.52	—	9/12	14/12
7	2.13	—	9/12	14/12
KEMAMAN				
1	0.71	3220	5/12	17/12
2	3.66	1610	4/12	18/12
3	1.83	160	4/12	18/12
4	3.05	400	4/12	18/12
5	1.52—5.18	11270	3/12	19/12
6	0.46—3.66	3270	4/12	18/12
7	6.10	2420	30/11	15/12
8	0.46	80	6/12	14/12
9	0.61	120	6/12	14/12
10	0.91—1.52	1130	4/12	14/12
11	0.91—1.22	1610	4/12	17/12
12	0.91	2820	4/12	17/12
13	0.30—0.91	3060	4/12	16/12
14	0.61	320	5/12	—
15	0.61 1.22	560 9660	5/12 4/12	— —
16	0.91	3220	5/12	8/12
17	—	20	6/12	—
18	0.46	320	2/12	6/12
19	0.91	160	2/12	7/12
20	0.15—0.30	800	4/12	6/12
21	1.21	600	3/12	15/12
22	1.83	720	3/12	15/12
23	0.30	60	2/12	8/12
24	0.61	120	4/12	6/12
25	0.61	200	4/12	6/12
26	0.61—1.52	2740	2/12	7/12
27	1.83	200	2/12	10/12
28	3.66	5800	2/12	10/12
29	0.46	120	4/12	10/12

FIG. 11.4 LOCATION OF ROADS FLOODED, DECEMBER 1983 FLOOD



$$Q = \frac{1}{n} R^{2/3} I^{1/2} A$$

$$Q \propto \frac{1}{n}, R^{2/3} \qquad R_2 \doteqdot H_2$$

$$H_1 > H_2 \quad . \quad \frac{1}{n_1} \gg \frac{1}{n_2}$$

$\therefore Q_1 > Q_2$ in most cases of natural rivers.

Therefore, flood flow capacity in (2) zone is small despite its large flow area.

FIG. 11.5 FLOOD FLOW CAPACITY

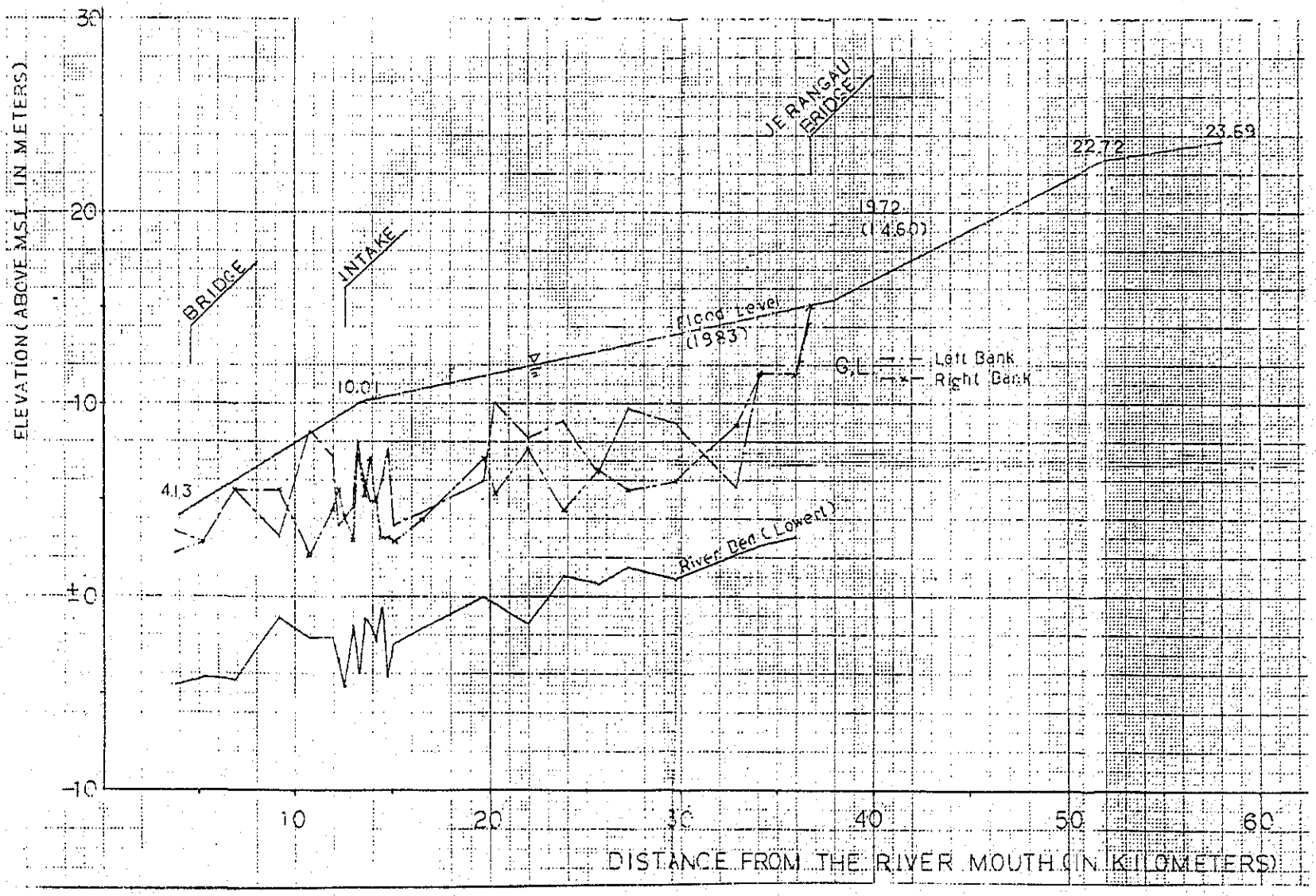


FIG. 11.6 LONGITUDINAL PROFILE ALONG THE DUNGUN RIVER

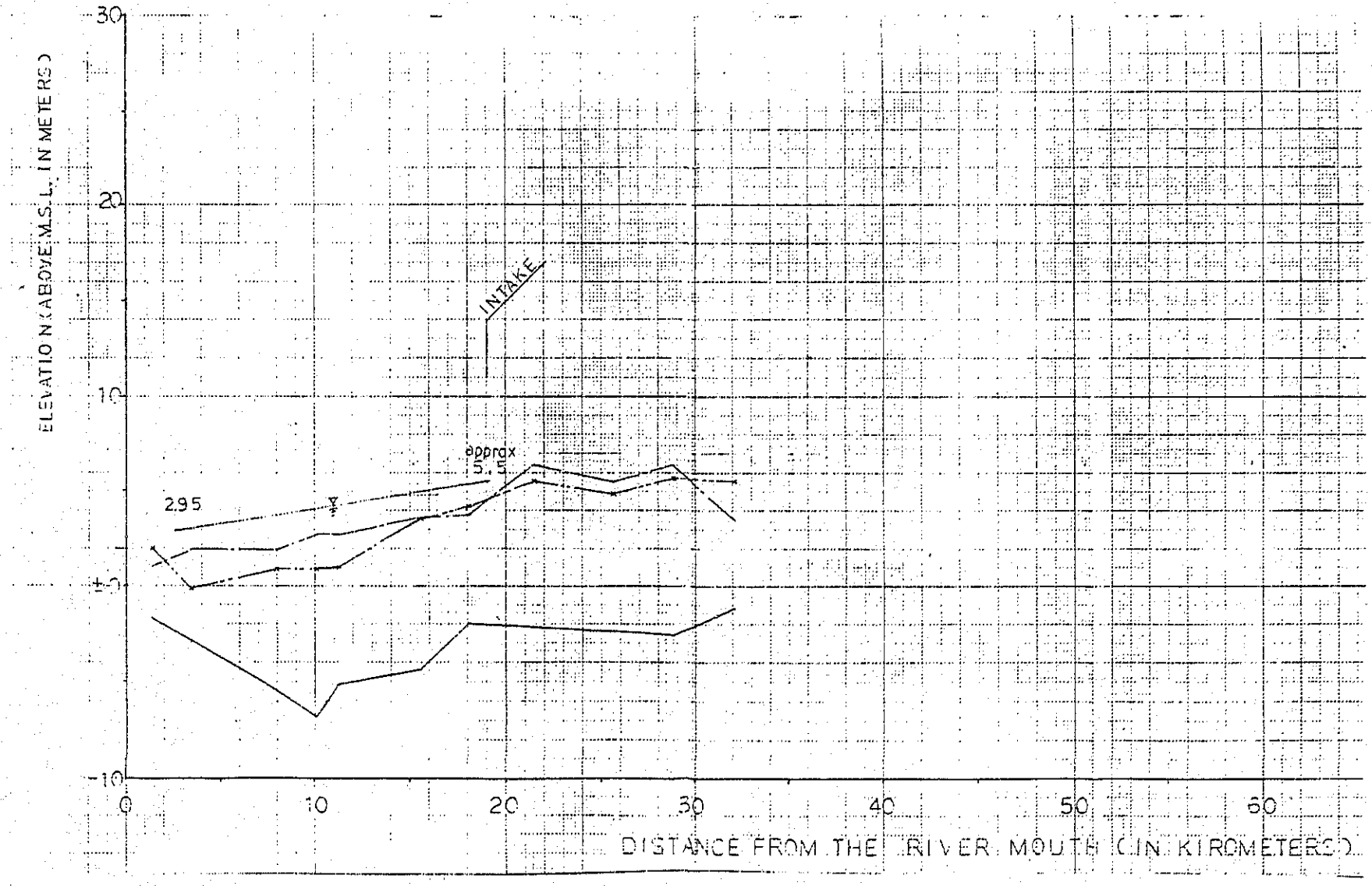


FIG. 11.7 LONGITUDINAL PROFILE ALONG THE PAKA RIVER

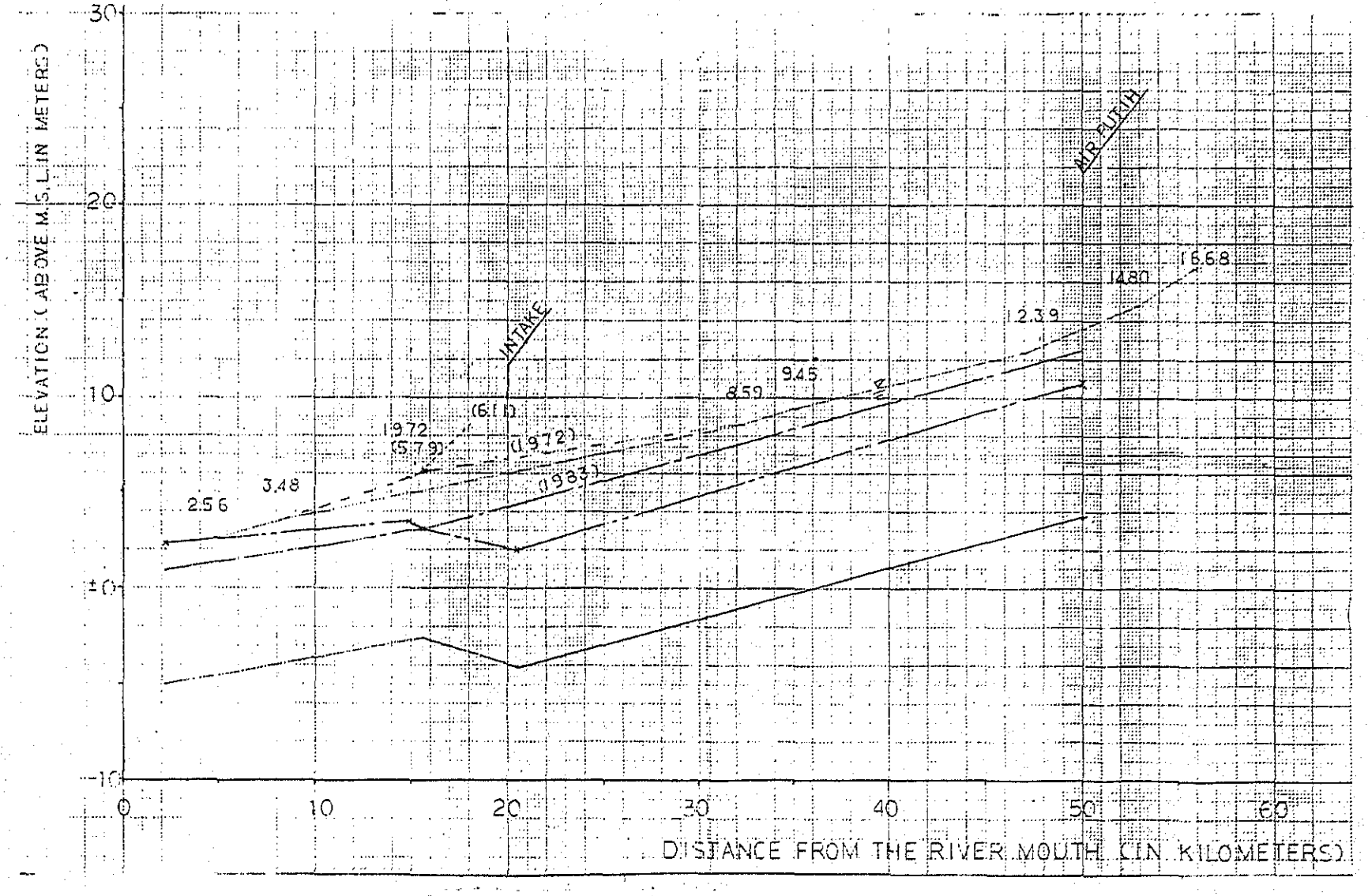


FIG. 11.8 LONGITUDINAL PROFILE ALONG THE KEMAMAN RIVER