iv) Future population in the hinterland

The TPZ (timber processing zone) proposed by the STIDC includes residential estate development. The expected population is as shown in **Table-4.1.2.11.** STIDC expects this population to come from the third, sixth and seventh divisions. Consequently, the population of Sarikei district will increase while other districts will see declines.

Table-4.1.2.11 Population and Employment of The Timber Processing Zone

Year	Population	Emmployment
1997	14,600 - 20,000	5,600 - 6,200
2010	20,700 - 26,500	8,000 - 11,700

Source: STIDC

(4) Conclusion

The forecast populations of each district are tabulated in **Table-4.1.2.12** and **Figure-4.1.2.2** (details of the forecast are shown in **Appendix-II.4.1.2**).

The population of each district in 1997 (target year for the short-term plan) can be forecast by interpolation of the projected populations in 1995 and 2000.

Table-4.1.2.12 Population Forecast up to 2010, Hinterland

year / DISTRICT	1947	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Betong	25	28	32	35	37	39	44	48	53	59	66	73
Saratok	21	25	27	30	33	36	40	44	48	53	59	65
Sibu	50	77	88	98	119	139	155	171	184	201	221	237
Mukah	21	24	27	29	32	36	39	43	46	51	56	61
Kanowit	14	21	24	26	27	29	33	38	41	45	50	54
Dalat	13	15	16	18	20	22	24	26	28	31	34	37
Sarikei	24	28	31	34	39	44	48	52	71	82	89	96
Maradong	19	21	23	25	27	29	31	34	36	40	44	48
Daro	10	13	14	14	16	18	20	22	23	26	28	31
Julau	13	20	21	22	25	28	32	35	38	42	48	52
Kapit	19	25	27	30	34	38	43	47	52	56	63	69
Song	8	11	12	14	15	17	19	21	22	25	28	31
Belaga	5	6	6	7	9	12	13	15	17	18	21	23
Total	242	314	349	382	434	486	541	596	659	729	807	877

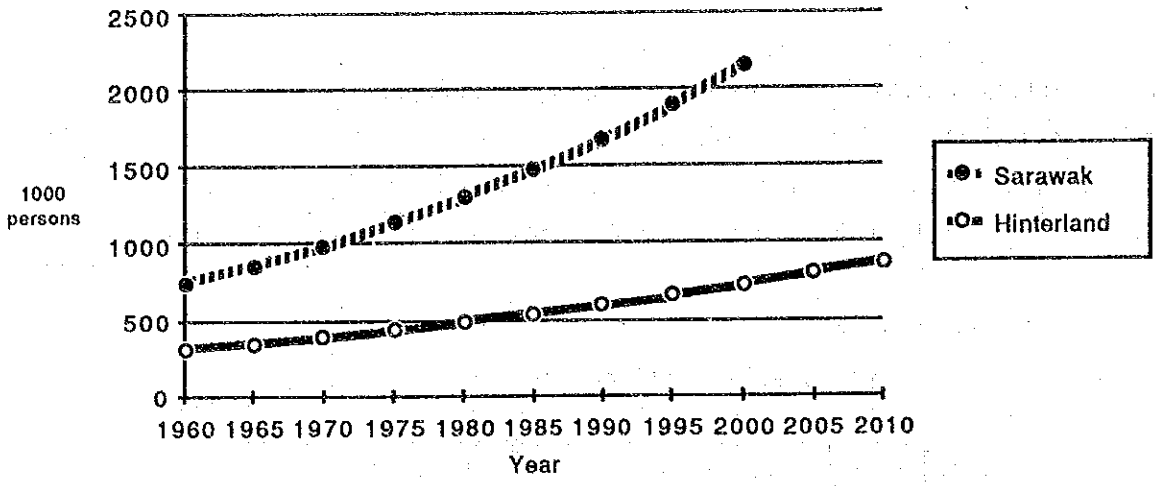


Figure-4.1.2.2 Projection of Population in Sarawak and the Hinterland

4.2 Forecast of Gross Domestic Product

4.2.1 Total gross domestic product

Projection of the total and sectorial gross domestic product (GDP) up to 1995 was conducted by the Sarawak Planning Unit (SPU) as shown in **Table-4.2.1.1.**

Table-4.2.1.1 GDP Projection by Sarawak Planning Unit
(Million Ringgit, 1978=100)

Sector \ Year	1985	share (%)	1990	share (%)	1995	share (%)
Agriculture, Livestock & Fishery	504	9.5	654	10.4	900	10.7
Forestry	674	12.6	768	12.2	713	8.5
Mining & Quarrying	1805	33.7	1892	30.0	2380	28.4
Manufacturing	641	12.0	983	15.6	1619	19.4
Construction	260	4.9	247	3.9	363	4.3
Wholesale & Retail	420	7.9	469	7.4	612	7.2
Transport, Storage & Communication	220	4.1	319	5.0	501	6.0
Government Services	454	8.5	570	9.0	682	8.2
Other Services	361	6.8	457	7.2	619	7.3
Total	5349	100.0	6312	100.0	8367	100.0

Source: Sarawak Planning Unit

Future total GDP up to 2010 was forecast by using a time-series regression on the basis of the actual and the forecast data by SPU. The results are shown in **Figure-4.2.1.1.**

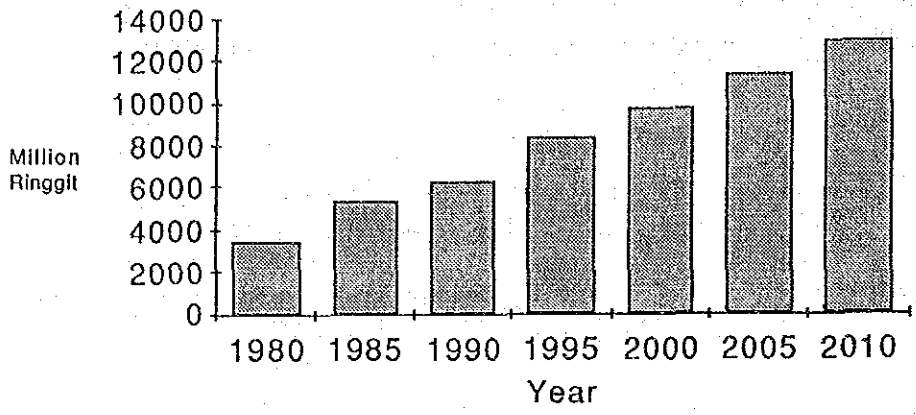


Figure-4.2.1.1 Sarawak GDP Projection

4.2.2 Gross domestic product of agricultural sector

According to SPU, the GDP of the agriculture, livestock and fishery sector is expected to increase its share slightly from 10.2% in 1990 to 10.7% in 1995. However, as the share of this sector had dropped from 14.8% to 9.3% between 1980 and 1984, rising to the 10% level in 1988, it is likely to remain around 10% in the future. Consequently, the share in 1997 and 2010 can be forecast at 10.7%, the same percentage as that in 1995.

Then, the future GDP of the agriculture sector can be obtained by multiplying the forecast total GDP and the forecast share of agriculture sector (**Table-4.2.2.1**).

Table-4.2.2.1 Projection for GDP of Agriculture Sector in Sarawak
(Million Ringgit, 1978=100)

YEAR	Total GDP	Agriculture Sector Share (%)	GDP
1985	5349	9.5	504
1990	6312	10.2	654
1995	8367	10.7	900
1997	8840	10.7	950
2010	12900	10.7	1380

4.3 Forecast of Cargo Volume at Rajang Port

4.3.1 Transportation system

(1) Internationl Cargo

i) Timber

a. Logs

Timber logs produced in the Rajang River Region are first transported to log yards or log ponds on river banks by trucks. Depending on whether the logs are floaters or sinkers, they are made into rafts or loaded onto barges and brought downstream to the timber processing zone (TPZ) developed by the STIDC at the Tg. Manis area or to private timber factories scattered in the river system.

Rafts are about 20m wide and 400m or more long (about 1,000 to 1,500m^3) and towed by tugboats of from 100 to 180 HP. The size of barges used for sinker transportation is from 40ft x 120ft to 50ft x 180ft (average: 50ft x 150 ft, 1,200m^3) with engines of 250-350 HP.

In the Tanjung Manis area, floaters and sinkers for processing will be deposited in log ponds prepared on water near the TPZ and brought into timber yards in the premises of the sawmills of the TPZ. Logs for export without processing are loaded on ocean-going ships directly from rafts or barges.

b. Timber products

Timber products processed in the TPZ are transported from factories by trucks, forklifts, etc., to transit sheds prepared behind the timber export wharf. And some of the finished timber products from some private sawmills are brought by barges and discharged at the shallow wharf next to the export wharf, then deposited in the transit shed temporarily. As the lot of timber products from private factories is usually small, temporary storage will enable them to be export lot big enough for transportation by large vessels. General cargo ships, RO/RO ships and container ships will be used for export of timber products. Sawn timber is not so suitable for container transportation due to its length, but high grade same timber, plywood, dowel/molding and down-stream products such as furniture can be put in container vans.

Figure-4.3.1.1 illustrates movements of timber in Rajang Port.

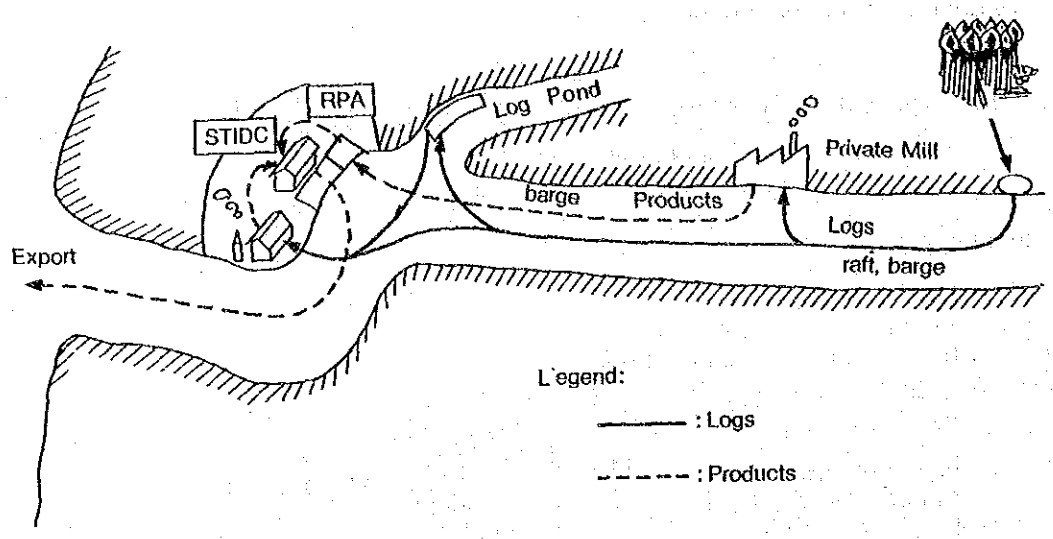


Figure-4.3.1.1 Movements of Timber in Rajang Port

ii) Coal

Coal is mined at the Merit Pila Mine near Kapit and loaded onto 1,000m^3-barges at the loading point established next to Kapit, then transported to a coal terminal in Tanjung Manis area. Coal is discharged from barges at shallow wharf and conveyed to stockyard in the terminal.

From the stockyard, coal goes out on three routes: to a thermal power plant next to the terminal for fuel, to a deep wharf for export to foreign countries and/or Peninsular Malaysia and for coastal transportation to another thermal power plant near Kuching.

Figure-4.3.1.2 illustrates movements of coal in Rajang Port.

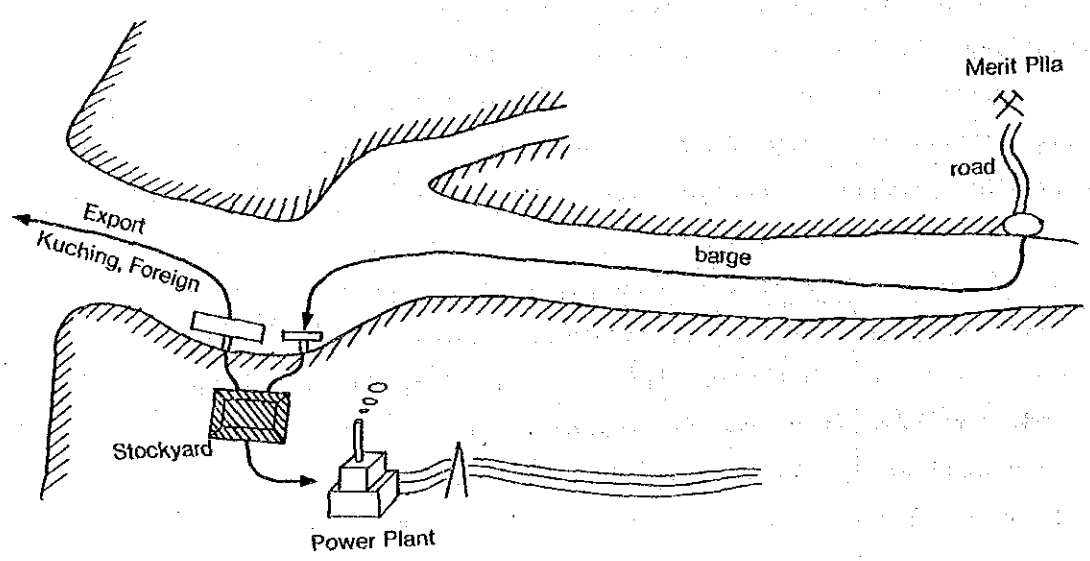


Figure-4.3.1.2 Movements of Coal in Rajang Port

iii) Containers

Containers transporting imported consumer goods will be discharged at Sibu center or other container/general cargo terminals from ocean-going ships. And laden containers including export cargo such as agricultural and industrial products, etc., will be loaded on ocean-going ships at Sibu center, Sibu South and Sarikei. Empty containers remaining at Sibu Center due to imbalance of export and import cargoes will be forwarded to the TPZ by barges or lighters and laden with timber products, then exported from the timber products wharf.

Figure-4.3.1.3 illustrates movements of containers in Rajang Port.

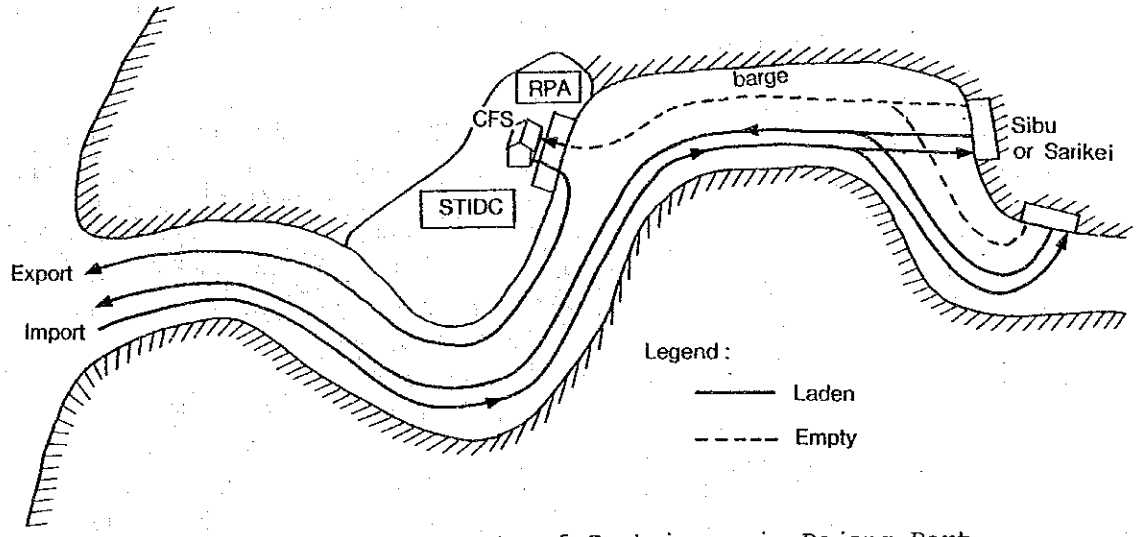


Figure-4.3.1.3 Movements of Containers in Rajang Port

iv) Oil Products

All petroleum products will be handled at an old and a new oil jetty at Sungei Merah.

Edible oil (crude palm oil) will be produced at a palm tree estate in the hinterland, especially Saratok and Betong districts, and carried to Sarikei Port, then exported to a refinery at Johor Port etc.

There are some options in palm oil transportation mode as follows:

- trucks (staffed in drums) -> sheds at Sarikei wharf
  -> general cargo ships

- tank lorries -> oil tanks at Sarikei wharf -> palm oil tankers

- a pipeline -> oil tanks at Sarikei wharf -> palm oil tankers

The first two modes are applicable to the demand and land haulage mileage. As the distance from Saratok or Betong Districts to Sarikei wharf is 50km or more, installation of a pipeline is too costly considering the relatively small volume of palm oil (30,000tons in 1997 and 45,000tons in 2010). In this report, we adopt the first mode, trucks (in drums), because the volume is relatively small, because the road is not adequate (narrow and not sealed) for tank lorries and because this mode is currently employed to haul palm oil to Sarikei from the hinterland. However, the second mode, tank lorries/oil tanks at Sarikei, can be adopted if the volume grows rapidly and the road is improved.

Figure-4.3.1.4 illustrates movements of oil products in Rajang Port.

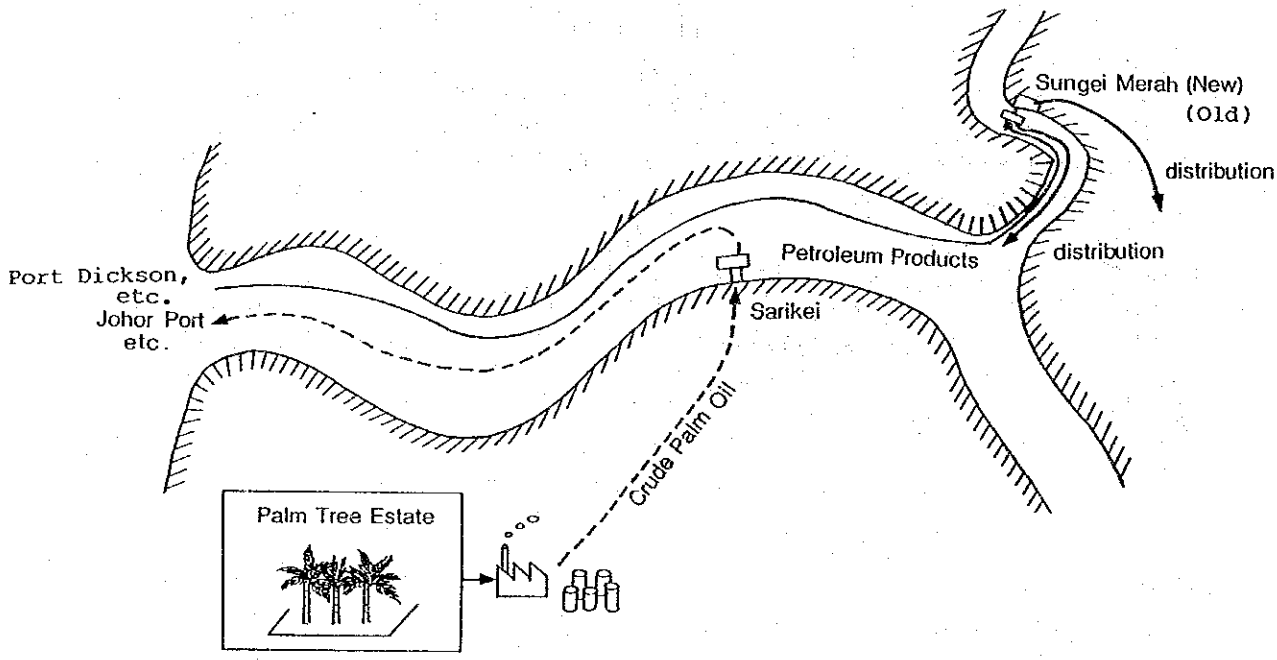


Figure-4.3.1.4 Movements of Oil Products in Rajang Port

v) Others

Other cargo will be handled at Sibu center, Sarikei and Bintangor as handled at present.

(2) Coastal Cargo

Figure-4.3.1.5 shows coastal cargo vessel routes in the study area.

(3) Riverine Cargo

Figure-4.3.1.6 shows riverine cargo vessel routes in the study area.

(4) Passenger Service

Figure-4.3.1.7 shows passenger vessel routes in the study area.

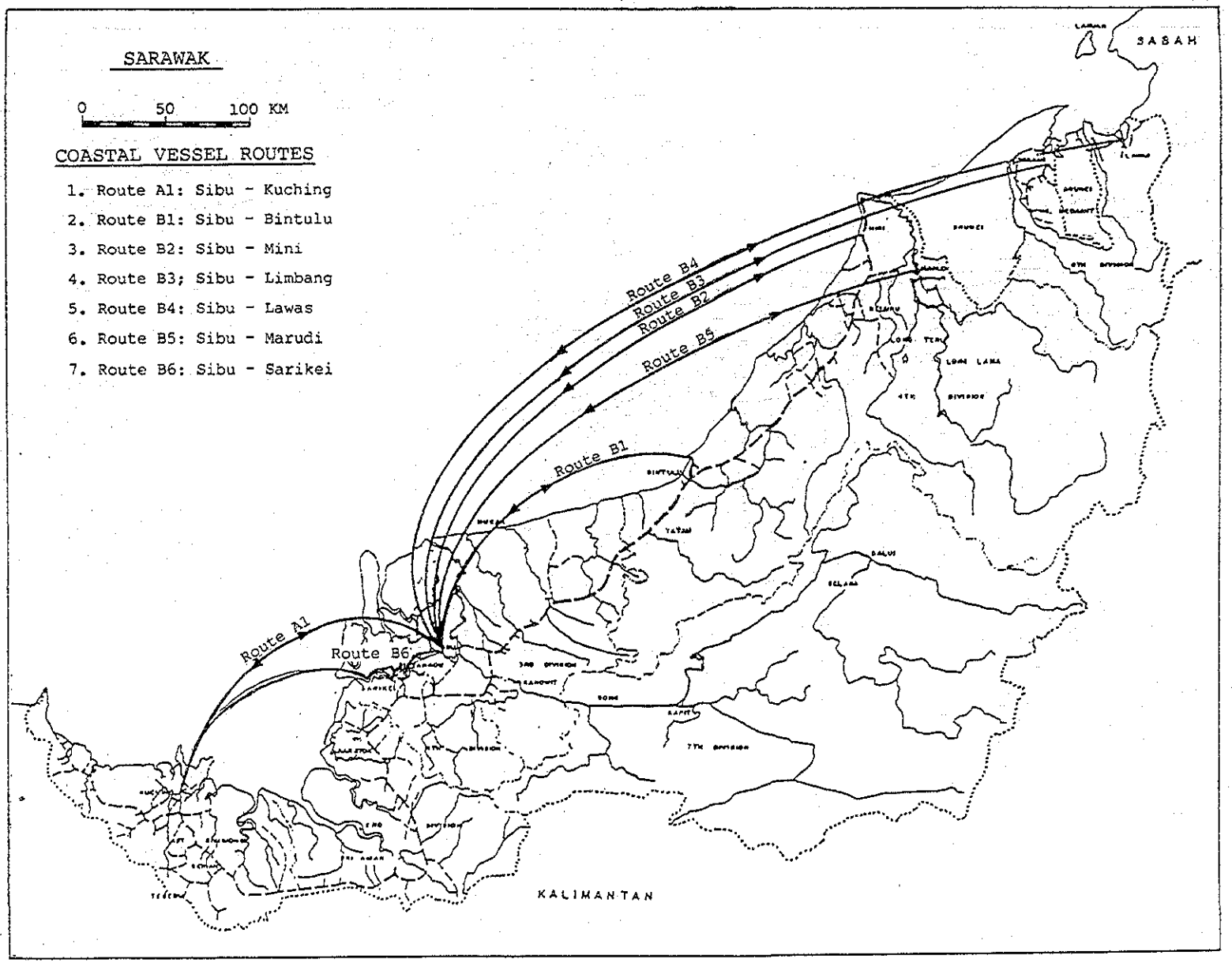


Figure-4.3.1.5 Coastal Vessel Routes

RIVERINE CARGO VESSEL ROUTES

Sibu - Durin
Sibu - Durin - Kanowit
Sibu - Kanawit
Sibu - Kanawit - Ng Dap
Sibu - Kanawit - Song
Sibu - Song
Sibu - Song - Kapit - Tanah Balleh
Sibu - Song - Kapit
Sibu - Kapit
Sibu - Kapit - Belaga
Sibu - Kapit - Tanah Balleh
Sibu - Dalat
Sibu - Kuit - Dalat
Sibu - Singat - Daro - Matu
Sibu - Sg. Kuit - Igan
Sibu - Paloh
Sibu - Ng. Ngemah
Not to scale

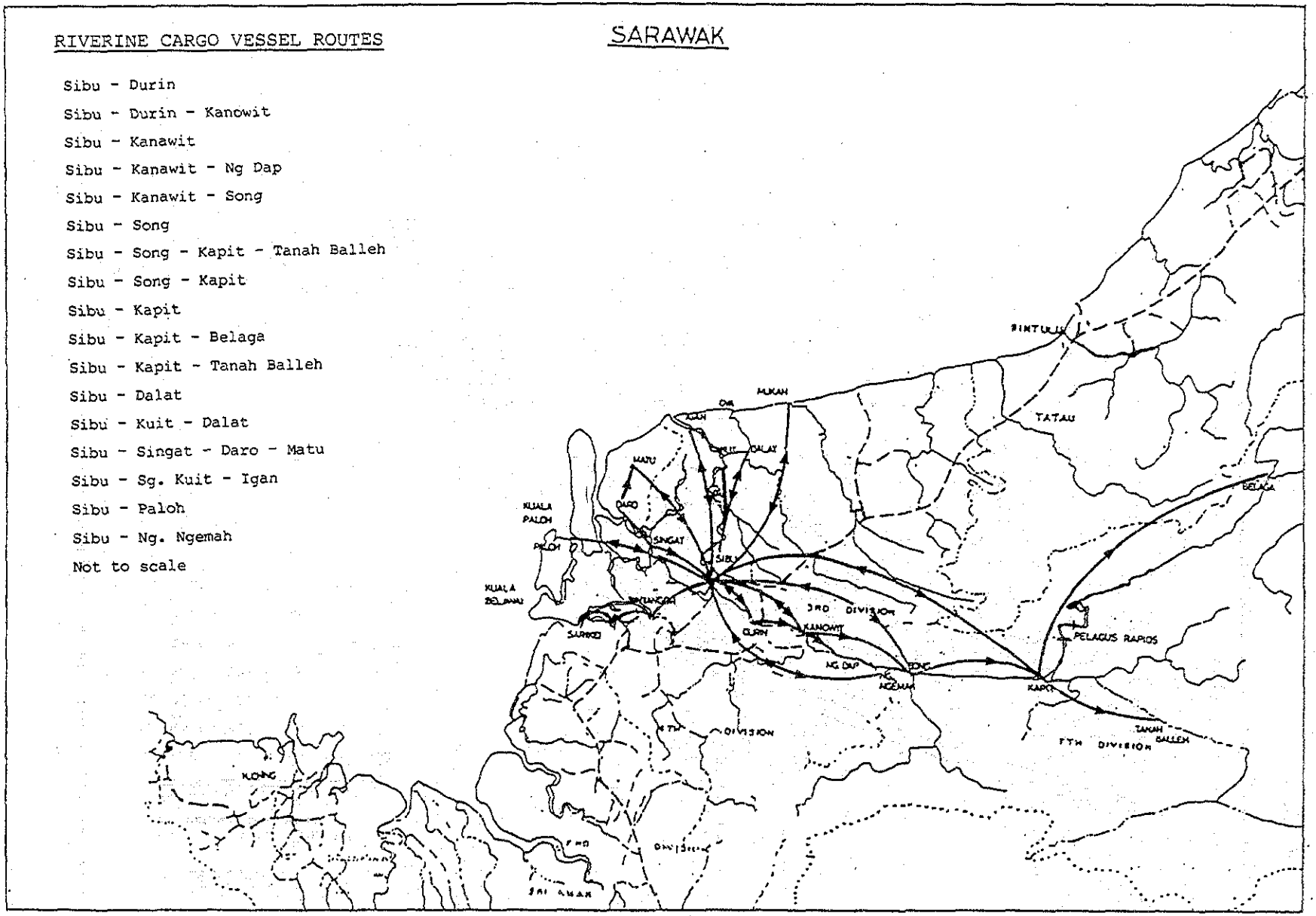


Figure-4.3.1.6 Riverine Cargo Vessel Routes

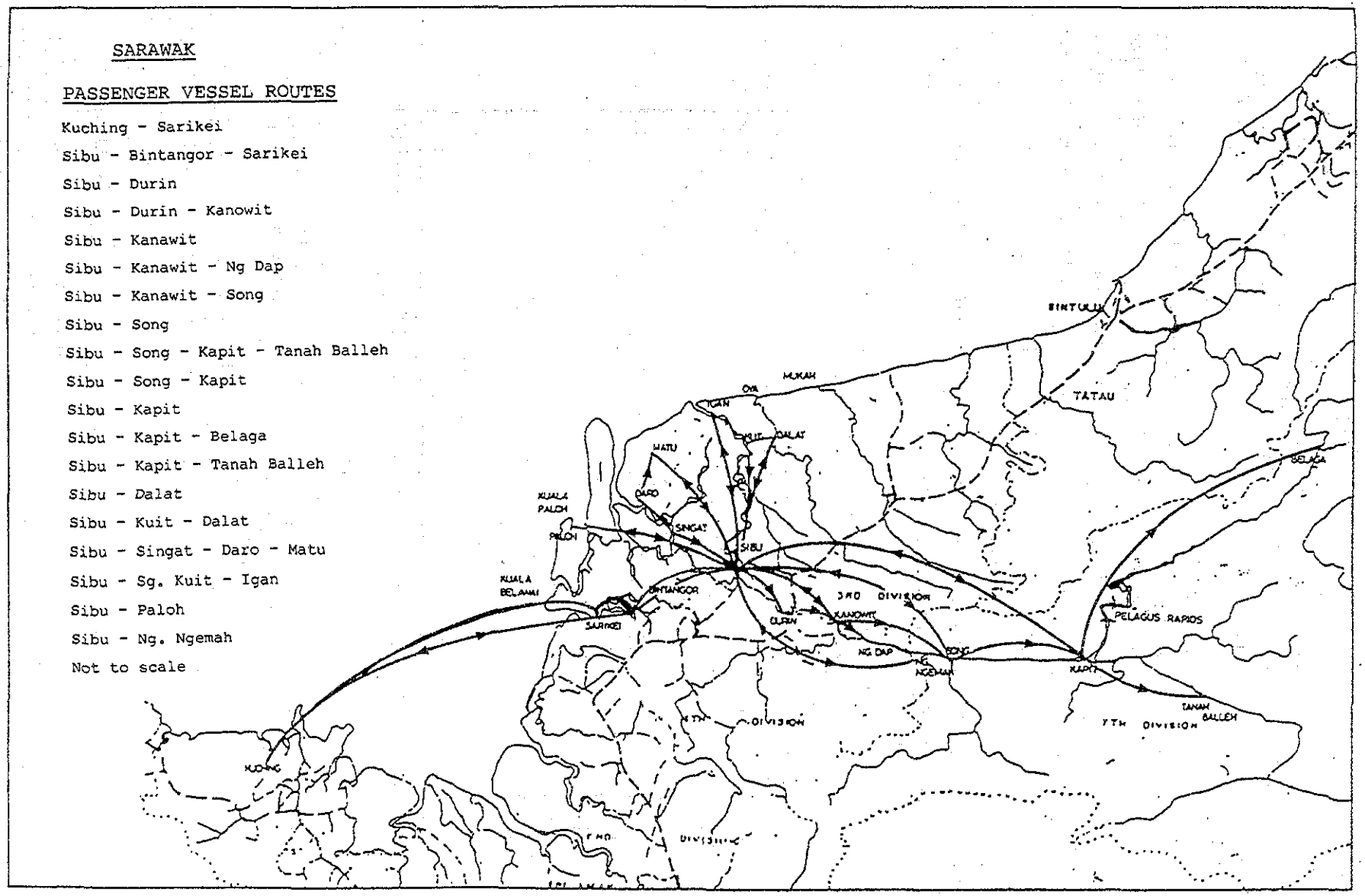


Figure-4.3.1.7 Passenger Vessel Routes

4.3.2 Cargo volume of international trade

(1) Timber

i) Total log production

a. Sarawak

Figure-4.3.2.1 shows log production in Sarawak. Although the latest statistics show that the log production volume is 18 million m^3, according to the Forest Department, Sarawak, the body responsible for the timber industry in Sarawak, log production will fall to 10 million m^3 in 1995 and 8 million m^3 in the future. STIDC has also projection of log production in Sarawak. Moreover, the International Tropical Timber Organization (ITTO) has recommended an allowable log production volume. These figures are shown in **Table-4.3.2.1** and **Figure-4.3.2.2.**

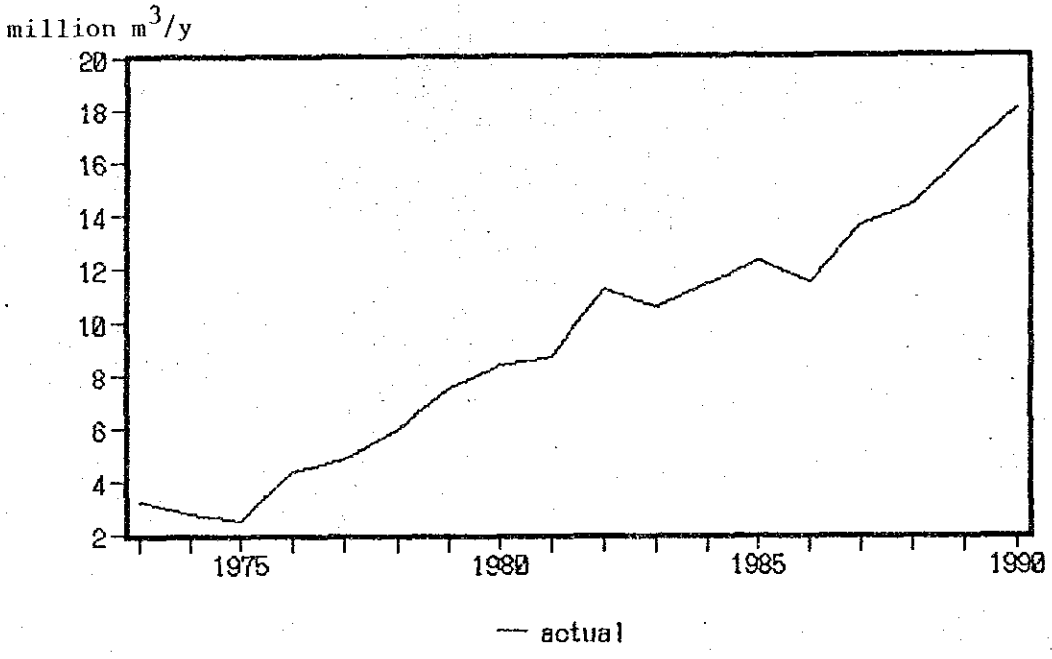


Figure-4.3.2.1 Log Production in Sarawak

Table-4.3.2.1 Future Log Production in Sarawak

	(1000 m^3/y)
Present Production	18,000 (1990)
Projection by Foreset Department	10,000 (1995)
	8,000 (future)
Projection by STIDC	9,000 (1996)
ITTO Recommendation*	9,200 (<60% slope, 2000)

* Assuming 45 cm dbh limit, 35 years cycle, etc.

Source: Forest Department, Sarawak,
STIDC,
ITTO, "The Promotion of Suitable Forest Management, A Case Study in Sarawak, Malaysia", 1990.

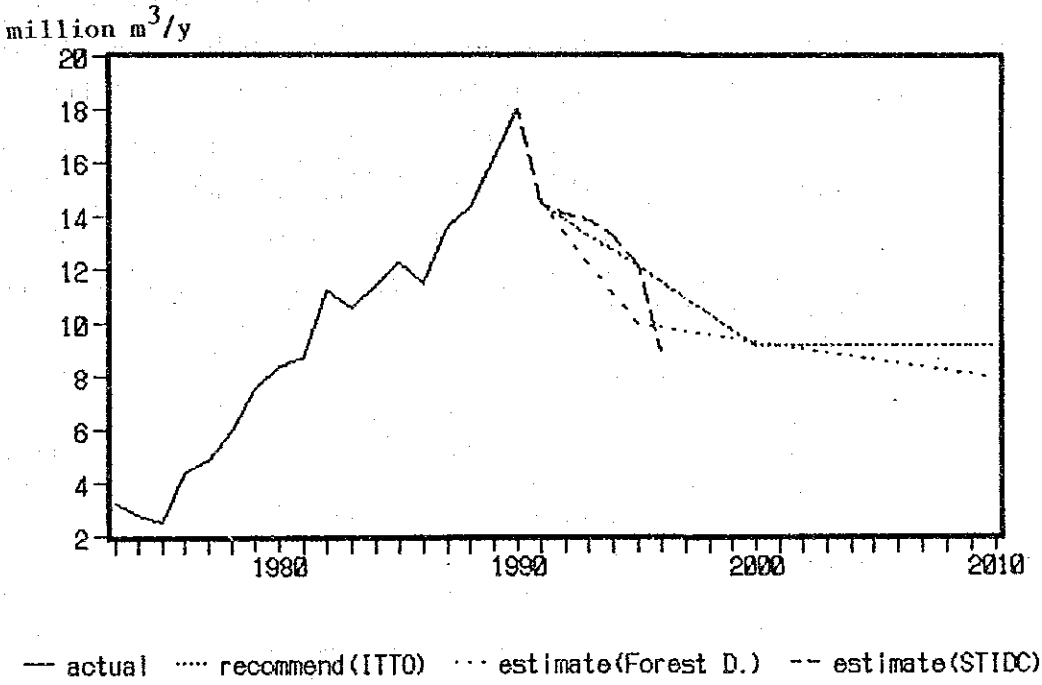


Figure-4.3.2.2 Projection of Log Production in Sarawak by the Forest Department, STIDC and ITTO

Log production volume in Sarawak can be estimated on the basis of this information as shown in **Table-4.3.2.2.**

Table-4.3.2.2 Log Production Forecast in Sarawak

(1000 m^3/y)

Year	Production Volume		Remarks
1997	High	10,000	Forest Department projection
	Low	9,000	STIDC projection
2010	High	9,200	ITTO recommendation (middle)
	Low	8,000	Forest Department projection

b. Rajang River Region

In the Rajang River Region (the 3rd, 6th and 7th Divisions), log production accounted for about 40% of total production in Sarawak in 1989. As timber resources in other regions are expected to be more scarce in future, the proportion of production in the Rajang River Region will become larger in future.

Figure-4.3.2.3 shows that the growth of the share of Rajang River Region has been gradually stopping and that the share is likely to be saturated in the range between 0.4 and 0.5. This curve can be fit with the following formula.

$$S = \frac{Ms}{1+a*e^{-bt}} \qquad (4.3.2.1)$$

S: Share of the Rajang River Region

Ms: Saturation Level

t: Year (1980 = 1)

a,b: parameters

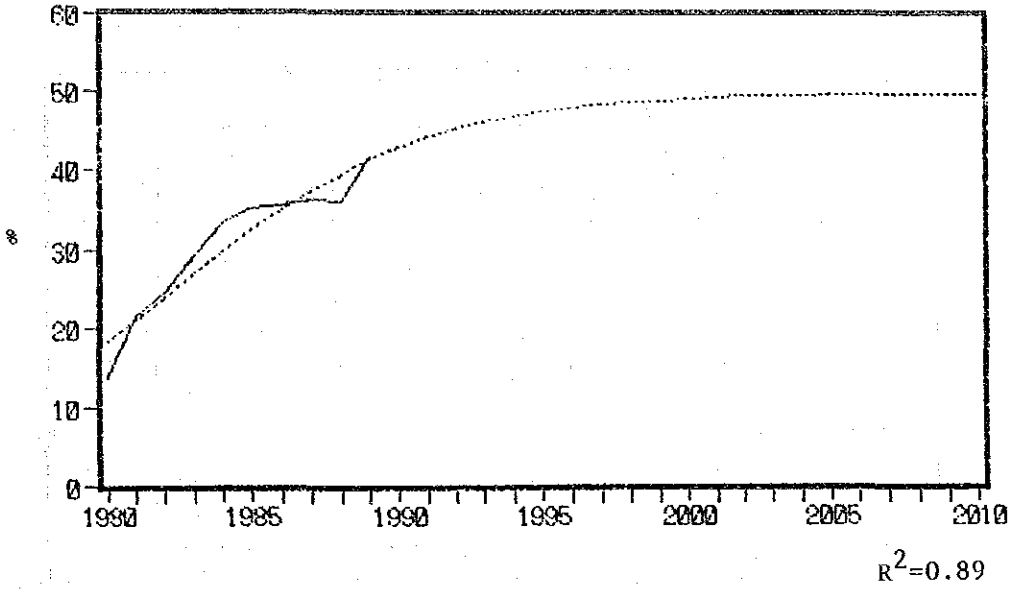


Figure-4.3.2.3 Ratio of Log Production
Rajang River Region/Sarawak

Then, We can get following equation.

$$S = \frac{50}{1+2.19 \times e^{-0.234t}} \quad (R^2=0.89) \qquad (4.3.2.2)$$

The share in 1997 and 2010 can be forecast by this formula to be 48% and 50%, respectively.

Consequently, future log production in the Rajang River Region can be obtained as shown in **Table-4.3.2.3** and **Figure-4.3.2.4.**

Table-4.3.2.3 Log Production Forecast
in the Rajang River Region
(1000t/y)

Year	Production Volume	
1997	High	5,300
	Low	4,700
2010	High	4,600
	Low	4,000

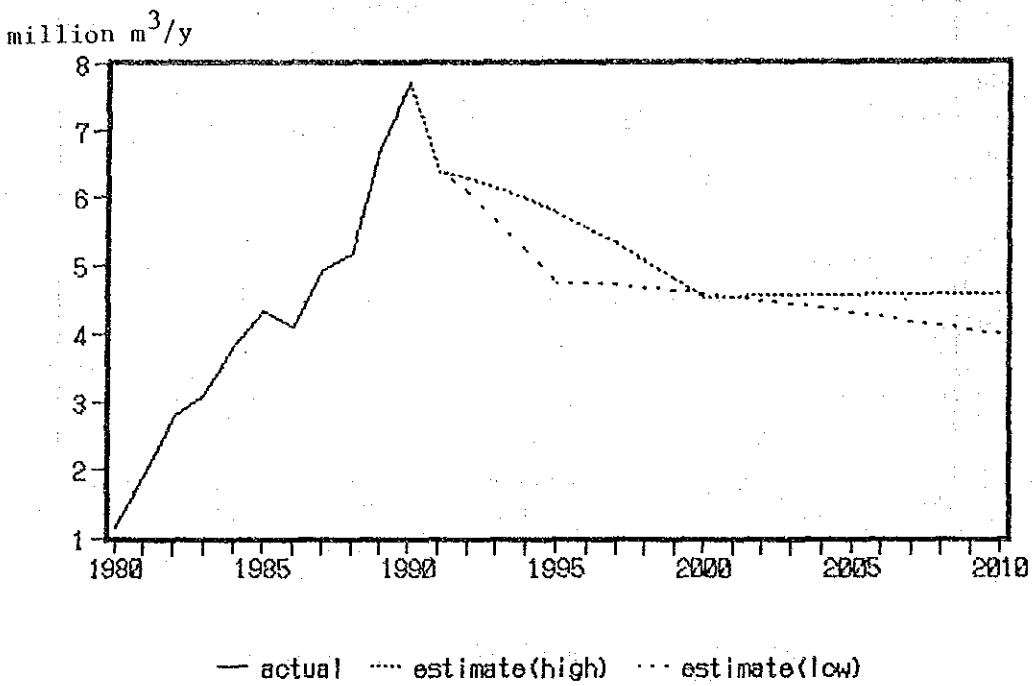


Figure-4.3.2.4 Projection of Log Production
Rajang River Region/Sarawak

ii) Timber Processing

a. Present situation

According to the STIC, the present situation of the timber processing industry in Sarawak and the Rajang River Region is as shown in **Table-4.3.2.4** and **4.3.2.5.**

Table-4.3.2.4 Present Situation of the Timber Processing Industry in Sarawak (1988)

Factory	Nos	Capacity m^3/year
Sawmill	226	2,034,000
Veneer/Plywood	8	600,000
Dowel/Moulding	13	80,000
Laminated Board	4	18,000 (sawn timber)
Wood Chips	1	62,000
TOTAL	252	2,776,000

Source: STIDC

Table-4.3.2.5 Present Situation of the Timber Processing Industry in the Rajang River Region (1988)

Factory	Nos	Capacity (m^3/year)
Sawmill	49	520,000
Veneer/Plywood	3	216,000
Dowel/Moulding	10	25,000
Wood Chips	1	62,000
TOTAL	63	823,000

Source: STIDC

b. Future timber industry

- Timber processing zone (STIDC)

Establishment and development of the timber processing zone will be done in phases. The factories and the installed capacities are as shown in **Table-4.3.2.6.**

Table-4.3.2.6 Capacities of Timber Factories in STIDC's TPZ

(1000 m^3)

Phase	1995	1997	2000	2005	2010
Sawmill	231	329	557	980	1403
Plywood/veneer	216	297	486	755	1025
Wood chips	111	153	250	389	528
Particleboard	76	104	170	285	359
Laminated Board			84	188	292
Dowel/Moulding	88	123	204	263	409
Kiln Drying	230	316	518	575	863
Preserv. Plant	230	316	518	575	863
Furniture					
Other					
Max. Log Consumption	837	1170	1946	3097	4394
70%	586	819	1362	2168	3076
60%	502	702	1168	1858	2636

calculated under the assumption that the:

i) recovery rate of plywood/veneer is 60%,

ii) recovery rate of dowel/moulding is 60%,

iii) recovery rate of sawmill is 70%,

iv) wood chips, particle board, kiln drying and preservation plants do not consume logs but rejected woods from above three plants.

Source: STIDC

- Private Factories

In addition to the present factory situation, 46 factories are under construction or have filed for construction permits as **Table-4.3.2.7** shows.

Table-4.3.2.7 Private Timber Factories in the Rajang River Region

Factory	Present			Future		
	Nos	Maximum Capacity ($1000m^3/y$)	Maximum Log Con. ($1000m^3/y$)	Nos	Maximum Capacity ($1000m^3/y$)	Maximum Log Con. ($1000m^3/y$)
Sawmill	76	700	1412	92	815	1629
Veneer/Plywood	5	282	564	6	324	648
Dowel/Moulding	10	25	42	10	25	42
Wood Chip/etc.	1	48	60	1	48	60
TOTAL	63	1061	2078	109	1212	2379

Con. : Consumption

Source: STIDC

- Future log consumption, processing and export (conclusion)

Table-4.3.2.8 shows the maximum log consumption and timber processing capacity in the Rajang River Region in 1997 and 2010.

On the basis of future logging and processing plans as shown in this table, future log processing output and export of timber products and logs can be projected assuming that operation rate of all timber factories is 70%, and the results are shown in **Table-4.3.2.9.**

Table-4.3.2.8 Max. Log Consumption & Timber Products ($1000\ m^3$)

	Present	1997	2010
Log Consumption			
STIDC		1170	4394
Private	1572	1806	1806
TOTAL	1572	2976	6200
Timber Products			
STIDC			
Sawn Timber		329	1403
Plywood		297	1025
Dowel/Moulding		123	409
Particle Bd.		104	359
Laminated Bd			292
Woodchip		153	528
(TOTAL)	0	1006	4016
Private			
Sawn Timber	700	815	815
Plywood	282	324	324
Dowel/Moulding	25	25	25
Woodchip	48	48	48
(TOTAL)	1055	1212	1212
TOTAL	1055	2218	5228

Source: STIDC

Table-4.3.2.9 Future Log Consumption & Exports of Timber Products
(1000 m3)

	Present	1997	2010
Log Consumption			
STIDC		819	3076
Private	1100	1264	1264
TOTAL	1100	2083	4340
Products Export			
STIDC			
Sawn Timber		230	778
Plywood		208	718
Dowel/Moulding		86	286
Particle Bd.		73	251
Laminated Bd			204
Woodchip		34	118
(TOTAL)	0	631	2355
Private			
Sawn Timber	490	571	571
Plywood	197	227	227
Dowel/Moulding	18	18	18
Woodchip	34	34	34
(TOTAL)	739	850	850
TOTAL	739	1481	3205

70% operation rate
Based on Table-4.3.2.8.

Table-4.3.2.10 shows the projection of export of logs and timber products.

Table-4.3.2.10 Export of Timber Logs and Products from Rajang Port
(1000 m^3)

Year	Log Production	Factory	Log Consumption	Processing Output			Products Export Through Rajang Port Wharf			Log Export
				S/T	O/P	C.	S/T	O/P	C.	
1997	5,000	TPZ	819	230	367	34	230	367	34	2917
		Private	1264	571	245	34	286*	123*	0	
		(total)	2083	801	612	68	516	490	34	
2010	4,340	TPZ	3076	778	1459	118	778	1459	118	0
		Private	1264	571	245	34	571	245	0	
		(total)	4340	1349	1704	152	1349	1708	118	

S/T: Sawn Timber

O/P: Other Timber Products

C.: Wood Chips

* Assumed that 50% of timber products from the private factories will be exported through Rajang Port in 1997.

(2) Coal

i) Coal thermal power plant

Electricity in Sarawak is supplied by SESCO (Sarawak Electricity Supply Corporation), and demand has been growing by 10% annually over the past decade. SESCO has a plan for installing 41 new generators up to 2001, as shown in **Table-4.3.2.11** Although the main fuel of these generators is LNG, SESCO is interested in coal as an alternative fuel for thermal power plants on the basic of the "Four-fuel Diversification Strategy" of the Malaysian Government. Sarawak is so rich in coal resources that new power plants can be operated with coal. Moreover, in the Rajang River Region, coal can be easily obtained from the Merit Pila mine, which has one of the biggest and richest coal deposits in Sarawak. SESCO is preparing a plan for three coal thermal power plants in the Kuching, Sibu and Bintulu areas or Mukah Balingian by using coal from the Merit Pila mine and other two mines, Silantek and Mukah Balingian. The outline of the plan for the plant and coal supply is shown in **Figure-4.3.2.5.**

The Tg. Manis area could be a possible location for a coal thermal power plant. The area has only a small population but deep water that could be used for a coal terminal. Therefore, we propose a coal terminal and thermal power plant in the Tg. Manis area.

Table-4.3.2.11 SESCO Proposed generation Plant (In case of installing coal thermal power station)

	Year 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Load demand forecast (MW)													
Kuching	93.5	104.5	113.5	123.2	135.1	146.5	160.3	173.5	189.6	204.8	223.4	240.9	262.4
Sri Amn	2.9	3.1	3.3	3.5	3.8	4.1	4.4	4.6	5.0	5.3	5.6	6.0	6.4
Sarikei	4.4	4.9	5.4	5.9	6.5	7.2	7.9	8.7	9.5	10.4	11.3	12.4	13.7
Sibu	29.6	34.0	38.7	44.0	49.1	55.3	62.0	66.6	72.4	78.6	84.4	91.7	99.6
Bintulu (after 1992)				24.5	28.2	32.0	36.6	41.7	46.7	52.9	59.8	66.6	75.0
Miri (after 1996)								54.4	58.7	63.5	67.9	73.4	81.1
Total load forecast (MW)	130.4	146.4	160.9	201.1	222.7	245.1	271.2	349.5	381.9	415.5	452.4	491.0	538.2
Required reserve margine (MW)	46.0	46.0	46.0	60.0	60.0	60.0	60.0	60.0	60.0	90.0	90.0	90.0	90.0
Total reqired generating capacity (MW)	176.4	192.4	206.9	261.1	282.7	305.1	331.2	409.5	441.9	505.5	542.4	581.0	628.2
Existing available capacity (MW)													
Diesel	113.3	93.1	89.3	89.3	83.6	80.3	65.6	65.6	53.2	24.7	24.7	24.7	24.7
Gas turbine				27.8	27.8	27.8	27.8	84.3	84.3	84.3	80.4	80.4	80.4
Hydro	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
Total (MW)	192.5	172.3	168.5	196.3	190.6	187.3	172.6	229.1	216.7	188.2	184.3	184.3	184.3
Proposed plant start-up													
1) Gas turbine P.S.													
Bintulu G/T 1-3(30MW)				90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
4 (30MW)					30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
5&6(30MW)													
7 (30MW)													
Convert Bintulu G/T													
to C.C 1-3(15MW)						45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
4 (15MW)							15.0	15.0	15.0	15.0	15.0	15.0	15.0
Total P.S. capacity (MW)				90.0	120.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0
2) Coal fired P.S.													
A-station 1 (50MW)							50.0	50.0	50.0	50.0	50.0	50.0	50.0
(Sibu) 2 (50MW)								50.0	50.0	50.0	50.0	50.0	50.0
3(100MW)											100.0	100.0	100.0
B-station 1 (50MW)									50.0	50.0	50.0	50.0	50.0
(Kuching) 2 (50MW)										50.0	50.0	50.0	50.0
C-station 1 (50MW)													
(Bintulu) 2 (50MW)													
3(100MW)													
Total P.S. capacity (MW)							50.0	100.0	150.0	200.0	300.0	300.0	300.0
Total plant-up capacity (MW)	0.0	0.0	0.0	90.0	120.0	165.0	215.0	265.0	315.0	365.0	465.0	465.0	465.0
Total new available capacity (MW)	192.5	172.3	168.5	286.3	310.6	352.3	387.6	494.1	531.7	553.2	649.3	649.3	649.3
Available margin (MW)	16.1	-20.1	-38.4	25.2	27.9	47.2	56.4	84.6	89.8	47.7	106.9	68.3	21.1
(%)	8.4%	-11.7%	-22.8%	8.8%	9.0%	13.4%	14.5%	17.1%	16.9%	8.6%	16.5%	10.5%	3.3%

Source: SESCO

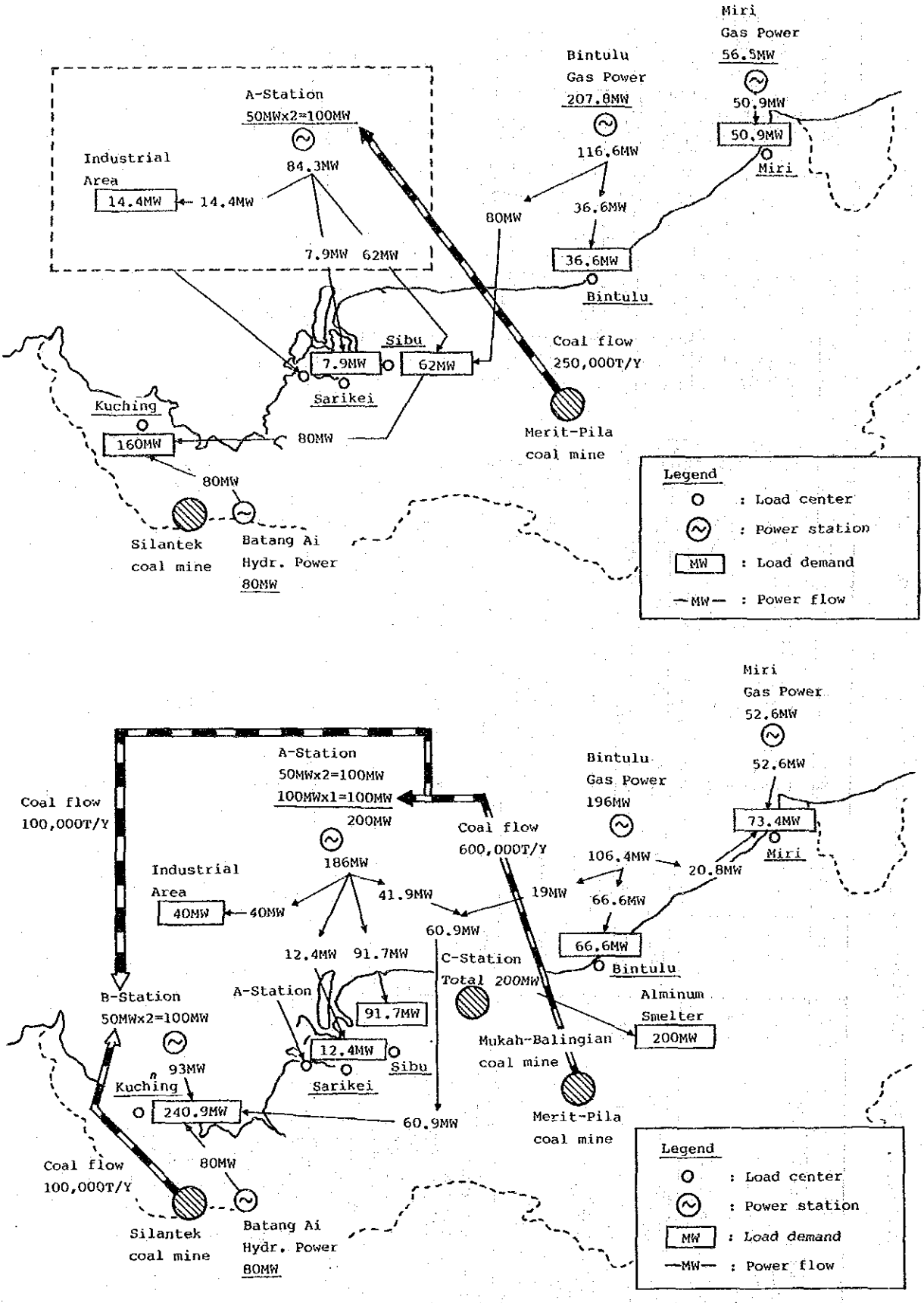


Figure-4.3.2.5 Power Plant and Coal Supply (1995, 2000)

ii) Thermal power plant in Sibu area

Capacity and coal consumption projections for the plant are as follows.

Table-4.3.2.12 Specifications of Coal Thermal Power Plant in Sibu Area

Item	1997	2010	Remark
Capacity (KW)	100,000	200,000	
Coal Consumption (Tons)	250,000	500,000	2.5 t/y*KW
Lime Stone Consumption (Tons)	7,500	15,000	3% of Coal
Subsidiary Fuel Oil (KL)	8,000	16,000	0.08KL/KW
Byproducts (Tons)			
Plaster	5,000	10,000	5% of Coal
Ash	15,000	300,000	15% of Coal

Plaster and some ash (fry ash) can be exported.

The new plant can be connected with the existing transmission line network for a supply of electricity.

iii) Coal supply to power plant in Kuching

As stated above, a power plant in the Kuching area will be supplied with some of the coal from the Merit Pila mine from the year 2000. Some 100,000 tons of coal will be shipped out of the coal terminal, which will be established next to the power plant in the Tg. Manis area.

iv) Export of coal

The coal from Merit Pila can be used as raw material as well as fuel for power plant. High-quality coal could be exported to Peninsula Malaysia and foreign countries such as South Korea, Taiwan and Japan. Export volumes are expected to be 250,000 tons and 500,000 tons in 1997 and 2010, respectively.

v) Conclusion

Consequently, coal and related cargo handling at the Rajang Port is expected to be as shown in **Tables-4.3.2.13** and **4.3.2.14.**

Table-4.3.2.13 Coal Transportation

(metric ton)

Year	Riverine Transportation (Kapit→Tg. Manis)	Consumption at Power Plant	Export	
			to Kuching	International
1997	500,000	250,000	0	250,000
2010	1,100,000	500,000	100,000	500,000

Table-4.3.2.14 Transportation of Related Cargo

Year	Import		Export
	Lime Stone (MT)	Oil (KL)	Plaster (MT)
1997	7,500	8,000	10,500
2010	15,000	16,000	21,000

(3) Other cargoes

i) Forecast method

Cargo volumes handled at the Rajang Port in future, other than timber and coal, were forecast by following commodity group:

Import

- motor vehicles

  motor vehicles, construction equipment and machinery

- food

  rice, sugar, salt and flour

- fertilizer and feed

  fertilizer, maize and poultry/animal feed

- petroleum products

  fuel oil, gasoline, jet oil and other petroleum products

- miscellaneous

  other commodities

Export

- agricultural products

  agricultural products (except palm oil and kernel) and fishery products

- palm oil
- palm kernel
- petroleum products

  fuel oil, gasoline, jet oil and other petroleum products

- miscellaneous

  other commodities

Forecast method for the each commodity group is as follows:

- Import

  motor vehicles

  multicorrelation with total GDP in Sarawak and number of registered cars in the hinterland

  food

  correlation with population in the hinterland

  fertilizer and feed

  correlation with GDP of agriculture sector in Sarawak

  petroleum products

  multicorrelation with total GDP in Sarawak and number of registered cars in the hinterland

  miscellaneous

  correlation with population in the hinterland

- Export

  agricultural products

  correlation with GDP of agriculture sector in Sarawak

  palm oil/kernel

  unit production per area and plantation area in the hinterland

  petroleum products

  correlation with import volume of petroleum products at Rajang Port

  miscellaneous

  correlation with total GDP in Sarawak

ii) Forecast process

a. motor vehicles (import)

The import volume of motor vehicles at Rajang Port can be explained by following equation.

$$V_m i = a * GDP + b * Nc + C \qquad (4.3.2.3)$$

where,

$V_m i$: import volume of motor vehicle at Rajang Port

GDP: total GDP in Sarawak

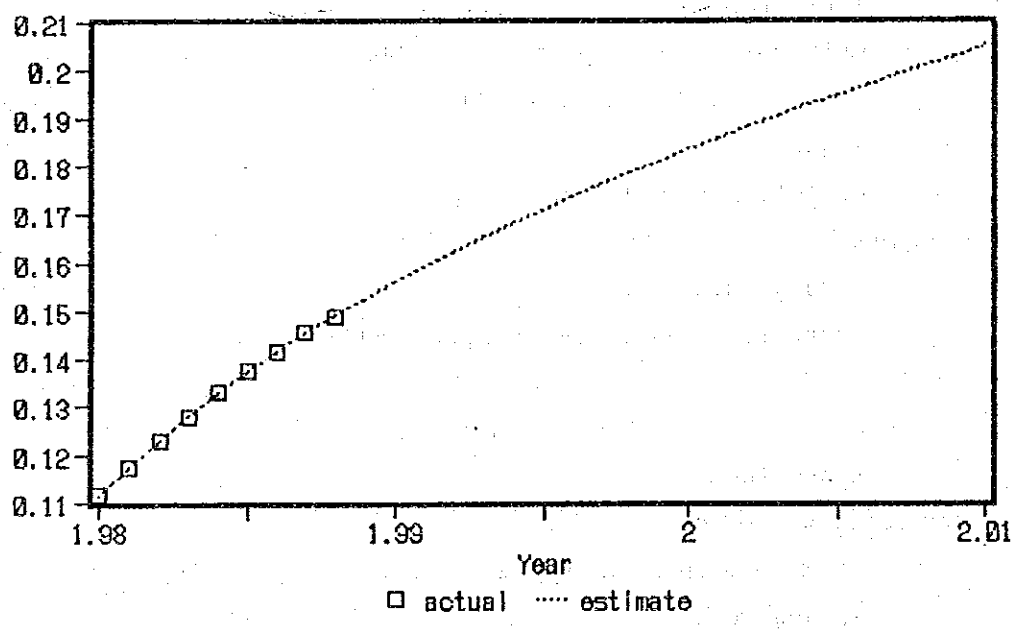
Nc: number of registered cars in the hinterland

a, b, c: parameters

And parameters can be obtained by multi-regression analysis as follows:

$$V_m i = -1.62 * Nc + 26.98 * GDP - 2342 \quad (R^2 = 0.94) \qquad (4.3.2.4)$$

The future GDP in Sarawak has been projected in 2.2.2, and the number of registered cars in the hinterland can be obtained by forecasting the number of registered cars per person in Sarawak as shown in **Figure-4.3.2.6** and **Table-4.3.2.15.**



$y = 0.000241 \sqrt[3]{x} - 0.477$ (r=0.9998)

x= year

y= No. of Registered Cars per Person in Sarawak

Figure-4.3.2.6 No. of Cars Registered per Person in Sarawak

Table-4.3.2.15 No. of Registered Cars in the Hinterland

Year	No. of Regist. Car in Sarawak (vehicles/person)	Population in the Hinterland (x1000)	No. of Regist. Car in the Hinterland (vehicles)
1985	0.137	541	74300
1990	0.156	596	93000
1995	0.171	659	112700
1997	0.176	687	120900
2010	0.205	877	179800

The future import volume at Rajang Port can be forecasted by using this equation as shown in **Table-4.3.2.16.**

Table-4.3.2.16 Projection of Import Volume of "Motor Vehicle" at Rajang Port

Year	GDP in Sarawak (million Rg.)	No. of car in the Hinterland	Import Volume at Rajang Port (1000 tons)
1985	5349	74300	13
1990	6312	93000	22
1995	8370	112700	46
1997	8840	120900	47
2010	12900	179800	59

b. food (import)

Figure-4.3.2.7 shows the relationship between the import volume of "food" at Rajang Port and the population in the hinterland. The Dotted line is a regression line which fits the correlation. And the correlation equation is as follows.

$$V_fi = 242 * POP - 75498 \quad (r=0.84) \qquad (4.3.2.5)$$

where,

V_fi: import volume of food at Rajang Port

POP: population in the hinterland

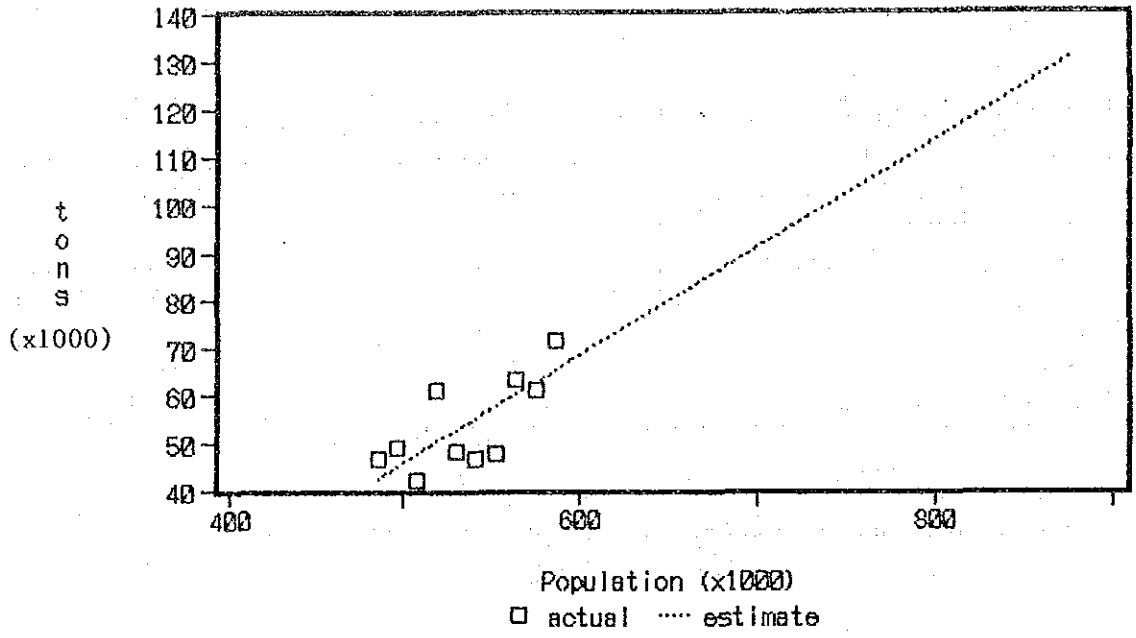


Figure-4.3.2.7 Future Cargo Volume
Food (Import)

The future import volume at Rajang Port can be forecasted by using this equation as shown in **Table-4.3.2.17.**

Table-4.3.2.17 Projection of Import Volume of "Food" at Rajang Port

Year	Population in the Hinterland (x1000)	Import Volume at Rajang Port (1000 tons)
1985	541	56
1990	596	69
1995	659	84
1997	687	91
2010	877	137

c. fertilizer and feed (import)

Figure-4.3.2.8 shows the relationship between the import volume of "fertilizer and feed" at Rajang Port and GDP of agriculture sector in Sarawak. Dotted line is a regression line which fits the correlation. And the correlation equation is as follows.

$$V_{ff}i = 210 * GDP_a - 64596 \quad (r=0.92) \qquad (4.3.2.6)$$

where:

$V_{ff}i$: import volume of "fertilizer and feed" at Rajang Port

GDP_a: GDP of agriculture sector in Sarawak

The future import volume at Rajang Port can be forecasted by using this equation as shown in **Table-4.3.2.18.**

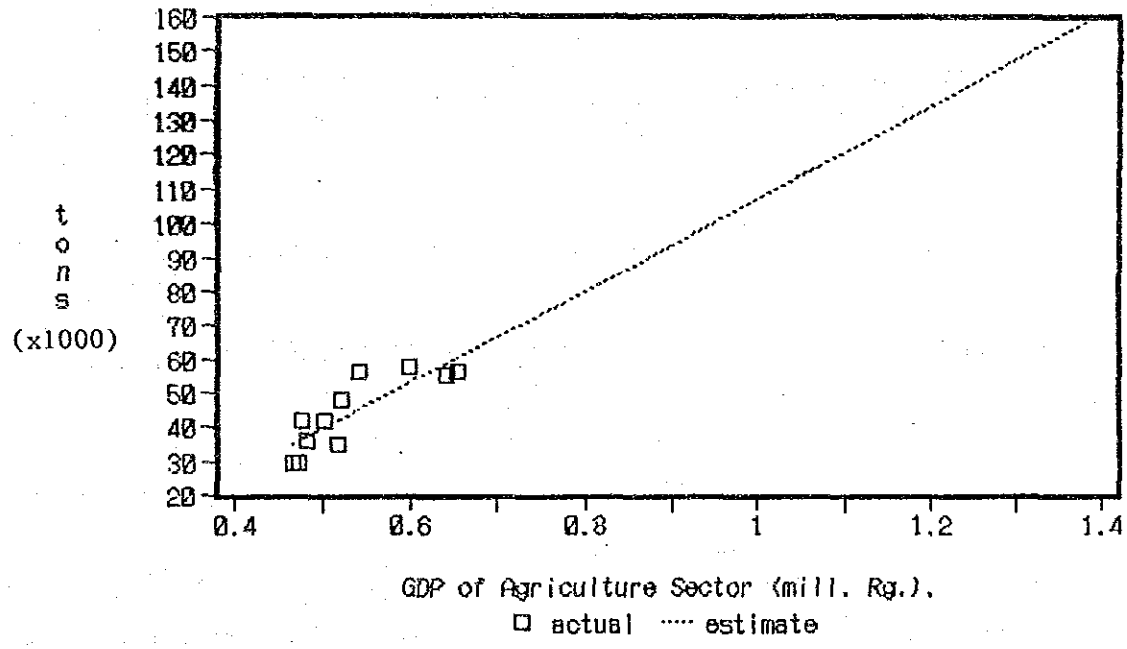


Figure-4.3.2.8 Future Cargo Volume
Feed/Fertilizer (Import)

Table-4.3.2.18 Projection of Import Volume of "Fertilizer and Feed" at Rajang Port

Year	GDP of Agriculture Sector in Sarawak (million Rg.)	Import Volume at Rajang Port (1000 tons)
1985	504	42
1990	654	61
1995	900	94
1997	950	101
2010	1380	159

d. petroleum products (import)

Import volume of petroleum products at Rajang Port can be explained by following equation.

$$V_p^i = a * GDP + b * N_C + c \qquad (4.3.2.7)$$

where,

V_p^i: Import volume of petroleum products at Rajang Port

And parameters can be obtained by multi-regression analysis as follows:

$$V_p^i = 3.25 * N_C + 4.93 * GDP - 52335 \quad (R^2 = 0.93) \qquad (4.3.2.8)$$

In the same way as the import volume of "motor vehicles" is forecast in "a. motor vehicles (import)", the future import volume at Rajang Port can be forecast this equation as shown in **Table-4.3.2.19.**

Table-4.3.2.19 Projection of Import Volume of "Petroleum Products" at Rajang Port

Year	GDP in Sarawak (million Rg.)	No. of Car in the Hinterland	Import Volume at Rajang Port (1000 tons)
1985	5349	74300	211
1990	6312	93000	281
1995	8370	112700	355
1997	8840	120900	384
2010	12900	179800	595

e. miscellaneous (imports)

Figure-4.3.2.9 shows the relationship between the import volume of "miscellaneous" at Rajang Port and population in the hinterland. Dotted line is a regression line which fits the correlation. And the correlation equation is as follows.

$$V_o^i = 1374 * POP - 494462 \quad (r = 0.91) \qquad (4.3.2.9)$$

where,

V_o^i: import volume of "miscellaneous" at Rajang Port

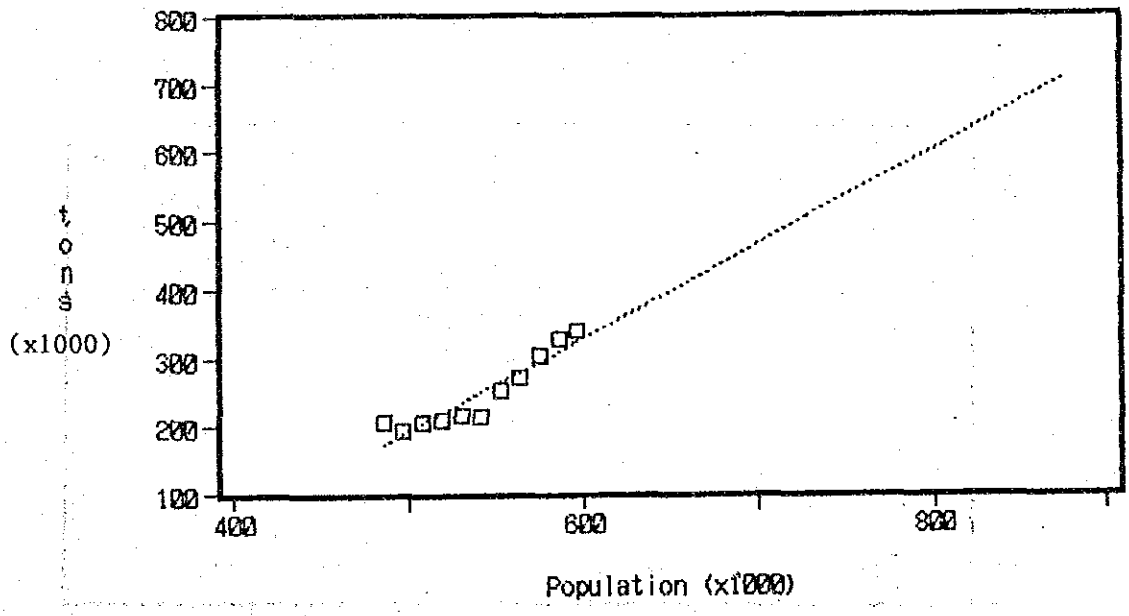


Figure-4.3.2.9 Future Cargo Volume Miscellaneous (Import)

The future import volume at Rajang Port can be forecasted by using this equation as shown in **Table-4.3.2.20.**

Table-4.3.2.20 Projection of Import volume of "Miscellaneous" at Rajang Port

Year	Population in the Hinterland (x 1000)	Import Volume at Rajang Port (1000 tons)
1985	541	213
1990	596	325
1995	659	411
1997	687	450
2010	877	711

f. agricultural products (exports)

Figure-4.3.2.10 shows the relationship between the export volume of "agricultural products" at the Rajang Port and GDP of the agriculture sector in Sarawak. The dotted line is a regression line fitting the correlation. And the correlation equation is as follows.

$$V_a^e = 128.5 * GDPa - 5178 \quad (r = 0.75) \qquad (4.3.2.9)$$

where,

V_a^e: export volume of "agricultural products" at Rajang Port

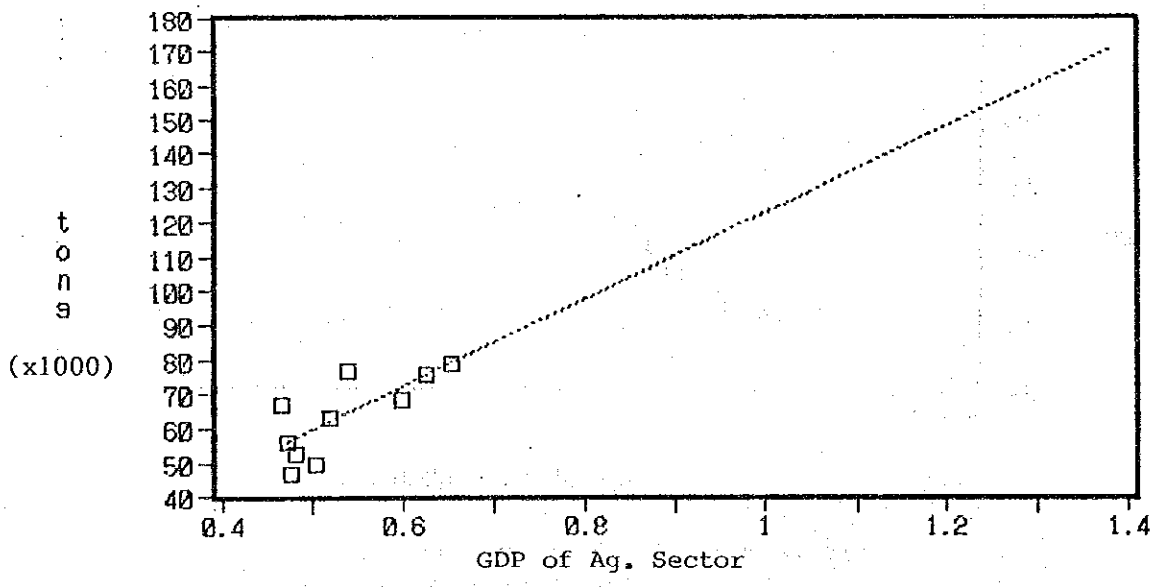


Figure-4.3.2.10 Future Cargo Volume Agricultural Products (Export)

The future export volume at the Rajang Port can be forecast by using this equation as shown in **Table-4.3.2.21.**

Table-4.3.2.21 Projection of Export Volume of "Agricultural Products" at Rajang Port

Year	GDP of Agriculture Sector in Sarawak (million Rg.)	Export Volume at Rajang Port (1000 tons)
1985	504	49
1990	654	79
1995	900	110
1997	950	117
2010	1380	172

g. Palm Oil/Palm Kernel (export)

Table-4.3.2.22 shows palm oil tree plantation plan up to 1995.

Table-4.3.2.22 Palm Oil Tree Plantation Plan (up to 1995) in the Hinterland

Agency	District	Area(ha)		
		-1985	1986-1990	1991-1995
FELCRA	All	0	0	7000
KSIADP	Kalaka	0	0	2800
KSIADP	Saribas	0	2900	1300
(total)		0	2900	11100
SLDB	Mukah	3514	0	2000
TOTAL		3514	2900	13100

Source: Sarawak Planning Unit

As palm oil produced in the SLDB scheme has not been exported from Rajang Port, it is assumed that the palm oil from the SLDB will not be exported form Rajang Port hereafter. Palm oil trees start to yield crops in three years after plantation and reach almost the maximum yield level in another four years. And unit production rate of palm oil and palm kernel per oil palm plantation area are as shown in **Table-4.3.2.23.** Consequently, future production of palm oil and palm kernel in the hinterland is expected to account for as shown in **Figure-4.3.2.11** and **Table-4.3.2.24**, under assumption that the plantation area will increase in steady pace (2900ha/5 per year: 1986-1990, 11100ha/5 per year: 1991-1995).

Table-4.3.2.23 Unit Production Rate of Palm Oil/Kernel

Product	Palm Oil	Palm Kernel
Rate (ton/ha)	3.18	0.85

Source: Agriculture Statistics,
Statistic Department, Sarawak

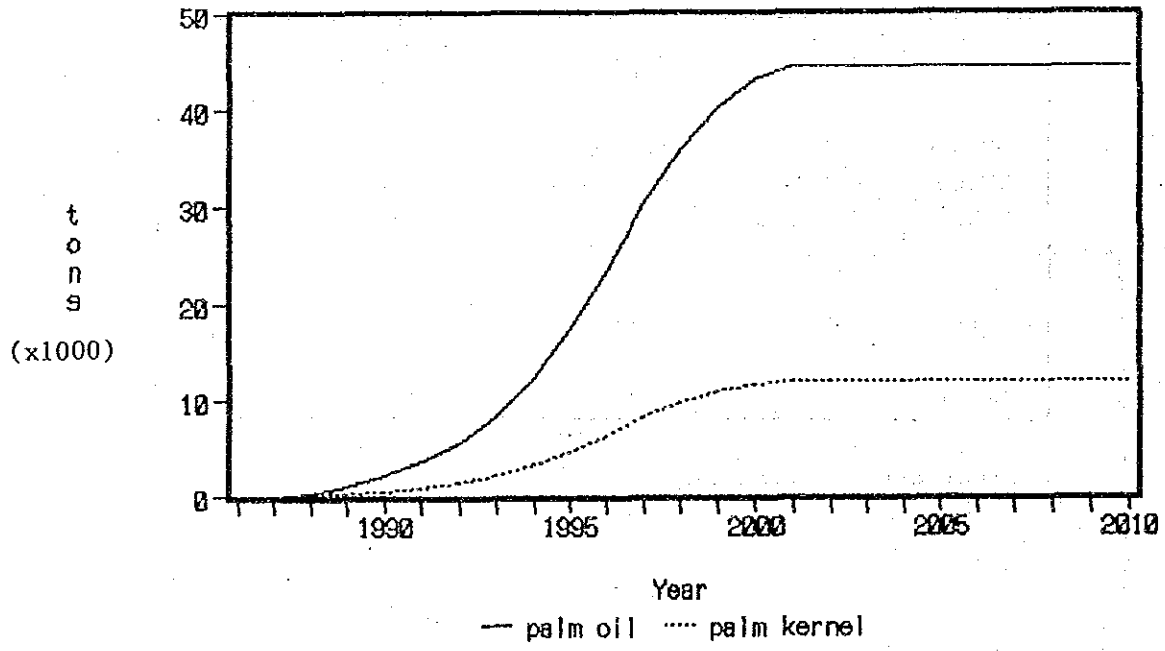


Figure-4.3.2.11 Future Production of Palm Oil/Kernel in the Hinterland

Table-4.3.2.24 Future Production of Palm Oil/Kernel in the Hinterland (tons)

Year	Palm Oil	Palm Kernel
1990	2200	600
1995	17300	4700
1997	30400	8200
2000	43100	11700
2010	44500	12000

It is assumed that these volumes will be exported form Rajang Port.

h. Petroleum Products (export)

Some part of imported petroleum products are transshipped to other parts of Sarawak and Saba. The volume of exported petroleum products has a tight relationship with volume of imported petroleum products. **Figure-4.3.2.12** shows the relationship between import and export volume of petroleum products at Rajang Port. The dotted line is a regression line which fits the correlation. And correlation equation is as follows.

$$V_p^e = 0.641 * V_p^i - 59148 \quad (r = 0.98) \qquad (4.3.2.10)$$

where,

V_p^e: *export volume of "petroleum products" at Rajang Port*

V_p^i: import volume of "petroleum products" at Rajang Port

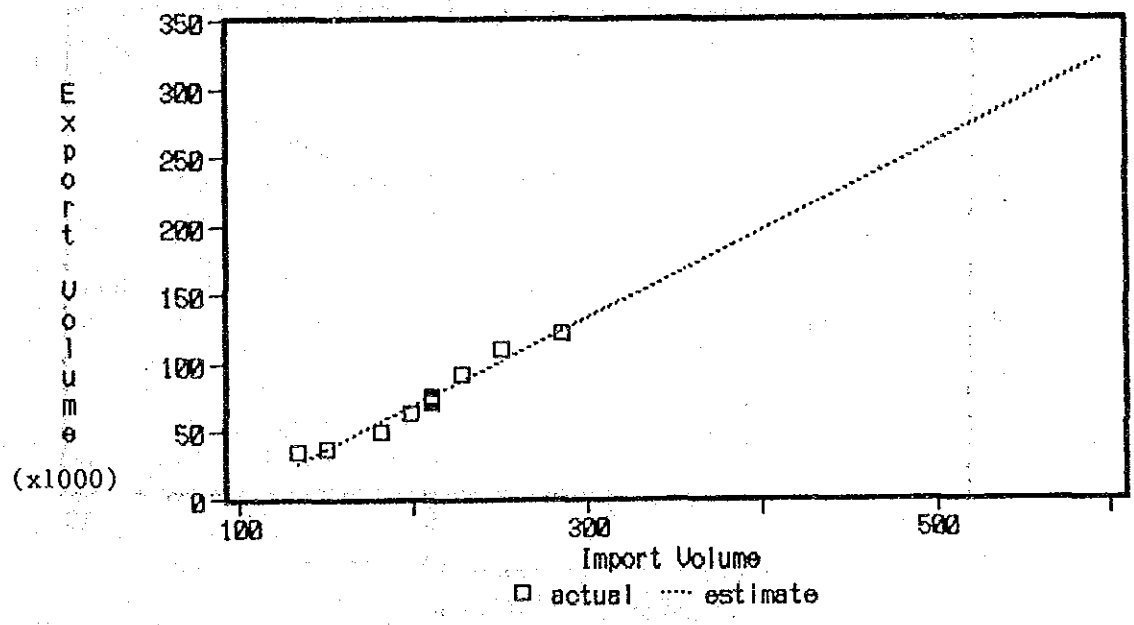


Figure-4.3.2.12 Relationship between Import and Export Volume at Rajang Port

The future export volume can be forecast by this equation as shown in **Table-4.3.2.25.**

Table-4.3.2.25 Projection of Export Volume of "Petroleum Product" at Rajang Port

Year	Import Volume at Rajang Port (1000 tons)	Export Volume at Rajang Port (1000 tons)
1985	211	74
1990	281	121
1995	355	168
1997	384	187
2010	595	322

i. miscellaneous (exports)

Figure-4.3.2.13 shows the relationship between the export volume of "miscellaneous" at Rajang Port and GDP in Sarawak. The dotted line is a regression line fitting the correlation. And the correlation equation is as follows.

$$V_o^e = 7.54 * GDP - 21799 \quad (r = 0.95) \qquad (4.3.2.11)$$

where.

V_o^e: export volume of "miscellaneous" at Rajang Port

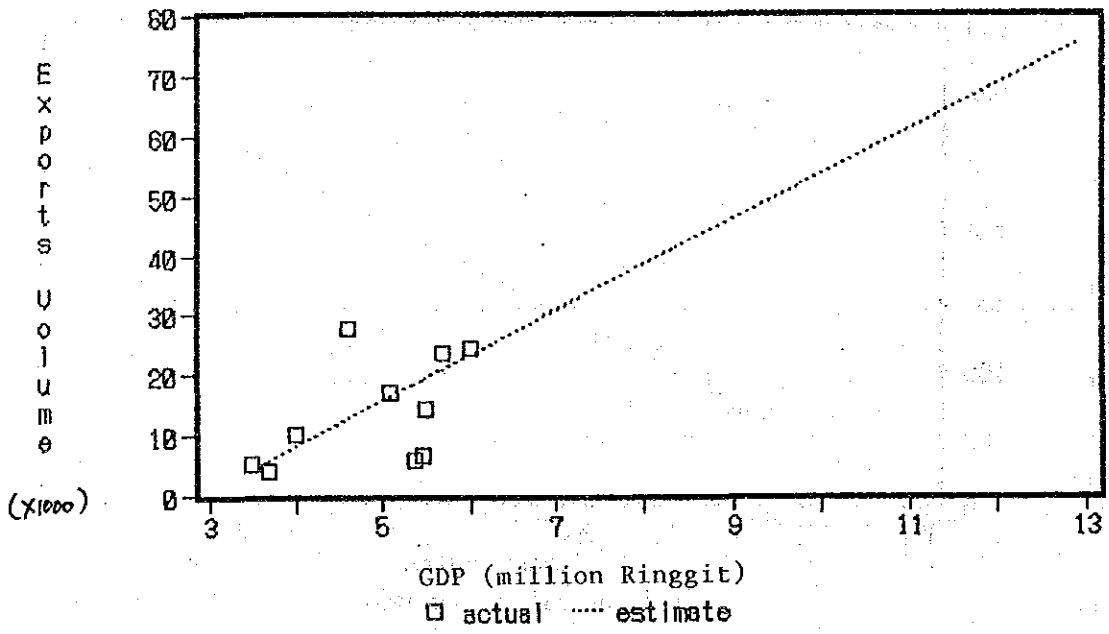


Figure-4.3.2.13 Future Cargo Volume Miscellaneous (Export)

The future export volume at Rajang Port can be forecast by using this equation as shown in **Table-4.3.2.26.**

Table-4.3.2.26 Projection of export volume of "Miscellaneous" at Rajang Port

Year	GDP in Sarawak (million Rg.)	Export Volume at Rajang Port (1000 tons)
1985	5349	6
1990	6312	26
1995	8367	41
1997	8840	45
2010	12900	75

iii) Conclusion

Table-4.3.2.27 shows the cargo volume projection for "other cargoes".

Table-4.3.2.27 Projection of Cargo Volume Handled at Rajang Port

Unit: 1000 tons

Commodity \ Year	1980	1985	1990	1995	1997	2010
Import	**457**	**561**	**758**	**990**	**1081**	**1676**
motor vehicles	6	13	22	46	47	59
food	47	56	69	84	91	137
fertilizer and feed	35	42	61	94	101	159
petroleum products	133	211	281	355	384	595
cargo related to thermal power plant					8	15
miscellaneous	236	239	325	411	450	711
Export	**105**	**131**	**232**	**344**	**401**	**650**
agricultural products	66	49	79	110	117	172
palm oil	0	0	2	17	30	45
palm kernel	0	2	4	8	11	15
petroleum products	34	74	121	168	187	322
cargo related to thermal power plant					11	21
miscellaneous	5	6	26	41	45	75
TOTAL	**562**	**692**	**990**	**1334**	**1482**	**2326**

(4) Unitized Cargoes

i) Container Cargoes

a. Containerization Ratio

Table-4.3.2.28 shows cargo volume that can be containerized, TEUs handled and containerization ratio at Rajang Port.

Table-4.3.2.28 Container Ratio

Year	Containerizable Cargo* (1000F/T)		Laden TEUs		Container Cargo (F/T)		Ratio (%)	
	Export	Import	Ex.	Im.	Ex.	Im.	Ex.	Im.
1982	77	227	5	191	60	2292	0.1	0.1
1983	80	233	105	728	1260	8736	1.6	3.7
1984	64	250	51	1726	612	20712	1.0	8.3
1985	55	239	155	2395	1860	28740	3.4	12.0
1986	70	271	332	3014	3984	36168	5.7	13.3
1987	91	300	752	3979	9024	47748	9.9	15.9
1988	92	330	1132	5072	13584	60864	14.8	18.4
1989	100	350	1584	6010	19008	72120	19.0	20.6

* Containerizable Cargo: agricultural products (export)
miscellaneous cargo (export and import)
assumption: cargo volume per TEU = 12 tons (National Port Plan)

In the "National Port Plan," the Economic Planning Unit, Malaysia, containerization ratios for Peninsular Malaysia were projected as follows:

Table-4.3.2.29 Containerization Ratio Projection for Peninsular Malaysia (%)

	1985	1990	1995	2000	2005	2010
Exports						
Rubber	65	65	75	80	85	85
Latex	50	50	50	50	50	50
Sawn Timber	10	10	10	15	15	15
Other Exports	45	55	60	70	80	85
Imports						
Chemicals	40	40	50	60	60	60
Heavy Cargo*	20	20	20	25	30	35
Other Imports	45	55	60	70	80	85

* "Heavy Cargo" consists of Iron and Steel, Tin Plate and Paper (including newsprint).

Source: Economic Planning Unit, Malaysia, "National Port Plan"

Generally, the containerization ratio grows on a so-called logistic curve as follows:

$$Rc(t) = P / (1 + a * \exp(-b*t)) \qquad (4.3.2.12)$$

where,

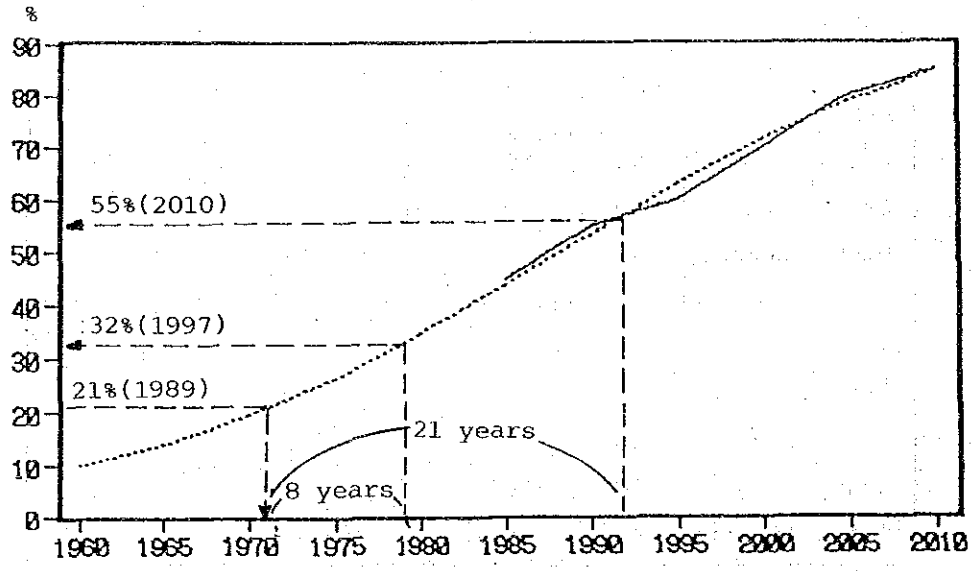
Rc(t): containerization ratio in year t

P: saturation level of the ratio

d, b: parameters

Containerization ratio for "other exports" and "other imports" in **Table-4.3.2.29** can be fit to formula (4.3.2.12) with parameters calibrated by regression as shown in **Figure-4.3.2.14.** The ratio for the Rajang Port can be regarded to be the 1971 level, that is, 18 years behind that for

Peninsular Malaysia according to this logistic curve. Therefore, the ratios for agricultural products (export) and miscellaneous cargoes (export and import) at Rajang Port in 1997 and 2010 (1979 and 1992 on the curve) can be read from this curve to be 32 and 55, respectively.



- National Port Plan --- Logistic Curve

R=0.9874971 (ln(P/Rc(T)-1)=ln(a)-b*t)

Figure-4.3.2.14 Containerization Ratio

Some percentage of sawn timber and other timber products will also be exported in containers in the future. The containerization ratios of sawn timber in 1997 and 2010 were set on the basis of **Table-4.3.2.29** and those of other timber products were assumed to be the same as that of agricultural products (export) and miscellaneous cargoes (export and import) stated above.

Consequently, the future containerization ratio at the Rajang Port can be projected as shown in **Table-4.3.2.30.**

Table-4.3.2.30 Forecast of containerization Ratio at Rajang Port (%)

Year	1989		1997		2010	
	Ex.	Im.	Ex.	Im.	Ex.	Im.
Agri. Prod. (export) miscelleous (ex. im.)	19	21	32	32	55	55
Sawn Timber	-	-	10	10	15	15
Other Timber Products	-	-	32	32	55	55

b. Container Cargo

Container cargo volume can be calculated as production of containerizable cargo and containerization ratio. The difference between laden containers import and export will be carried out of Sibu and Sarikei as empty containers.

Most these containers will be carried to the new timber products wharf in the Tg. Manis area and loaded with the timber products.

As the number of empty containers forwarded from Sibu are insufficient for timber products export from the timber products terminal in Tg. Manis area, empty containers should be imported.

How many tons of cargo can be vanned in one container is another important point for a TEU projection. In the "National Port Plan", average tons per TEU was projected to be 12. However, we fixed different average tons for timber products in this report. We assumed that 70% of full capacity of 20-foot container ($29m^3 \times 0.7 = 20m^3$) can be filled with timber products, because timber products are rectangular and can be stored efficiently.

Consequently, we set average tons per TEU as shown in Table-4.3.2.31.

Table-4.3.2.31 average tons per TEU

Commodity	average tons/TEU
Genanal	12
Timber Products	20*

* $1m^3$ is converted to be 1 freight ton.

Table-4.3.2.32 shows containerizable cargo and TEUs at Rajang Port.

Table-4.3.2.32 Forecast of Container Cargo at Rajang Port

unit: 1000t, TEU

			1989	1997	2010
Containerizable Cargo Volume 1	Export		100	162	247
	Import		350	450	711
Containerizable Cargo Volume 2	Export			516	1349
	Import			0	0
Containerizable Cargo Volume 3	Export			490	1704
	Import			0	0
Container Cargo Volume	Export	1	19	52	136
		2		52	202
		3		157	937
	Import		72	144	391
TEUs	Export	Laden 1	1584	4300	11300
		Laden 2		2600	10100
		Laden 3		7900	46900
		Empty	4422	0	0
	Import	Laden	6010	12000	32600
		Empty	109	2800	35700

cargo 1: agricultural products

cargo 2: sawn timber

cargo 3: plywood, etc.

ii) Palletized Cargo

The pallet ratio, the ratio of palletized cargo occupying total cargo except container cargo, has decreased the last decade and the ratio in 1990 was 12%.

Table-4.3.2.33 shows palletized cargo volume projected under the assumption that the future pallet ratio at the Rajang Port will be the same as that in 1990.

Table-4.3.2.33 Projection of Palletized Cargo Volume at Rajang Port (1000 tons)

Year	General Cargo (1)	Containerization Cargo (2)	Palletizable Cargo (1)-(2)	Palletized Cargo {(1)-(2)}x0.12
1997	892	197	695	83
2010	1373	528	845	101

Timber log, timber products, coal and petroleum products are not included.

(5) Conclusion of Demand Forecast

i) Total cargo volume

Table-4.3.2.34 shows cargo volumes of exports, imports and total cargo volume handled at the Rajang Port in 1997 and 2010.

Cargo volumes of all commodities, except timber logs, will grow as the state economy grows. The export volume of logs is expected to decline to zero due to the reduction of log production in Sarawak and the shift to down-stream timber industries, that is, timber processing industries. By contrast, export volume of timber products is expected to increase.

Table-4.3.2.34 Cargo Volume Projection

(1000 Freight Tons)

COMMODITY	1989	1997	2010
EXPORT	4439	5049	4455
Timber Products	422	1481	3205
Logs	3715	2917	0
Coal	79	250	600
Agricultural Products	76	128	187
Palm Oil	0	30	45
Petroleum Products	122	187	322
Others	25	56	96
IMPORT	785	1081	1676
Motor Vehicles	24	47	59
Food	71	91	137
Feed/Fertilizer	55	101	159
Petroleum Products	285	384	595
Others	350	458	726
TOTAL	5224	6130	6131

4.3.3 Cargo volume of coastal and riverine cargo transportation

At present, in the study area, coastal and riverine transportation lands and loads at Sibu, Sarikei and Bintangor wharves as shown in **Table-4.3.3.1.**

We assume that the transportation demand for general cargo (consumption goods) and rice grows with the growth in population of districts involved in each transportation. **Table-4.3.3.2** shows the forecast population growth rates from 1988 to 1997 and 2010 for each route.

Population of Sarikei district includes populations of TPZ. So, the demand of Sarikei can be divided into the demands of TPZ and the rest of Sarikei according to the proportion of populations for the two areas. Finally, we obtained future demand for coastal and riverine transportation at Sibu, Sarikei and Bintangor wharves (**Table-4.3.3.3**). Here, we obtained the demand for cement by interpolating and extrapolating the forecasts conducted in "Master Plan Study for Coastal and Riverine Transport in Sarawak".

Table-4.3.3.1 Present Situation of Coastal and Riverine Transportation in the Rajang River Region (1988)

SIBU	GENERAL CARGO		RICE	CEMENT
	OUT	IN	OUT	IN
Ngemah	1656	84		
Song	3366	156		
Kapit	6984	1452		
Sarikei			7200	
Bintangor	3360	378	3000	
T.Sebubal				
Belaga	1400	166		
Durin	48	0		
Daro	2592	36		
Matu	1224	294		
Dalat	5382	102		
Oya	420	1800		
Kabong	1050	1110		
R. Other	0	0		
Kuching	7644	24658		63240
Marudi	2210			
Miri	11160			
Limbang	3575			
Lawas	2818	11897		
Others	191	40		
Total	55080	42173	10200	63240

SARIKEI	GENERAL CARGO		RICE
	OUT	IN	IN
Sibu			7200
Ngemah			
Song			
Kapit			
Bintangor			
T.Sebubal			
Belaga			
Durin			
Daro			
Matu			
Dalat			
Oya			
Kabong			
R. Other			
Kuching	4682	9039	
Marudi			
Miri			
Limbang			
Lawas			
Others			
Total	4682	9039	7200

BINTANGOR	GENERAL CARGO		RICE
	OUT	IN	IN
Sibu	378	3360	3000
Ngemah			
Song			
Kapit			
Bintangor			
T.Sebubal			
Belaga			
Durin			
Daro			
Matu			
Dalat			
Oya			
Kabong			
R. Other			
Kuching		1836	
Marudi			
Miri			
Limbang			
Lawas			
Others			
Total	378	5196	3000

R. Other: Other riverine areas

Source: "Master Plan Study for Coastal and Riverine Transportation in Sarawak", 1990

Table-4.3.3.2(1) Population Growth in District(s) Involved in Each Route

(Sibu Wharf)

(1000 persons)

	1988	1997	2010	97/88	2010/88	District(s)
SIBU	165	191	237	1.16	1.44	Sibu
Ngemah	36	43	54	1.19	1.5	Kanowit
Song	20	23	31	1.15	1.55	Song
Kapit	45	54	69	1.2	1.53	Kapit
Sarikei	50	75	96	1.5	1.92	Sarikei
Bintangor	33	38	48	1.15	1.45	Maradong
Belaga	14	17	23	1.21	1.64	Belaga
Durin	34	40	52	1.18	1.53	Julau
Daro	21	24	31	1.14	1.48	Daro
Matu	21	24	31	1.14	1.48	Daro
Dalat	67	77	98	1.15	1.46	Dalat/Mukah
Oya	67	77	98	1.15	1.46	Dalat/Mukah
Kabong	89	105	138	1.18	1.55	Saratok/Betong
Kuching	574	687	877	1.2	1.53	Hinterland
Marudi	574	687	877	1.2	1.53	Hinterland
Miri	574	687	877	1.2	1.53	Hinterland
Limbang	574	687	877	1.2	1.53	Hinterland
Lawas	574	687	877	1.2	1.53	Hinterland
Others	574	687	877	1.2	1.53	Hinterland

Table-4.3.3.2(2) Pupulation Growth in District(s) Involved in each Route

(Sarakei Wharf)

(1000 persons)

	1988	1997	2010	97/88	2010/88	District(s)
Sarikei	50	75	96	1.5	1.92	Sarikei
Sibu	165	191	237	1.16	1.44	Sibu
Kuching	574	687	877	1.2	1.53	Hinterland

Table-4.3.3.2(3) Population Growth in District(s) Involved in Each Route

(Bintangor Wharf)

(1000 persons)

	1988	1997	2010	97/88	2010/88	District(s)
Sarikei	33	38	48	1.15	1.45	Maradong
Sibu	165	191	237	1.16	1.44	Sibu
Kuching	574	687	877	1.2	1.53	Hinterland

Table-4.3.3.3(1) Future Demand for Coastal and Riverine Transportation at Sibu Wharf

(ton)

	1997				2010			
	GENERAL CARGO		RICE	CEMENT	GENERAL CARGO		RICE	CEMENT
	OUT	IN	OUT	IN	OUT	IN	OUT	IN
Ngemah	2000	100	0	0	2500	100	0	0
Song	3900	200	0	0	5200	200	0	0
Kapit	8400	1700	0	0	10700	2100	0	0
Sarikei	0	0	8400	0	0	0	10700	0
Bintangor	3900	400	3500	0	4900	500	4400	0
T.Sebubal	0	0	2400	0	0	0	3100	0
Balaga	1700	200	0	0	2300	200	0	0
Durin	100	0	0	0	100	0	0	0
Daro	3000	0	0	0	3800	100	0	0
Matu	1400	300	0	0	1800	400	0	0
Datat	6200	100	0	0	7900	100	0	0
Oya	500	2100	0	0	600	2600	0	0
Kabong	1200	1300	0	0	1600	1600	0	0
Kuching	9200	28600	0	94200	11700	35500	0	137900
Marudi	2700	0	0	0	3400	0	0	0
Miri	13400	0	0	0	17100	0	0	0
Limbang	4300	0	0	0	5500	0	0	0
Lawas	3400	13800	0	0	4300	17100	0	0
Others	200	0	0	0	300	100	0	0
Total	65500	48800	14300	94200	83700	60600	18200	137900

Table-4.3.3.3(2) Future Demand for Coastal and Riverine Transportation at Sarikei Wharf

(ton)

	1997			2010		
	GENERAL CARGO		RICE	GENERAL CARGO		RICE
	OUT	IN	IN	OUT	IN	IN
Sibu	0	0	8400	0	0	10700
Kuching	5600	10500	0	7200	13500	0
Total	5600	10500	8400	7200	13500	10700

Table-4.3.3.3(3) Future Demand for Coastal and Riverine Transportation at Timber products Terminal (Tg. Sebubal)

(ton)

	1997		2010	
	GENERAL IN	RICE IN	GENERAL IN	RICE IN
Sibu	0	2400	0	3100
Kuching	3100	0	3900	0
Total	3100	2400	3900	3100

Table-4.3.3.3(4) Future Demand for Coastal and Riverine Transportation at Bintangor Wharf

(ton)

	1997			2010		
	GENERAL CARGO		RICE	GENERAL CARGO		RICE
	OUT	IN	IN	OUT	IN	IN
Sibu	400	3900	3500	500	4900	4400
Kuching	0	2100	0	0	2700	0
Total	400	6000	3500	500	7600	4400

4.4 Passenger Volume Forecast

4.4.1 Present Passenger Boat Service Network

In the study area, many passenger boat service routes have been established as shown in **Table-4.4.1.1.** About 70 passenger boats are operated on almost all routes. The coastal route of Sarikei-Kuching uses larger boats of about 160 passenger capacity.

Table-4.4.1.1 Present Passenger Volume
(two ways, daily)

Route	Freq.	1990 Capacity	Passengers
UPSTREAM			
Sibu-Durin	11	748	480
Sibu-Durin-Kanowit	5	340	177
Sibu-Kanowit	5	340	148
Sibu-Kanowit-Ng Dap	4	272	131
Sibu-Kanowit-Song	2	136	45
Sibu-Song	1	68	20
Sibu-Song-Kapit-Tanah Balleh	1	68	69
Sibu-Song-Kapit	4	272	213
Sibu-Kapit	5	340	176
Sibu-Kapit-Belaga	0.5	34	13
Sibu-Kapit-Belaga-Bakun	1	68	38
Sibu-kapit-Mawai	1	68	36
Sibu-Kapit-Tanah Balleh	0.5	34	73
Sibu-Kapit-Putai	0.5	34	23
DOWNSTREAM			
Sibu-Dalat	0.5	34	22
Sibu-Kuit-Dalat	0.5	34	20
Sibu-Singat-Daro-Kuit-Matu	0.5	34	18
Sibu-Penasu-Semah-Semop	0.5	34	70
Sibu-Sg.Kuit-Igan	1	68	56
Sibu-Paloh	0.5	34	50
Sibu-Ng Ngemah	0.5	34	50
OTHER			
Sibu-Bintangor-Sarikei	19	1292	
Sibu-Bintangor			283
Sibu-Sarikei			1212
Bintangor-Sarikei			221
Sarikei-Tg. Sebubal			
COASTAL EXPRESS			
Sarikei-Kuching	2	328	419

4.4.2 Forecast

We assume that passenger volume will grow as average population growth of districts involved in each route increases. **Table-4.4.2.1** shows the population growth rate from 1990 to 1997 and 2010 for each route. Then, we can forecast future demand for passenger transportation at Sibu, Sarikei and Bintangor wharves (**Table-4.4.2.2**).

As the TPZ will have a large population, 17,000 in 1997 and 24,000 in 2010, we proposed a new route between Sarikei and Tg. Sebubal. We estimated passenger volume of the new route by a gravity model. **Table-4.4.2.3** shows distance, passenger volume and population of districts involved in the main riverine routes.

We projected passenger volume of the new route by a gravity model as follows.

$$vij = k * (Pi * Pj / Dij^{a}) \qquad (4.4.2.1)$$

or,

$$Ln(Vij / Pi * Pj) = - a * Ln(Dij) + Ln(k) \qquad (4.4.2.2)$$

where,

Vij: Passenger Volume of route between i and j

Pi : Population of district i

Dij: Distance between i and j

k, a: parameters which can be calibrated empirically

Table-4.4.2.1 Population Growth in Districts Involved in Each Route

ROUTE	POPULATION (x 1000)*									Growth Rate		DISTRICTS
	1990			1997			2010			97/90	10/90	
UPSTREAM												
Sibu-Durin	171	35		191	40		237	52		1.13	1.44	SIBU JULAU
Sibu-Durin-Kanowit	171	35	38	191	40	43	237	52	54	1.13	1.43	SIBU JULAU KANOWIT
Sibu-Kanowit	171	38		191	43		237	54		1.12	1.4	SIBU KANOWIT
Sibu-Kanowit-Ng Dap	171	38		191	43		237	54		1.12	1.4	SIBU KANOWIT
Sibu-Kanowit-Song	171	38	21	191	43	23	237	54	31	1.11	1.43	SIBU KANOWIT SONG
Sibu-Song	171	21		191	23		237	31		1.11	1.43	SIBU SONG
Sibu-Song-Kapit-Tanah Balleh	171	21	47	191	23	54	237	31	69	1.12	1.44	SIBU SONG KAPIT
Sibu-Song-Kapit	171	21	47	191	23	54	237	31	69	1.12	1.44	SIBU SONG KAPIT
Sibu-Kapit	171	47		191	54		237	69		1.13	1.43	SIBU KAPIT
SIbu-Kapit-Belaga	171	47	15	191	54	17	237	69	23	1.13	1.46	SIBU KAPIT BELAGA
Sibu-Kapit-Belaga-Bakun	171	47	15	191	54	17	237	69	23	1.13	1.46	SIBU KAPIT BELAGA
Sibu-kapit-Mawai	171	47		191	54		237	69		1.13	1.43	SIBU KAPIT
Sibu-Kapit-Tanah Balleh	171	47		191	54		237	69		1.13	1.43	SIBU KAPIT
Sibu-Kapit-Putai	171	47		191	54		237	69		1.13	1.43	SIBU KAPIT
DOWNSTREAM												
Sibu-Dalat	171	26		191	29		237	37		1.12	1.4	SIBU DALAT
Sibu-Kuit-Dalat	171	26		191	29		237	37		1.12	1.4	SIBU DALAT
Sibu-Singat-Daro-Kuit-Matu	171	22	26	191	24	29	237	31	37	1.11	1.41	SIBU DARO DALAT
Sibu-Penesu-Semah-Semop	171	22		191	24		237	31		1.1	1.4	SIBU DARO
Sibu-Sg.Kuit-Igan	171	26		191	29		237	37		1.12	1.4	SIBU DALAT
Sibu-Paloh	171	52		191	75		237	96		1.28	1.62	SIBU SARIKEI
Sibu-Ng Ngemah	171	38		191	43		237	54		1.12	1.4	SIBU KANOWIT
OTHER												
Sibu-Bintangor-Sarikei	171	34	52	191	38	58	237	48	72			SIBU MARADONG SARIKEI
Sibu-Bintangor	171	34		191	38		237	48		1.12	1.4	SIBU MARADONG
Sibu-Sarikei	171	52		191	58		237	72		1.12	1.39	SIBU SARIKEI
Bintangor-Sarikei	34	52		38	58		48	72		1.12	1.4	MARADONAG SARIKEI
Sibu-Ng Ngemeh	171			191	17		237	24				
COASTAL EXPRESS												
Sarikei-Kuching	52	171	596	58	191	687	72	237	877	1.13	1.41	SARIKEI SIBU SARAWAK

*population of each district

Table-4.4.2.2 Future Demand for Passenger Transportation and Boat Service Frequency

Route	Capacity per Boat	Occup. Rate	FORECAST 1990 DAILY PASS. 1997 (2 ways)	2010 (2 ways)	DAILY FREQ. 1997 (2 ways)	2010 (2 ways)
UPSTREAM						
Sibu-Durin	60	0.5	542	691	11	12
Sibu-Durin-Kanowit	60	0.5	200	253	5	5
Sibu-Kanowit	60	0.5	166	207	5	5
Sibu-Kanowit-Ng Dap	60	0.5	147	183	4	4
Sibu-Kanowit-Song	60	0.5	50	64	2	2
Sibu-Song	60	0.5	22	29	1	1
Sibu-Song-Kapit-Tanah Balleh	60	0.5	77	99	1	2
Sibu-Song-Kapit	60	0.5	239	307	4	5
Sibu-Kapit	60	0.5	199	252	5	5
SIbu-Kapit-Belaga	60	0.5	15	19	0.5	0.5
Sibu-Kapit-Belaga-Bakun	60	0.5	43	55	1	1
Sibu-Kapit-Mawai	60	0.5	41	51	1	1
Sibu-Kapit-Tanah Balleh	60	0.5	82	104	1	2
Sibu-Kapit-Putai	60	0.5	26	33	0.5	1
T O T A L					42	46.5
DOWNSTREAM						
Sibu-Dalat	60	0.5	25	31	0.5	1
Sibu-Kuit-Dalat	60	0.5	22	28	0.5	0.5
Sibu-Singat-Daro-Kuit-Matu	60	0.5	20	25	0.5	0.5
Sibu-Penasu-Semah-Semop	60	0.5	77	98	1	2
Sibu-Sg.Kuit-Igan	60	0.5	63	78	1	1
Sibu-Paloh	60	0.5	64	81	1	1
Sibu-Ng Ngemah	60	0.5	56	70	1	1
T O T A L					5.5	7
OTHER						
Sibu-Bintangor-Sarikei	60				23	28
Sibu-Bintangor		0.5	317	396		
Sibu-Sarikei		0.5	1357	1685		
Bintangor-Sarikei		0.5	248	309		
Sibu-Tg. Sebubal	60	0.5	70	123	1	2
T O T A L					23	30
COASTAL EXPRESS						
Sarikei-Kuching	164	0.5	407	431	2	3

Table-4.4.2.3 Distance, Passenger Volume of Main Riverine Routes and Population

Route	Distance (m)	Passengers (2 ways, daily)	Population (x1000)
Sibu-Durin	50	480	Sibu(171), Julau(35)
Sibu-Kanowit	50	456	Sibu(171), Kanowit(38)
Sibu-Song	100	65	Sibu(171), Song(21)
Sibu-Bintangor	45	283	Sibu(171), Maradong(34)
Bintangor-Sarikei	20	221	Maradong(34), Sarikei(52)

By using the data of **Table-4.4.2.3**, k and a in (4.4.2.1) or (4.4.2.2) are calculated to be 2.2 and 0.99, respectively (r = 0.90). Then we can calculate passenger volume between Sarikei and Tg. Sebubal as follows.

Table-4.4.2.4 Passenger Volume Forecast between Sarikei and Tg. Sebubal

Year	1998	2010
Population (x1000)		
TPZ	17	24
The reset of Sarikei	58	72
Distance (km)	32	32
Passenger Volume (daily, 2 ways)	70	123

Frequency of the service between Tg. Sebubal and Sarikei should be 1 and 2 round trips in 1997 and in 2010, respectively, assuming that passenger capacity of the boat engaged in the service will be 136 for round trip and that the occupancy rate will be 50%.

5. Required Facilities

5.1 Cargo Volume to be Handled at Each Wharf of Rajang Port

5.1.1 International trade cargo

(1) Cargo Volume at Each Wharf

i) Share of Cargo Handling Volume among Wharves

The cargo handling volume at each wharf is set under the assumption as follows:

- logs will be handled at the Tg. Manis Anchorage,
- timber products will be handled at a timber terminal in Tg. Manis area, as well as at the Tg. Manis Anchorage,
- coal will be handled at a coal terminal in the Tg. Manis area,
- petroleum products will be handled at Sg. Merah,
- other cargo will be handled at all wharves except Sg. Merah,
- the share of handling volume of the other cargo in future will be basically maintained at current levels,
- the wharf at Tg. Manis will also handle general cargo consumed in the timber processing zone.

ii) General Cargo consumed in the timber processing zone

Imported "food" and "miscellaneous" cargo are assumed to be consumed in the timber processing zone. The volumes were calculated based on the share of population in the zone of all population in the hinterland. Future population, the ratio against all population in the hinterland and the cargo volumes are shown in **Table-5.1.1.1.**

Table-5.1.1.1 Forecast of General Cargo handled at Tg. manis Wharf

Year	Population (TPZ) A	Population (Hinterland) B	Share (A/B) %	Cargo volme (1000 tons) Food R.P.	Food T.M.	Miscell. R.P.	Miscell. T.M.
1997	17300	687000	2.5	91	2	450	11
2010	23600	877000	2.7	137	4	711	19

R.P.: total volume at Rajang Port

T.M.: volume handled at wharf in Tg. Manis area

iii) Handling volume of cargo at each wharf

Consequently, handling volumes at each wharf in 1997 and 2010 are forecast as follows:

Table-5.1.1.2 Cargo Volume Handled at Each Wharf

Wharf	1989	1997	2010
Sibu	495	711	1097
Sarikei	56	147	223
Bintangor	12	24	38
S. Merah	340	536	856
Tg. Sebubal	0	1388	3917
Tg. Manis Anchorage	4185	3324	0
TOTAL	**5088**	**6130**	**6131**
EXPORT	4378	5049	4455
IMPORT	710	1081	1676

unit: 1,000tons, container cargo included

Table-5.1.1.3 Container Cargo Volume Handled at Each Wharf

Wharf	1989	1997	2010
Sibu	12125	22400	61200
Sarikei	0	3600	9600
Bintangor	0	200	600
Tg. Sebubal	0	21200	114600
TOTAL	**12125**	**47400**	**186000**
LADEN	7597	26800	101300
EMPTY	4531	20600	84700

unit: TEU

(2) Cargo Handling Volume at Each Wharf

Cargo handling volume at Sibu, Sarikei, Bintangor, Sungei Merah, new terminals in Tg. Manis area and Tg. Manis anchorage in 1997 and in 2010 are as follows.

Table-5.1.1.4 Cargo Handling Volume Forecast
Sibu, Sarikei, Bintangor,
Sungei Merah and Tg. Manis Area
(1997, 1000 F/T)

Commodity	Sibu	Sarikei	Bintang	S.Merah	Tg. Manis		Tg.Manis Anchorage	Total
					Timber T.	Coal T.		
EXPORT								
Timber Log	0	0	0	0	0	0	2917	2917
Timber Prod.	0	0	0	0	868	0	408	1275
Plywood/etc.	0	0	0	0	334	0	122	456
Sawn Timber	0	0	0	0	466	0	285	751
Wood Chips	0	0	0	0	68	0	0	68
Coal	0	0	0	0	0	250	0	250
Palm Oil	0	26	0	0	0	0	0	26
Agr. Prod.	29	40	2	0	6	0	0	77
Petroleum Prod.	0	0	0	187	0	0	0	187
Others	23	4	0	0	0	11	0	38
Container(t)	28	22	1	0	210	0	0	261
Container(TEU)								
Laden	2300	1800	100	0	10600	0	0	14800
Empty	0	0	0	0	0	0	0	0
Pallet(t)	8	9	0	0	1	0	0	18
(total)	88	101	3	187	1085	261	3325	5049
IMPORT								
Motor Veh.	38	0	0	0	8	0	0	46
Food	72	5	0	0	2	0	0	79
Feed/Fertilizer	54	20	15	0	0	0	0	89
Petroleum Prod.	19	4	0	349	4	8	0	384
Others	249	8	3	0	6	8	0	274
Container(t)	134	4	1	0	5	0	0	144
Container(TEU)								
Laden	11200	300	100	0	400	0	0	12000
Empty	0	0	0	0	2800	0	0	2800
Pallet(t)	57	5	2	0	1	0	0	65
(total)	623	46	21	349	26	16	0	1081
T O T A L	**711**	**147**	**24**	**536**	**1111**	**277**	**3325**	**6130**
Riverine								
Timber P.(in)	0	0	0	0	409	0	0	409
Coal(in)	0	0	0	0	0	500	0	500
Container(t)	0	0	0	0	0	0	0	0
Container(TEU)								
Laden	0	0	0	0	0	0	0	0
Empty(out)	8900	0	0	0	0	0	0	8900
Empty(in)	0	1500	0	0	7400	0	0	8900

Table-5.1.1.5 Cargo Handling Volume Forecast
Sibu, Sarikei, Bintangor,
Sungei Merah and Tg. Manis Area
(2010, 1000 F/T)

Commodity	Sibu	Sarikei	Bintang	S.Merah	Tg. Manis		Tg.Manis Anchorage	Total
					Timber T.	Coal T.		
EXPORT								
Timber Log	0	0	0	0	0	0	0	0
Timber Prod.	0	0	0	0	2073	0	0	2073
Plywood/etc.	0	0	0	0	770	0	0	770
Sawn Timber	0	0	0	0	1151	0	0	1151
Wood Chips	0	0	0	0	152	0	0	152
Coal	0	0	0	0	0	600	0	600
Palm Oil	0	40	0	0	0	0	0	40
Agr. Prod.	29	37	2	0	6	0	0	74
Petroleum Prod.	0	0	0	322	0	0	0	322
Others	25	4	0	0	0	21	0	50
Container(t)	75	58	2	0	1140	0	0	1275
Container(TEU)								
Laden	6200	4800	200	0	57500	0	0	67200
Empty	0	0	0	0	0	0	0	0
Pallet(t)	9	11	0	0	1	0	0	21
(total)	138	150	4	322	3220	621	0	4455
IMPORT								
Motor Veh.	47	0	0	0	12	0	0	59
Food	106	9	0	0	4	0	0	119
Feed/Fertilizer	83	32	23	0	0	0	0	138
Petroleum Prod.	29	6	0	543	6	20	0	595
Others	260	8	3	0	8	15	0	294
Container(t)	366	11	4	0	10	0	0	391
Container(TEU)								
Laden	30600	900	300	0	800	0	0	32600
Empty	0	0	0	0	35700	0	0	35700
Pallet(t)	68	7	4	0	1	0	0	80
(total)	959	73	34	534	41	35	0	1676
T O T A L	**1097**	**223**	**38**	**856**	**3261**	**656**	**0**	**6131**
Riverine								
Timber P.(in)	0	0	0	0	816	0	0	816
Coal(in)	0	0	0	0	0	1100	0	1100
Container(t)	0	0	0	0	0	0	0	0
Container(TEU)								
Laden	0	0	0	0	0	0	0	0
Empty(out)	24400	0	100	0	0	0	0	24500
Empty(in)	0	3900	0	0	20600	0	0	24500

(2) Calling ship forecast

i) Maximum ship size

Maximum ship size for transport of each commodity is as shown in **Table-5.1.1.6** (please see the details in 2.4).

Table-5.1.1.6 Maximum Ship Size

Commodity	Ship Type	Max. Size	Max. Load Factor
Timber Products	Conventional	5,000	1.0
		10,000	1.0
Coal	Dry Bulk Carrier	10,000	1.0
		20,000	0.9
		30,000	0.8
Petroleum Products	Tanker	3,000	1.0 (Sungei Merah)
Container	Cellular	5,000	1.0 (Sibu, Tg.Manis)
		10,000	1.0 (Tg.Manis)
	Others	5,000	1.0 (Sibu, Tg.Manis)
		10,000	1.0 (Tg.Manis)
General	Conventional	1,000	1.0 (Sarikei, Bintangor)
		2,000	1.0 (Sibu)
		5,000	1.0 (Sibu)

ii) Future ship size distribution at each wharf

Figure-5.1.1.1 and **5.1.1.2** show average GRT of ships which called at the each wharf and average handling volume per ship.

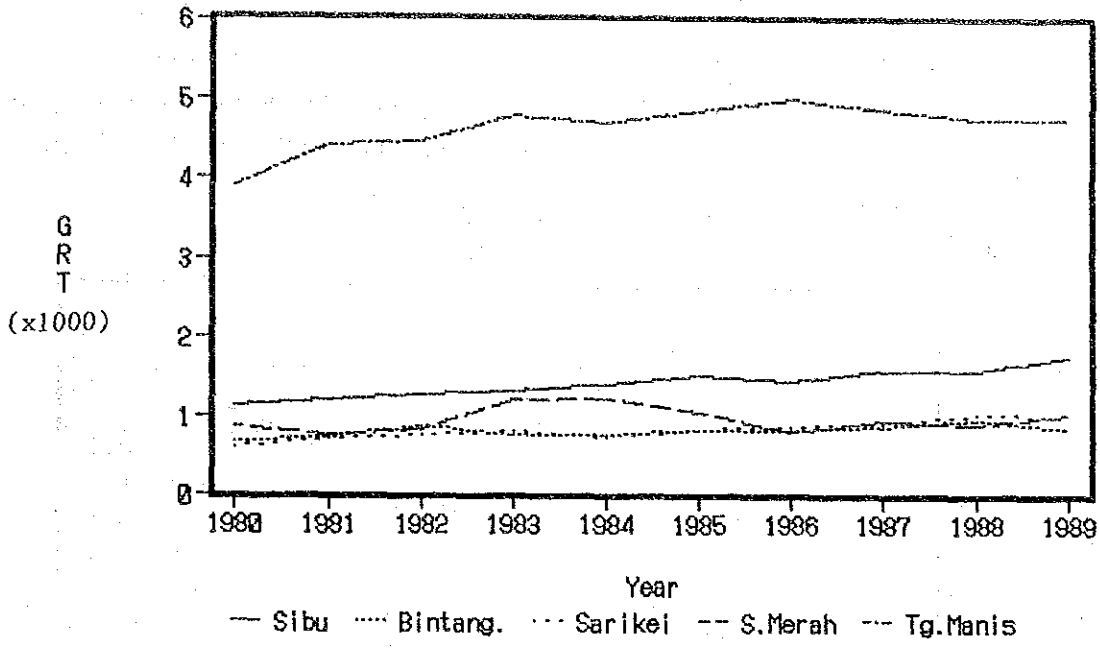


Figure-5.1.1.1 Average GRT at Each Wharf

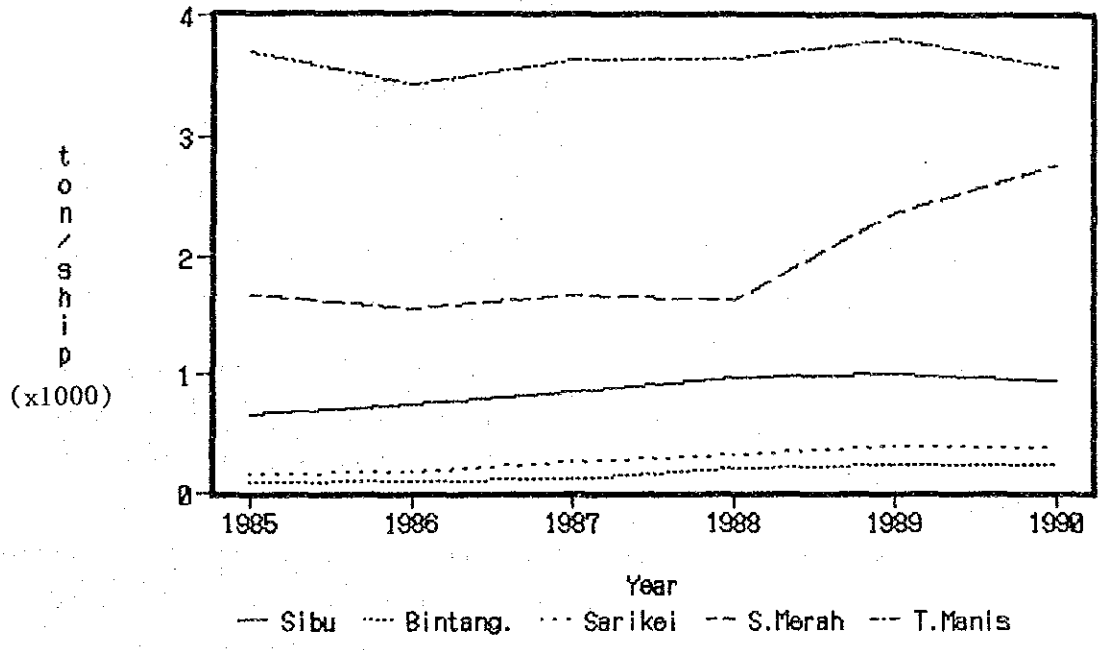


Figure-5.1.1.2 Average handling Volume per Ship at Each Wharf

Average GRTs at Bintangor, Sarikei and Sungei Merah have grown in the past decade and leveled off at about 1,000 GRT. Similarly, the average GRT at Tanjun Manis has leveled off at about 5,000 GRT. However, that at Sibu is still growing and is likely to increase to 2,200 GRT in 1997 and 3,000 GRT in 2010 (**Figure-5.1.1.3**).

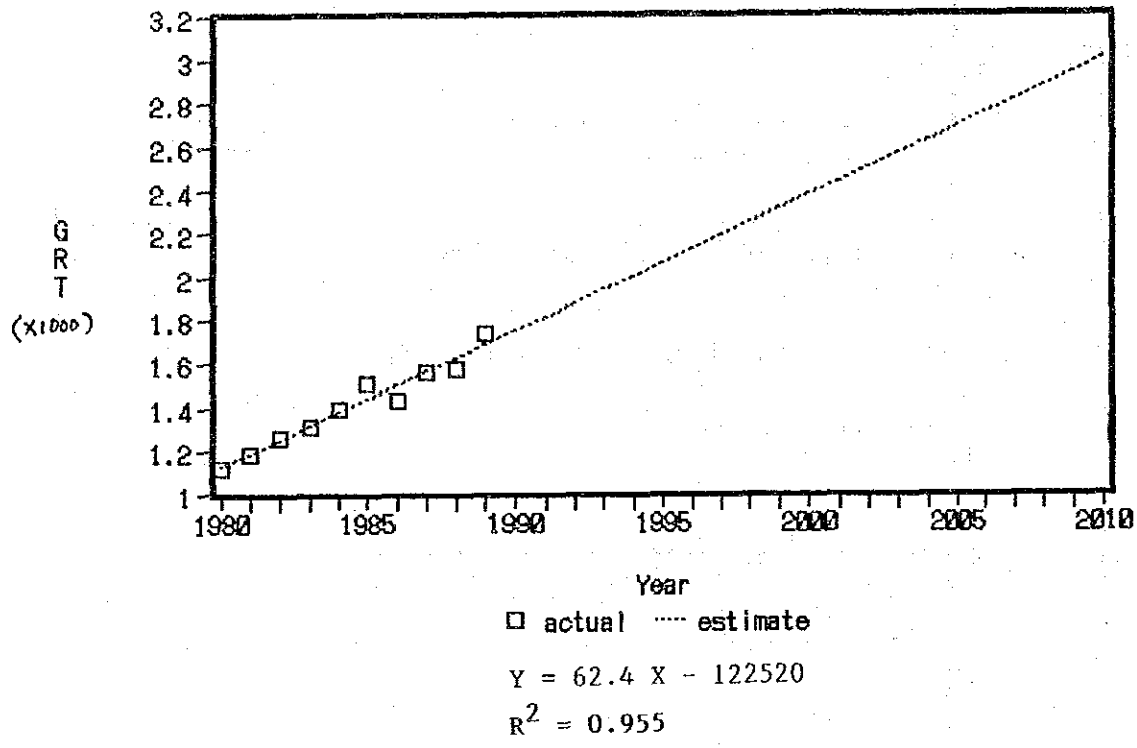


Figure-5.1.1.3 Projection of Average GRT at Sibu

Secondly, average handling volumes at all wharves except Sungei Merah have leveled off. And that at Sungei Merah is likely to remain at current levels in future because the size of ship now calling is at the maximum due to the water depth condition.

There will be a great difference in the size of ships that will be accommodated at a new timber products terminal because the loading condition will change by shifting from loading midstream in the river through barges to loading at the wharf with quay-side handling equipment. This will increase the ship size to the 10,000DWT class, which needs a depth of -10.0m for navigation; the maximum navigable depth at the estuary of Rajang River. The average GRT of ships currently calling at the Tg. Manis anchorage is about 5,000, equivalent to about 7,500DWT, so it is assumed that the average handling volume per ship will be 7,500 tons.

Consequently, average GRT, average handling volume per ship and no. of ship calling can be estimated as shown in **Table-5.1.1.7** and **5.1.1.8.**

Table-5.1.1.7 Average GRT, Average Handling Volume per Ship and No. of Ship Calling at the Each Wharf of Rajang Port (1997)

WHARF	Ave. GRT	Ave. Volume Per Ship	Total Volume to be Handled	No. of ship
Sibu	2200	1000	711000	711
Bintangor	1000	230	24000	104
Sarikei	1000	400	147000	368
S. Merah	1000	3000	536000	179
T. Manis (timber)	5000	7500	1111000	148

Table-5.1.1.8 Average GRT, Average Handling Volume per Ship and No. of Ship Calling at the Each Wharf of Rajang Port (2010)

WHARF	Ave. GRT	Ave. Volume per ship	Total Volume to be Handled	No. of ship
Sibu	3000	1000	1097000	1097
Bintangor	1000	230	38000	165
Sarikei	1000	400	223000	558
S. Merah	1000	3000	856000	285
T. Manis (timber)	5000	7500	3261000	435

The GRT distribution in ships calling at each wharf can be projected by assuming that:

- the GRT distribution in ships calling at Sarikei, Bintangor and Tg. Manis will not change because the average GRTs at these wharves have leveled off, and
- the ratio of ships ranging between 2,000 and 4,000GRT will increase at Sibu.

Table-5.1.1.9 GRT Distribution of Ships for International Trade (1997)

	Sibu	Sarikei	Bintang.	S.Merah	T.Manis (timber)	T.Manis (coal)	T.Manis Anchorage
Below 1000	218	223	65	-	6	15	35
1000 - 1999	129	145	39	-	3	12	17
2000 - 2999	152			-	18		112
3000 - 3999	144			-	45		289
4000 - 4999	14			-	40		253
5000 - 5999	38			-	15		92
6000 - 6999	16			-	7	1	46
7000 - 7999				-	1	3	2
8000 - 8999				-	1	3	6
9000 - 9999				-	3	2	17
10000 - 14999				-	4	8	22
15000 - 19999				-	4		22
Over 20000				-	1		6
T O T A L	711	368	104	534	148	44	919

Table-5.1.1.10 GRT Distribution of Ships for International Trade(2010)

	Sibu	Sarikei	Bintang.	S.Merah	T.Manis (timber)	T.Manis (coal)	T.manis Anchorage
Below 1000	112	339	103	-	17	31	
1000 - 1999	101	219	62	-	8	25	
2000 - 2999	370			-	53		
3000 - 3999	347			-	135		
4000 - 4999	36			-	118		
5000 - 5999	94			-	44		
6000 - 6999	38			-	22		
7000 - 7999				-	2	1	
8000 - 8999				-	3	1	
9000 - 9999				-	8	1	
10000 - 14999				-	11	4	
15000 - 19999				-	11	9	
Over 20000				-	3	11	
T O T A L	1097	558	165	1024	435	83	0

The GRT distribution at each wharf can be converted to DWT distribution by using **Figure-5.1.1.4** and following assumptions were set for projection of DWT distribution.

- ships of less than 3,000DWT will not call at the Tg. Mains timber products Terminal
- ships of 300DWT will be used for petroleum products delivery and ships ranging between 1000 and 3000 DWT will be used for the import to Sungei Merah.
- ships of following size will call at the coal terminal:

  10,000 - 20,000DWT --- coal exports to foreign countries (1997) and Kuching (2010)

  20,000 - 30,000DWT --- coal exports to foreign countries (2010)

  1,000 - 2,000DWT --- cargo related to the thermal power plant

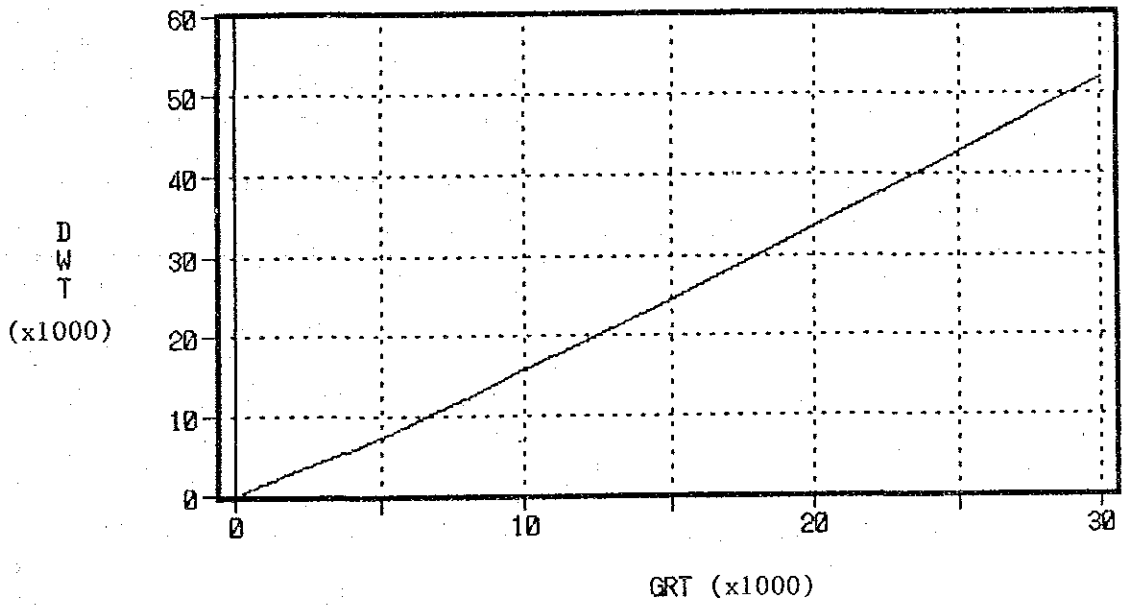


Figure-5.1.1.4 Relationship between GRT and DWT

Table-5.1.1.11 DWT Distribution of Ships (1997)

	Sibu	Sarikei	Bintang.	S.Merah	T.Manis (timber)	T.Manis (coal)	T.Manis Anchorage
Below 1000	140	144	42	374			23
1000 - 1999	118	124	35	40		27	18
2000 - 2999	104	100	27	120			12
3000 - 3999	125				13		79
4000 - 4999	123				24		153
5000 - 5999	101				31		200
6000 - 6999					25		166
7000 - 7999					17		94
8000 - 8999					11		55
9000 - 9999					6		28
10000 - 14999					9	8	35
15000 - 19999					4	9	17
Over 20000					8		39
T O T A L	711	368	104	534	148	44	919

Table-5.1.1.12 DWT Distribution of Ships (2010)

	Sibu	Sarikei	Bintang.	S.Merah	T.Manis (timber)	T.Manis (coal)	T.Manis Anochorage
Below 1000	85	218	66	644			
1000 - 1999	83	189	56	95		56	
2000 - 2999	82	151	43	285			
3000 - 3999	305				39		
4000 - 4999	299				71		
5000 - 5999	243				91		
6000 - 6999					75		
7000 - 7999					49		
8000 - 8999					32		
9000 - 9999					16		
10000 - 14999					26	3	
15000 - 19999					13	4	
Over 20000					23	20	
T O T A L	1097	558	165	1024	435	83	0

5.1.2 Coastal and riverine cargo

At Sibu, general cargo transported between Sibu and Kuching and rice shipped out of Sibu are handled at private wharves. This situation is expected to continue. Therefore, future cargo volume handled at Sibu, Sarikei, Tg. Sebubal and Bintangor is as follows:

Table-5.1.2.1 Coastal and Riverine Transportation Forecast for Sibu, Sarikei, Bintangor and Tg. Sebubal (Government Wharves, unit: ton)

Coastal Transportation (1997)

	General Cargo		Rice		Cement	TOTAL
	OUT	IN	OUT	IN	IN	
Sibu	27900	14200	0	0	94200	188400
Sarikei	5600	10500	0	8400	0	24500
Tg. Sebubal	0	3100	0	2400	0	5500
Bintangor	400	6000	0	3500	0	9900

Riverine Transportation (1997)

	General Cargo		Rice		Cement	TOTAL
	OUT	IN	OUT	IN	IN	
Sibu	28400	6000	0	0	0	34400

Coastal Transportation (2010)

	General Cargo		Rice		Cement	TOTAL
	OUT	IN	OUT	IN	IN	
Sibu	35500	17700	0	0	137900	256500
Sarikei	7200	13500	0	10700	0	31400
Tg. Sebubal	0	3900	0	3100	0	7000
Bintangor	500	7600	0	4400	0	12500

Riverine Transportation (2010)

	General Cargo		Rice		Cement	TOTAL
	OUT	IN	OUT	IN	IN	
Sibu	36500	7400	0	0	0	43900

Table-5.1.2.2 Coastal and Riverine Transportation Forecast for Sibu, Sarikei, Bintangor and Tg. Sebubal (Private Wharves, unit: ton)

Coastal Transportation (1997)

	General Cargo		Rice		Cement	TOTAL
	OUT	IN	OUT	IN	IN	
Sibu	9200	28600	14300	0	0	52100

Coastal Transportation (2010)

	General Cargo		Rice		Cement	TOTAL
	OUT	IN	OUT	IN	IN	
Sibu	11700	35500	18200	0	0	65400

5.1.3 Passenger

As stated in 4.4.2, future passenger volume at Sibu, Sarikei, Bintangor and Tg. Sebubal is as follows:

Table-5.1.3.1 Passenger Volume Forecast for Sibu,Sarikei, Bintangor and Tg. Sebubal (2 ways, daily)

WHARF	********** 1997 **********				********** 2010 **********			
	---- Riverine Service ----			Coastal Service	---- Riverine Service ----			Coastal Service
	U-st.	D-st.	Other		U-st.	D-st.	Other	
Sibu	1849	327	1674	0	2347	411	2081	0
Sarikei	0	0	1675	407	0	0	2117	431
Bintangor	0	0	565	0	0	0	705	0
Tg. Sebubal	0	0	70	0	0	0	123	0

U-st.: upstream, D-st.: downstream

The required frequency of boat service at each wharf is expected as follows:

Table-5.1.3.2 Passenger Boat Frequency Forecast for Sibu, Sarikei, Bintangor and Sebubal (2 ways, daily)

WHARF	********** 1997 **********				********** 2010 **********			
	---- Riverine Service ----			Coastal Service	---- Riverine Service ----			Coastal Service
	U-st.	D-st.	Other		U-st.	D-st.	Other	
Sibu	42	5.5	23	0	46.5	7	28	0
Sarikei	0	0	24	2	0	0	30	3
Bintangor	0	0	23	0	0	0	28	0
Tg. Sebubal	0	0	1	0	0	0	2	0

U-st.: upstream, D-st.: downstream

5.2 Facility for International Trade

5.2.1 Expansion of existing facilities

(1) Sibu

i) Handling capacity

According to our demand forecast, cargo handling at Sibu in 1997 and 2010 will be as follows:

Table-5.2.1.1 Forecast of Cargo Handling at Sibu (1997)

Cargo Type	Conventional	Container	
Ship Size (DWT)	3,000	3,000 (100TEU)	50m-Barge (48TEU)
Cargo Volume (FT, TEU)	549,000	13,500	8,900
Service Time (Hour)	10,300	900	1,200

Service Time: Handling Time, Arrival/Departure Time and Stand-by Time

Table-5.2.1.2 Forecast of Cargo Handling at Sibu (2010)

Cargo Type	Conventional	Container	
Ship Size (DWT)	3,000	3,000 (100TEU)	50m-Barge (48TEU)
Cargo Volume (FT, TEU)	656,000	36,800	24,400
Service Time (Hour)	16,700	2,600	3,200

The berth occupancy rate with the existing wharf can be calculated as follows (please see the details in **Appendix-II.5.2.1, Appendix-II.5.2.2** and **Appendix-II.5.2.3**).

Total Service Time = 12,400 hours (1997)

= 22,500 hours (2010)

Operation Time = 350 days x 14 hours/day = 4,900 hours

Berth Occupancy (4 berths) = 12,400 / 4,900 / 4 = 63%

= 22,500 / 4,900 / 4 = 115%

(the standard length of berth for 3000DWT ships is 110m)

According to UNCTAD'S recommendation, 60% is the maximum berth occupancy rate for a wharf with four berths in a group. So, the present wharf almost meets the demand for the year 1997 and additional berths will be needed at Sibu in 2010. However, as Sibu center does not have room for new berths, new berths should be installed at a new site.

ii) Berth requirements

a. Depth

The percentage of ships of below 3,000 DWT class is expected to be about 51% of the total ships calling at Sibu in 2010. So, the existing wharf and the new wharf will be able to divide the functions between them; that is, the former will accept large ships and the latter will accept smaller ships of less than 3,000DWT. Consequently, the required depth for the new wharf is six meters.

Empty containers will be carried by 50m-barges, which are used for log transportation from upstream areas of the river and have the following dimensions:

- Length: 50m
- Width: 16m
- TEU capacity: 48 TEUs

b. Length

The service time at the existing wharf of Sibu center should be 11,800 hours or less to make the berth occupancy rate 60% or less. The new wharf should thus provide the remaining service time of 10,700 hours. The berth occupancy rate can be obtained as follows:

$$10,700 / 4,900 / 4 = 55\%$$

Therefore, four berths for 3,000 DWT class vessels will be needed, and since the standard berth length for 3,000 DWT class ships is 110m, a berth length of 440m will be required.

iii) Storage Area

The storage area for break bulk cargo can be calculated as follows.

$$W = V / R = r \times w \times A \qquad (5.2.1.1)$$

where,

W: Cargo volume to be stored (FT)

V: Annual throughput (FT)

R: Revolving frequency (25 - 30 rounds/y)

r: Utilization rate (0.6)

w: Unit storage cargo volume per area (3 FT/m^2)

A: Storage area (m^2)

The storage area for containers can be calculated by the following formula:

$$T = V / R = s \times A / a \qquad (5.2.1.2)$$

where,

T: TEUs to be stored

V: Annual throughput

R: Revolving frequency (25 - 30 rounds/y)

s: Number of stories in container pile

Laden containers: 2 stories

Empty containers: 3 stories

a: Area per slot (45 - 55m^2 for folklift handling)

A: Storage area

Therefore, the following storage areas will be required:

Table-5.2.1.3 Required Storage Capacity at Sibu

Storage Area Category	Commodity	Annual Throughput (1000FT, TEU)		Storage Area (m^2)	
		1997	2010	1997	2010
Transit Shed	Agr. Prod. Food Fertilizer	549	656	12,200	14,600
Container Freight Station	Agr. Prod. Others	162	441	3,600	9,800
Open Storage Area Container Yard	Motor Veh.	38	47	0	0
	Empty	8,900	24,400	6,500	17,900
	Laden	13,500	36,800	14,900	40,500
TOTAL				37,200	82,800

The existing storage areas at Sibu center are as follows:

Transit Shed	14,400m^2
Open Storage Area	11,100m^2

In the ongoing renovation project, transit sheds No.1, 2 and 3 will be cleared and a new 3,500 m^2 shed will be built. The western area next to the premises of the RPA can be used for a storage area of about 10,000m^2 (the expansion project of container yard is going on in this area). So, Sibu center will have storage areas of 36,900m^2 in total, which will almost satisfy the demand for storage area in 1997 if storage area expansion is undertaken. However, further storage areas of 45,900m^2 (8,600m^2 for sheds and 37,300m^2 for container yard/open storage area) will be required in 2010. These further storage areas should be prepared in the new terminal.

iv) Location of the new wharf

As stated in 2.3, the south Sibu area is a possible site and the western area of Tg. Kumpel is appropriate because of the availability of space there.

v) Facility Layout

Figure-5.2.1.1 Shows a plan for a new terminal at the south Sibu site.

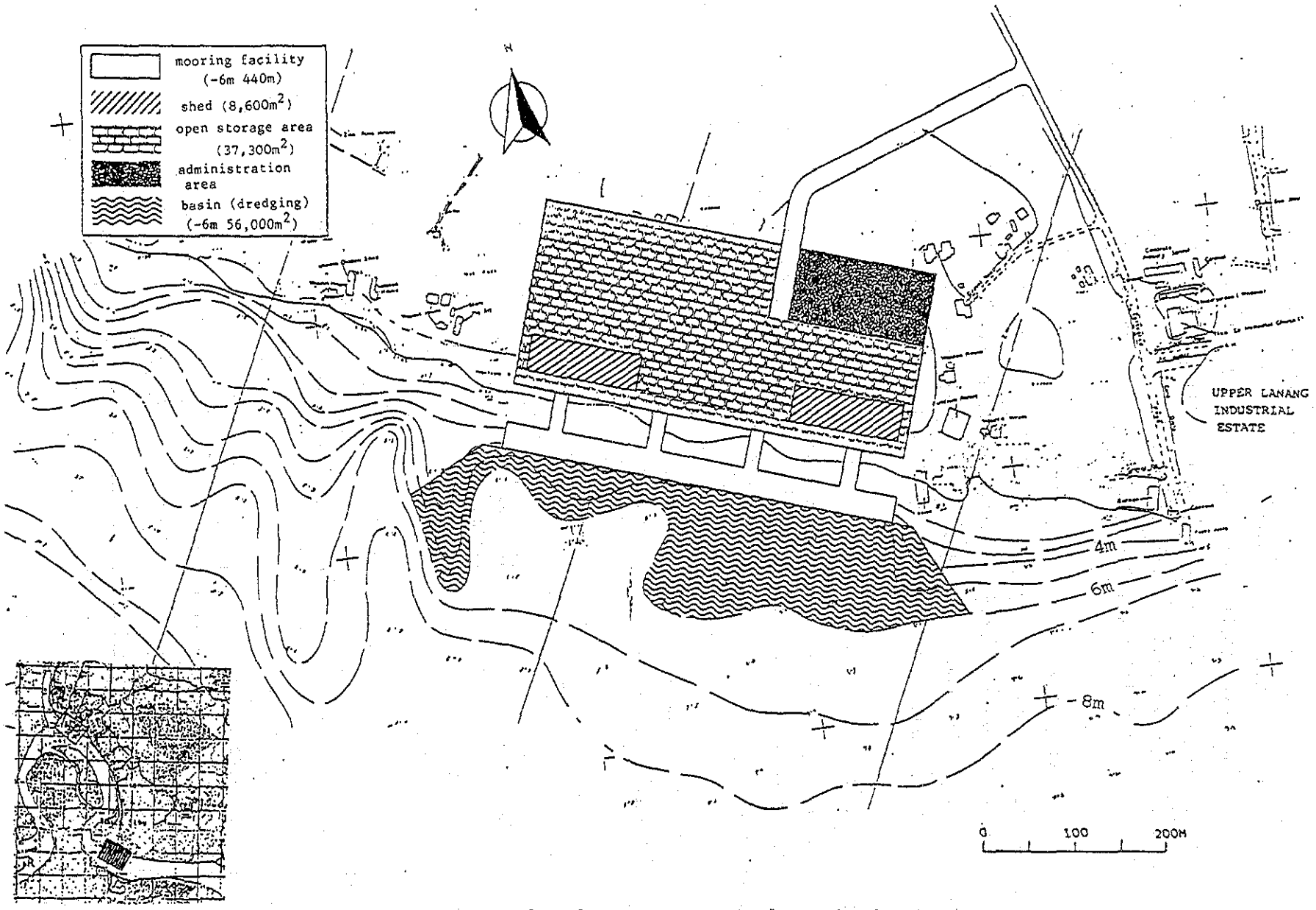


Figure-5.2.1.1 Plan for a New Terminal at the South Sibu

(2) Sarikei

i) Handling capacity

Similarly, according to our demand forecast, cargo handling at Sarikei will be as follows:

Table-5.2.1.4 Forecast of Cargo Handling at Sarikei (1997)

Cargo Type	Conventional	Container	
Ship Size (DWT)	1,500	1,500	50m-Barge (48TEU)
Cargo Volume (FT, TEU)	121,000	2,100	1,500
Service Time (Hour)	5,300	200	200

Table-5.2.1.5 Forecast of Cargo Handling at Sarikei (2010)

Cargo Type	Conventional	Container	
Ship Size (DWT)	1,500	1,500	50m-Barge (48TEU)
Cargo Volume (FT, TEU)	154,000	5,700	3,900
Service Time (Hour)	9,000	400	500

The Berth occupancy with the existing wharf can be calculated as follows:

Total Service Time = 5,700 hours (1997)
= 9,900 hours (2010)

Operation Time = 350 days X 14 hours/day = 4,900 hours

Berth Occupancy = 5,700 / 4,900 / 2 = 58%
= 9,900 / 4,900 / 2 = 101%
(9,900 / 4,900 / 3 = 67%)

So, one more berth will be required next to the berth which will be renovated up to 2010 as shown in **Figure-5.2.1.2.**

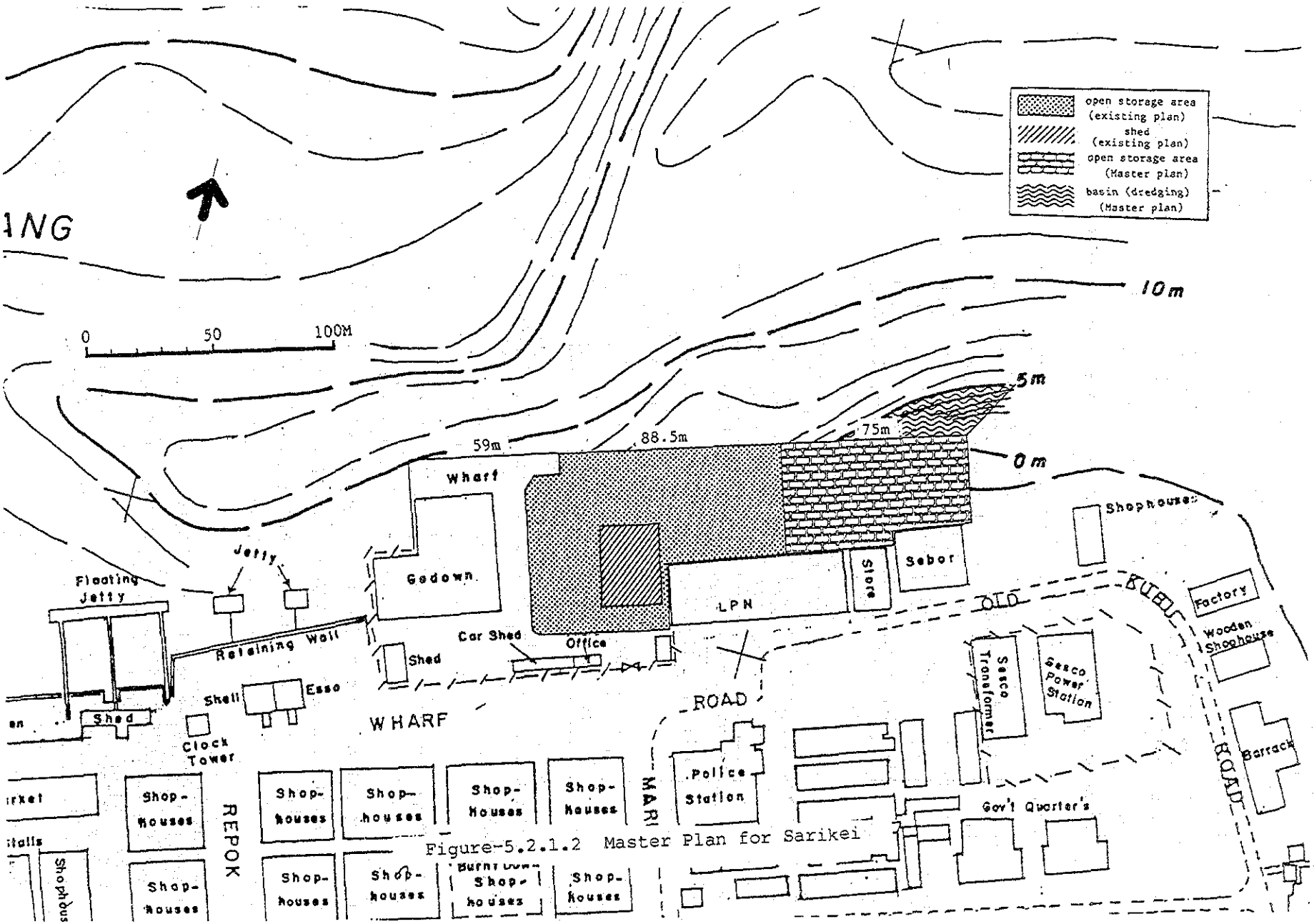


Figure-5.2.1.2 Master Plan for Sarikei

ii) Storage areas

The following storage areas will be required.

Table-5.2.1.6 Required Storage Capacity at Sarikei

Storage Area Category	Commodity	Annual Throughput (1000FT, TEU)		Storage Area (m^2)	
		1997	2010	1997	2010
Transit Shed	Agr. Prod. Food Fertilizer	117	177	2,200	3,300
Open Storage Area	Agr. Prod. Motor Veh.	30	46	600	900
Container Yard	Empty	1,500	3,900	700	1,900
	Laden	2,100	5,700	1,600	4,300
TOTAL				5,100	10,400

Currently, Sarikei Port has transit sheds of 1,600m^2 in total and open storage areas of 1,500m^2, and ongoing renovation will provide about 900m^2 of transit shed space and about 2,900m^2 of open storage areas. So, on completion of the renovation, Sarikei Port will have 6,900m^2 of storage area.

Consequently, a new storage area of 3,500m^2 will be required at Sarikei up to 2010, and this will be prepared behind a new berth which will be built up to 2010 as shown in **Figure-5.2.1.2.**

(3) Bintangor

i) Handling capacity

Similarly, according to our demand forecast, cargo handling at Bintangor will be as follows:

Table-5.2.1.7 Forecast of Cargo Handling at Bintangor (1997)

Cargo Type	Conventional	Container	
Ship Size (DWT)	1,500	1,500	50m-Barge (48TEU)
Cargo Volume (FT, TEU)	22,000	200	0
Service Time (Hour)	1,600	0	0

Table-5.2.1.8 Forecast of Cargo Handling at Bintangor (2010)

Cargo Type	Conventional	Container	
Ship Size (DWT)	1,500	1,500	50m-Barge (48TEU)
Cargo Volume (FT, TEU)	32,000	500	100
Service Time (Hour)	2,500	100	0

The berth occupancy with the existing wharf can be calculated as follows:

Total Service Time = 1,600 hours (1997)
= 2,600 hours (2010)

Operation Time = 350 days X 14 hours/day = 4,900 hours

Berth Occupancy = 1,600 / 4,900 / 1 = 33%
= 2,600 / 4,900 / 1 = 53%

So, no additional berths will be required up to 2010.

ii) Storage areas

The following storage areas will be required.

Table-5.2.1.9 Required Storage Capacity at Bintangor

Storage Area Category	Commodity	Annual Throughput (1000FT, TEU)		Storage Area (m^2)	
		1997	2010	1997	2010
Transit Shed	Agr. Prod. Food Fertilizer Motor Veh.	24	38	400	700
Container Yard	Empty	0	100	0	100
		1,200	500	200	400
TOTAL				600	1,200

Currently, Bintangor Port has transit sheds of 1,200m^2 and open storage areas of 900m^2.

Consequently, no new storage area will be required at Bintangor up to 2010.

(4) Sungei Merah

The old and new jetties will handle petroleum products amounting to 536,000 tons and 856,000 tons in 1997 and in 2010, respectively. These volumes can be handled with one jetty (assuming that the handling rate at the jetty is 250 - 750 FT/h). However, the old jetty has a strong current in front and small ships have great difficulty in berthing the jetty. So, we recommend that both jetties be used by large and small ships in case of slow current and that small ships use the new jetty then the current is strong.

Figure-5.2.1.3 shows a plan for the new oil jetty and the site where Petronas, the Malaysian petroleum company, plans to establish a new oil terminal.

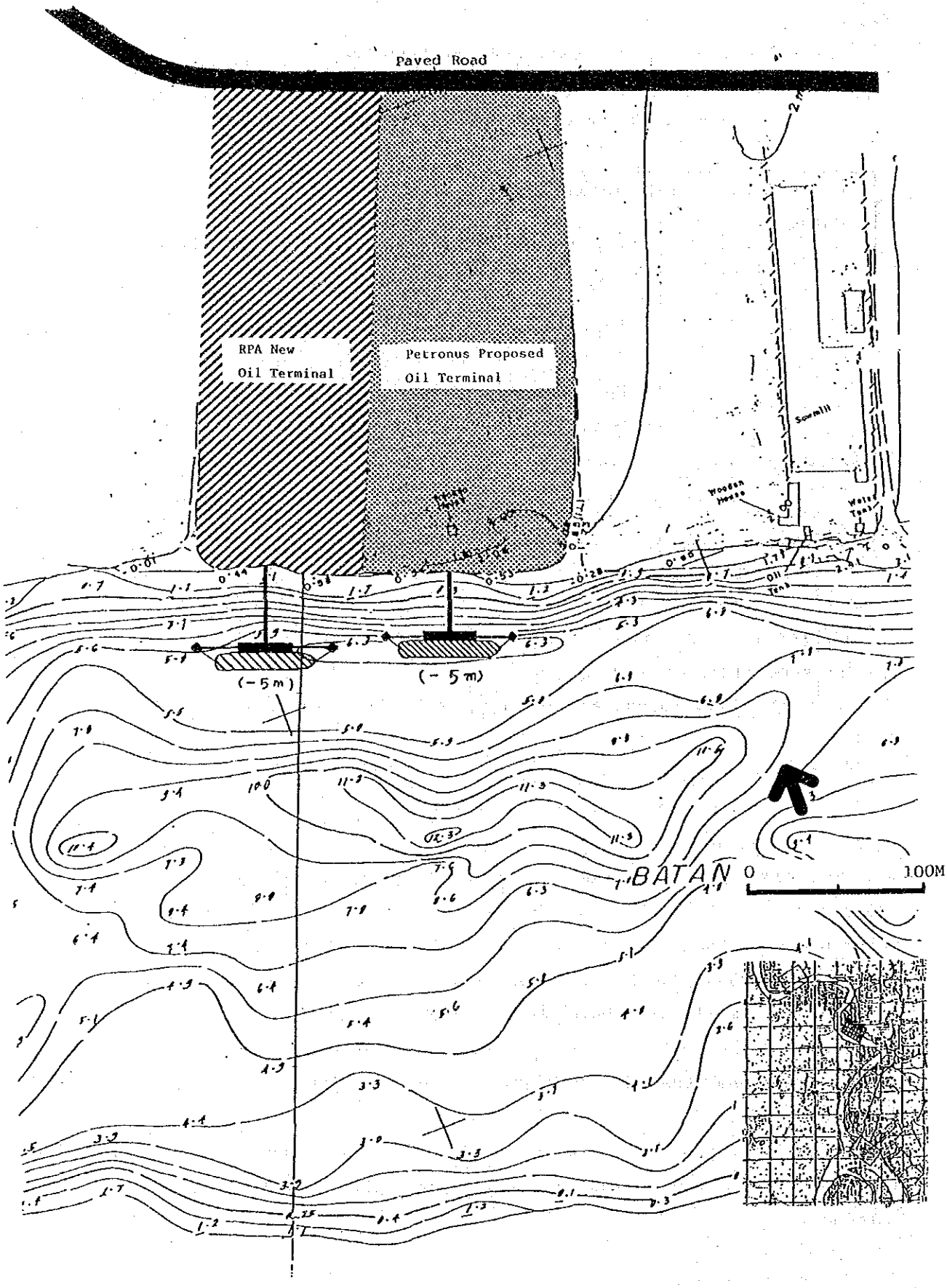


Figure-5.2.1.3 New Oil Terminal Site and plan for New Oil Jetty

5.2.2 New development in Tanjung Manis area

(1) Timber Products Terminal

i) Outline of development

Outline of the development is as follows:

- deep-water wharf for export of timber products
- shallow wharf for acceptance of timber products and empty containers
- transit sheds for timber products
- container yard
- handling equipment at a terminal

ii) Wharf Requirements

a. Berth depth

For timber products exports, 5,000 - 10,000 DWT class vessels are good because of the trading lot size. The maximum navigational depth is 10.0m for the Tanjung Manis area, even taking into consideration the high tides. Therefore, the berth depth of the deep-water wharf should be 10.0m. On the other hand, as the shallow berth will be used by 1,000m^3 class barges and lighters, its depth should be 5.0m.

b. Handling volume

Table-5.2.2.1 Handling Volume at the Timber Products Wharf

Wharf	Commodity	Volume (1000FT, TEU/Y)	
		1997	2010
Deep-Water Wharf (-10.0m)	Timber Products (Export)	868	2,073
	Containers (Ex & Im)	13,800	94,000
	Others (Ex & Im)	28	38
Shallow Wharf (- 5.0m)	Timber Products (In)	409	816
	Empty Containers (In)	7,400	20,600
Anchorage	Logs (Export)	2,917	0
	Timber Products (Export)	408	0

c. Berth Length

The recommended berth occupancy rate is 40%-70% (berth Nos: 1 - 6 or more) according to "Port Development" by UNCTAD. The proper number of berths can be calculated by using conditions such as ship size, load factor, annual throughput, handling productivity of equipment and other time factors so that the berth occupancy rate is about equal to the UNCTAD recommendation.

Table-5.2.2.2 Berth Nos. and Occupancy
Deep-Water Wharf (-10.0m)

Commodity	Av.Ship Size (DWT)	Volume (1000t, TEU/Y)		Berth Occupancy		Berth Nos	
		1997	2010	1997	2010	1997	2010
Timber P.	5,000	896	2,111	54	50	2	5
Containers	10,000 (500TEU)	13,800	94,000				

Timber P.: timber products,
Laden Con.: laden containers

The standard berth length for the 10,000DWT class of ships is 150m. So, berths with depth of 10m and lengths of 300m and 750m will be required in 1997 and 2010, respectively.

Table-5.2.2.3 Berth Nos. and Occupancy
Shallow Wharf (-5.0m)

Commodity	Av.Ship Size (DWT)	Volume (1000t, TEU/Y)		Berth Occupancy		Berth Nos	
		1997	2010	1997	2010	1997	2010
Timber P.	1,000	409	816	45	55	3	5
Empt. Con.	50m-barge (48TEU)	7,400	20,600				

The standard berth length for 1,000DWT class barge is 60m. So, berths with a depth of -5m and length of 180m and 300m will be required in 1997 and 2010, respectively.

iii) Storage facility

The storage area can be calculated with equation (5.2.1.1), and w, unit storage cargo volume per area, is assumed to be as follows:

Open storage yard: 3(FT/m^2)
Transit shed/CFS: 5(FT/m^2)

Although sawn timber does not always need to be stored in sheds, other timber products must be stored in this manner.

Empty and laden containers should be stored in two stories. The storage area can be calculated by the equation (5.2.1.2).

and s, number of stories in container pile, is assumed to be as follows:

Laden containers: 2 stories
Empty containers: 2 stories

Therefore, the following storage areas will be required:

Table-5.2.2.4 Required Storage Capacity at Timber Products Wharf

Storage Area Category	Commodity	Annual Throughput (1000FT, TEU)		Storage Area (m^2)	
		1997	2010	1997	2010
Transit Shed	Sawn timber (high grade) plywood dowel moulding others	586	1,302	9,400	20,800
Container Freight Station	Sawn timber (high grade) plywood dowel molding furniture	215	1,150	3,400	18,400
Open Storage Area	sawn timer (Other)	310	809	8,300	21,600
Container Yard		21,200	114,600	23,300	126,100
TOTAL				44,400	186,900

(2) Coal Terminal

i) Outline of development

The outline of the development is as follows:

- deep-water wharf for export of coal
- shallow wharf for acceptance of coal from Merit Pila and export and import of related cargo
- coal yard
- handling equipment at deep-water wharf and shallow wharf

ii) Wharf requirements

a. Berth depth

For coal export, large vessels have an advantage in transportation cost. The maximum navigational depth is 10.0m for the Tanjung Manis area, even taking into consideration the high tide. Therefore, the berth depth of the deep-water wharf should be 10.0m. On the other hand, as the shallow wharf will be used by 1,000m^3-class barges, its depth should be 5.0m.

b. Handling volume

Table-5.2.2.5 Handling Volume at Coal Terminal

Wharf	Commodity		Volume (1000t/y)	
			1997	2010
Deep-Water Wharf (-10.0m)	Coal	Export	250	600
Shallow Wharf (-5m)	Coal	In	500	1,100
	Limestone	In	8	15
	Oil	In	8	16
	Plaster	Out	11	21
	(total)		527	1,152

c. Berth length

The proper number of berth can be calculated as in 5.2.2, (1), c.

Table-5.2.2.6 Berth Nos. and Occupancy

Deep-Water Wharf (-10.0m)

Commodity	Av. Ship Size (DWT)	Load Fac.	Volume (1000FT/y)		Berth Occupancy		Berth Nos	
			1997	2010	1997	2010	1997	2010
Coal	20,000 (max. 30,000)	0.9	250	600	24	59	1	1

The standard berth lengths for 30,000 DWT and 20,000 DWT class ships are 200m and 165m, respectively. As the maximum ships sizes in 1997 and 2010 are assumed to be 20,000 DWT and 30,000 DWT, respectively, berths with a depth of 10m and length of 165m and 200m will be required in 1997 and 2010, respectively.

Table-5.2.2.7 Berth Nos. and Occupancy

Shallow Wharf (-5.0m)

Commodity	Av. Ship Size (DWT)	Load Fac.	Volume (1000FT/y)		Berth Occupacy		Berth Nos.	
			1997	2010	1997	2010	1997	2010
Coal	1,000	1.0	500	1,100	56	61	2	4
Limestone	1,000	1.0	8	15				
Oil	1,000	1.0	8	16				
Plaster	1,000	1.0	11	21				

The standard berth length for 1,000DWT-class ships is 60m. So, berths with depths of 5m and lengths of 120m and 240m will be required in 1997 and 2010, respectively.

iii) Stockyard

A thermal power plant needs coal for about three months of operation and three times a month-volume for export should be stored. Then, the coal stockyard capacity can be calculated as follows:

1997: 250,000 tons x 3/12 + 250,000 tons x 3/12
= 125,000 tons

2010: 500,000 tons x 3/12 + 600,000 tons x 3/12
= 275,000 tons

The standard capacity of a coal stockpile in a case where tractor shovels are used for coal movement is 5 t/m^2. Thus stock spaces of about 25,000m^2 and 55,000m^2 will be required in 1997 and 2010, respectively.

iv) Area for thermal power plant

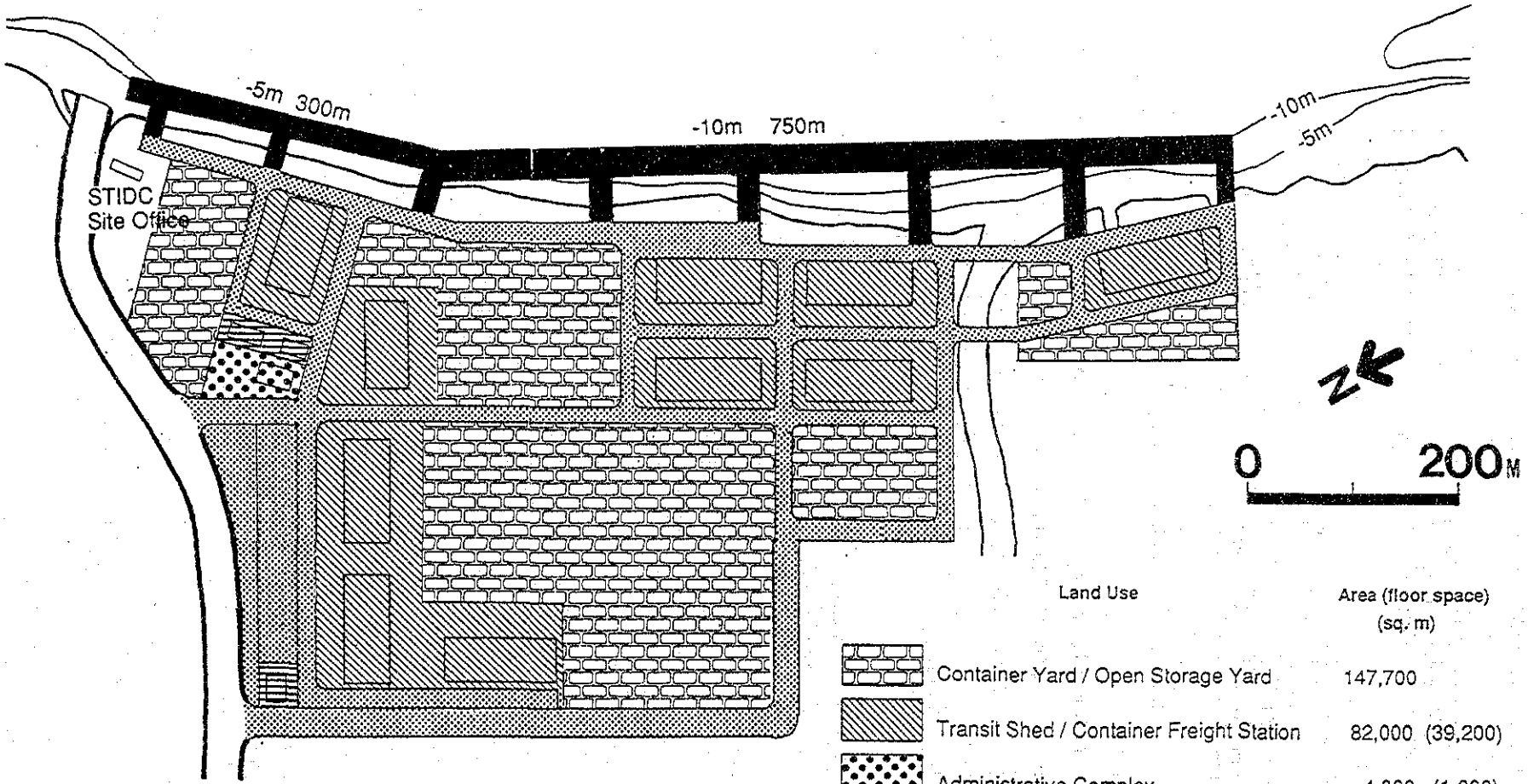
Capacity and area of the power plant in 1997 and 2010 are estimated as follows:

Table-5.2.2.8 Area for the Thermal Power Plant at Tg. Manis Area

	1997	2010
Capacity	50MW x 2 = 100MW	50MW x 2 = 100MW 100MW x 1 = 100MW (Total) 200MW
Area (excl. coal yard)	70,000 m^2	140,000 m^2
Coal Consumption	250,000 t/y	500,000 t/y

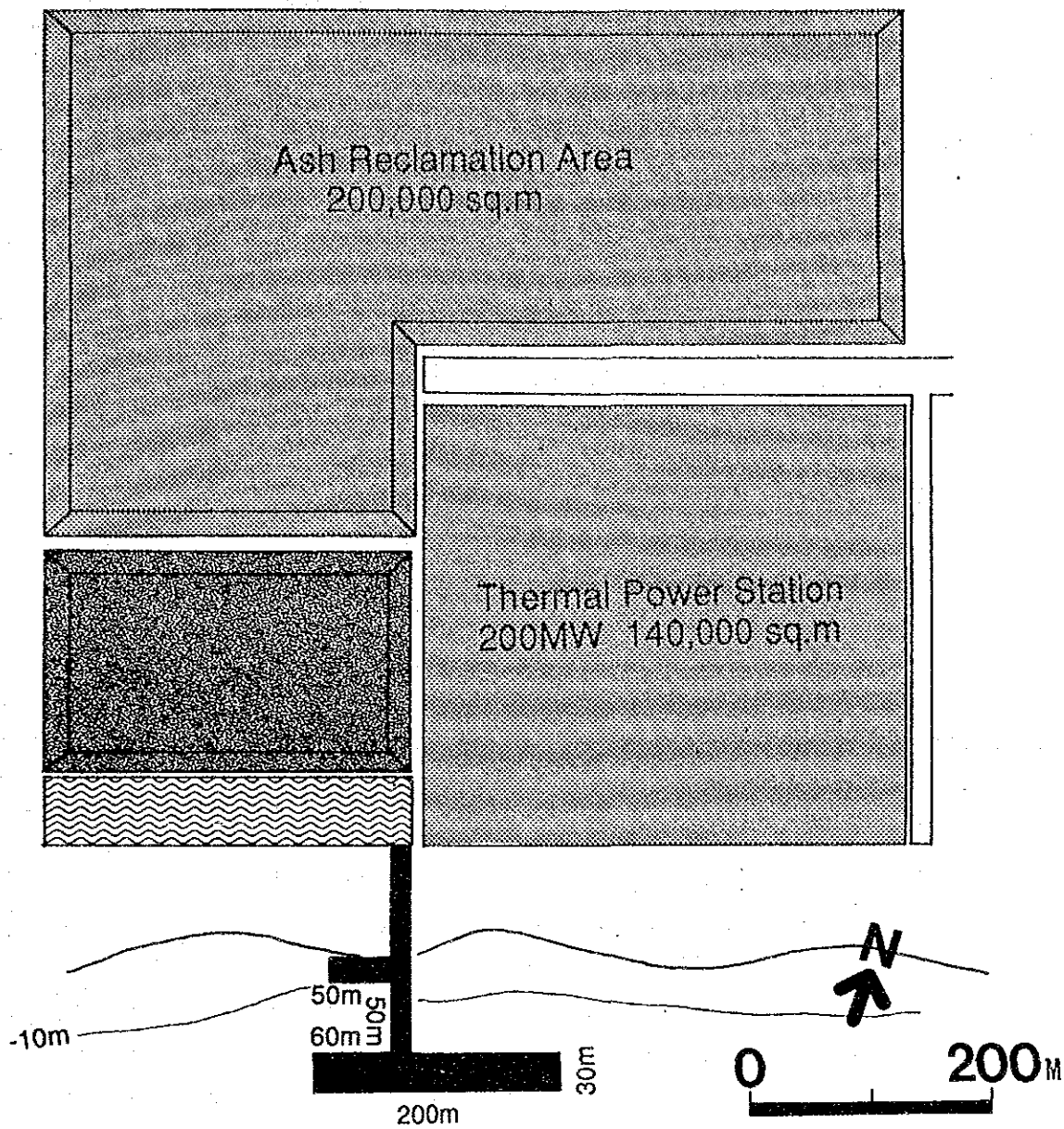
(3) Facility layout

The facility layout plans for the timber products and coal terminals are shown in **Figure-5.2.1.4** and **5.2.1.5.**



Land Use	Area (floor space) (sq. m)
Container Yard / Open Storage Yard	147,700
Transit Shed / Container Freight Station	82,000 (39,200)
Administrative Complex	*4,000 (1,000)*
Utility (Maintenance/Washing)	3,900 (1,900)
Road and Others	97,400
Total	335,000

Figure-5.2.1.4 Timber Products Terminal
MASTER PLAN Terminal Layout



Land Use	Area (sq. m)
Coal Yard	55,000 (275,000t)
Water Processing Pond and Others	16,000
Total	71,000

Figure-5.2.1.5 Coal Terminal
MASTER PLAN Terminal Layout

5.2.3 Handling equipment

Table-5.2.3.1 shows cargo handling equipment employed at the each wharf (see the details in **Appendix-II.5.2.4**)

Table-5.2.3.1 Cargo Handling Equipment at the Each Wharf

Wharf	Cargo	Activity	Equipment
Sibu	Containers	Ship<->Apron	Ship Crane
		Apron<->C.Y.	Large Forklift, Tractor+Chassis
		C.Y.<->CFS	Large Forklift
		Vanning/Devanning	Forklift
	General	Ship<->Apron	Ship Crane
		Apron<->Shed	Forklift
		Shed/CFS<->Truck	Forklift
Sarikei Bintang.	Containers	Ship<->Apron	Ship Crane
		Apron<->C.Y.	Large Forklift
		C.Y.<->CFS	Large Forklift
	General	Ship<->Apron	Ship Crane
		Apron<->Shed	Forklift
		Shed/CFS<->Truck	Forklift
T. Manis timber deep	Containers	Ship<->Apron	Ship Crane/Mobile Crane
		Apron<->C.Y.	Large Forklift, Tractor+Chassis
		C.Y.<->CFS	Large Forklift
		Vanning/Devanning	Forklift
	General	Ship<->Apron	Ship Crane
		Apron<->Shed	Forklift, Truck
		Shed/CFS<->Truck	Forklift
T. Manis timber shallow	Containers	Ship ->Apron	Ship Crane
		Apron ->C.Y.	Large Forklift, Tractor+Chassis
	General	Ship ->Apron	Ship Crane
		Apron ->Shed/CFS	Forklift, Truck

T. Manis Coal	Ship ->Apron	Ship Crane
	Apron ->Coal Yard	Dump Truck
	Coal Yard.	Power Shovel
	Coal Yard ->Apron	Dump Truck
	Apron ->Ship	Power Shovel, Dump Truck
		Shiploador

The equipment required can be determined on the basis of the cargo volume at a peak time, capacity and the cycle time of the equipment. **Table-5.2.3.2** and **Table-5.2.3.3** show no. of the each equipment at the each wharf in 1997 and 2010 (please see the details in **Appendix-II.5.2.4**).

Table-5.2.3.2 Required Cargo Handling Equipment (1997)
Rajang Port

Equipment	Capacity	Sibu Center	Sibu South	Sarikei	Bintangor	S.Merah	Tg.Manis		Total
							Timber	Coal	
Mobile Crane	150 ton						1		1
Tractor Head		3					11		14
Chassis	20, 40ft	3					11		14
Forklift	25, 42ton	2		1			3		6
Forklift	3ton	21		5	1		27		54
Truck	5ton						18		18
Dump Truck	10ton							4	4
Shovel Loader	$3m^3$							2	2
"	$1m^3$							2	2
Shiploader	250t/h							1	1

Table-5.2.3.3 Required Cargo Handling Equipment (2010)
Rajang Port

Equipment	Capacity	Sibu Center	Sibu South	Sarikei	Bintangor	S.Merah	Tg.Manis		Total
							Timber	Coal	
Mobile Crane	150 ton						2		2
Tractor Head		3	3				11		17
Chassis	20, 40ft	3	3				11		17
Forklift	25, 42ton	2	2	1			3		8
Forklift	3ton	19	14	7	1		78		119
Truck	5ton						27		27
Dump Truck	10ton							9	9
Shovel Loader	$3m^3$							2	2
"	$1m^3$							2	2
Shiploader	250t/h							1	1

Present equipment stock of the Rajang Port Authority is shown in **Table-5.2.3.4.**

Consequently, the equipment to be procured up to 1997 and 2010 is shown in **Table-5.2.3.5.**

Table-5.2.3.5 Cargo Handling Equipment To Be Procured

Equipment (Capacity)	1997	2010
Mobile Crane (150t)	0	1
Tractor Head + Chassis	5	8
Forklift (25/42t)	4	6
Forklift (3t)	6	71
Truck (5t)	0	6
Dump Truck (10t)	4	9
Shovel Loader ($3m^3$)	2	2
" ($1m^3$)	2	2
Ship Loader (250t/h)	1	1

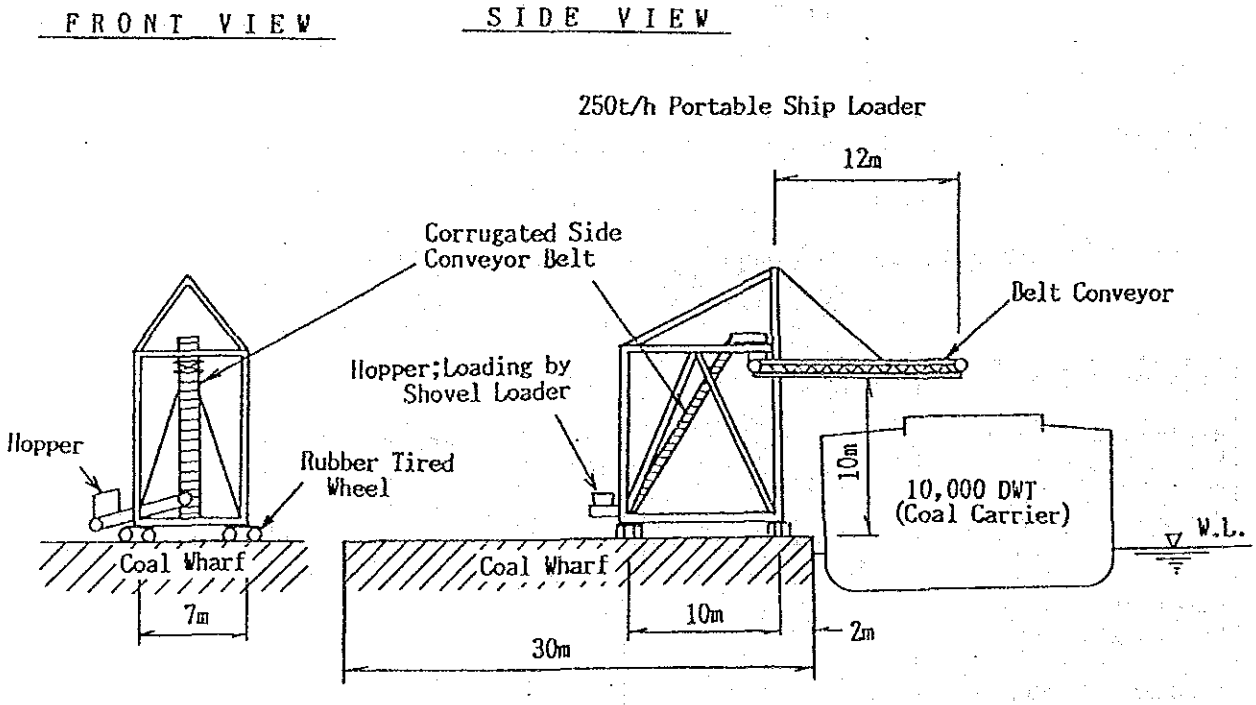


Figure-5.2.3.1 Ship Loader for Coal Loading Operation

Table-5.2.3.4 Cargo-Handling Equipment Stock of RPA

(at March,1990)

Equipment Description	Capacity	Total Unit	Location		
			Sibu	Sarikei	Bintangor
Forklift Truck	2,500kg	4	4	-	-
Forklift Truck	3,000kg	42	38	3	1
Forklift Truck	6,000kg	1	1	-	-
Forklift Truck	7,000kg	1	1	-	-
Container Forklift Truck	25,000kg	1	1	-	-
Container Forklift Truck	42,000kg	1	1	-	-
Total		50	46	3	1
Towing Tractor	2,500kg	19	16	1	2
Towing Tractor	4,500kg	2	2	-	-
Total		21	18	1	2
Low Loading Platform Trailers	3,000kg	5	-	1	4
Low Loading Platform Trailers	6,000kg	15	11	1	3
Skeletal Horn Type Trailer	6,000kg	1	-	1	-
Heavy-duty Low Loading Platform Trailer	20,000kg	2	2	-	-
Skeletal Container Drawbar Trailers(20-footer)	25,000kg	6	6	-	-
Skeletal Container Drawbar Trailers(40-footer)	40,000kg	1	1	-	-
Total		30	20	3	7
20-Footer Conventional Container Spreader	25,000kg	2	2	-	-
40-Footer Conventional Container Spreader	40,000kg	1	1	-	-
Total		3	3	-	-
Lattice Boom Truck Crane	150,000kg	1	1	-	-
Hand Portable Pallet Truck	2,000kg	3	2	-	1

5.2.4 Crafts

The Rajang Port Authority does not have any craft currently. However, tugboats will be required in order to manoeuvre large vessels of 10,000-30,000DWT class safely at the timber products terminal and the coal terminal in the Tg. Manis Area. Two tugboats should attend the large vessels, and the horse power of the tugboats should be 2000 or more(in case of 30,000DWT Vessel). At Sibu Port, more and larger ships are expected to call in future, So, we recommend that the RPA have at least one tugboat at Sibu. Moreover, crafts for fire fighting are also required.

Consequently, two tugboats of 2000ps and another of 1000ps with fire fighting equipment are required (please see details in 6).

5.2.5 Waterway and Basin

Figure-5.2.5.1 shows a plan for waterway and basin. The waterway can be arranged with a width of more than 300m, twice the overall length of a 10,000DWT class ship, and many waiting circles can be prepared in the Tg. Manis area.

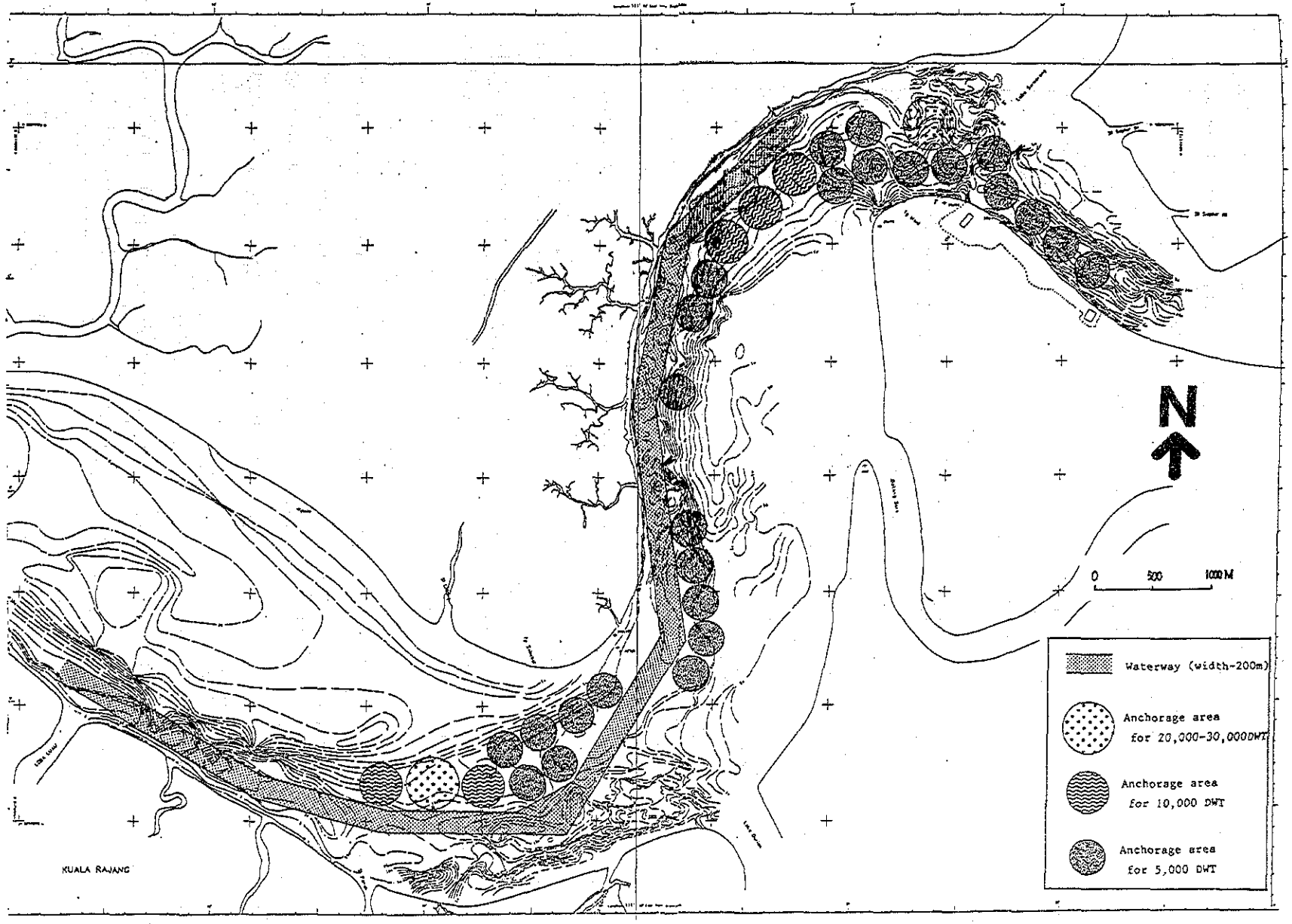


Figure-5.2.5.1 Plan for Waterway and Basin in Tg. Manis Area

5.2.6 Infrastructure and utility related to terminal development

The timber products terminal will need the following infrastructures and utilities for terminal operation. The costs of these infrastructures and utilities will be equivalent to about 4% of the cost needed for terminal construction.

Road (from a main road to the terminal)
Fence
Gate house
Weighing bridge
Electricity transmission line (within the terminal)
Electricity transformer station
Stand-by electricity generator
Water supply pipeline (from a main pipeline to the terminal)
Water tank
Drainage
Fire department

The timber products terminal will need road connection with the hinterland and a main water supply pipeline installed near the terminal; electricity can be supplied from generators which would be installed in the TPZ. And the coal terminal will need a main water supply pipeline (a road will no be required, nor does the coal terminal required much electricity).

On the other hand, as stated in II.3.1.3(3), a water supply pipeline to be installed between Sarikei and Tg. Sebubal has already been proposed by JKR, and a road from Belawai to Tg. Sebubal via Rajang village is under construction. Therefore, if these terminals are constructed on the east shore of Tg. Sebubal, an alternate plan for water supply and a road will not be required. The estimated cost for installation of the water supply pipeline from Sarikei to Tg. Sebubal would be 20 million Ringgit (25km, 800,000 Ringgit/km).

Moreover, port development would generate more land traffic on the urban road network adjacent to the port. Therefore, both port development and urban road development should be implemented in harmony each other.

5.2.7 Conclusion

Table-5.2.7.1 to **5.2.7.6** show the Short-term Plan for the year 1997 and the Master Plan for the year 2010.

Table-5.2.7.1 Short-term Plan for Mooring Facilities

(1997)

Wharf	Depth	Length	Remarks
Sibu Center	-		
Sibu South	-		
Sarikei	-		
Bintangor	-		
Sungei Merah	-5.0m	1 jetty	
Tg. Manis Area	-10.0m	300m	Timber Products Terminal
	-5.0m	180m	Timber Products Terminal
	-10.0m	165m	Coal Terminal
	-5.0m	150m	Coal Terminal

Table-5.2.7.2 Short-term Plan for Storage Facilities

(1997)

Wharf	Shed/CFS m^2	Open Storage Yard /Container Yard m^2	Total m^2	Remarks
Sibu Center	-	-	0	
Sibu South	-	-	0	
Sarikei	-	-	0	
Bintangor	-	-	0	
Sungei Merah	-	-	0	
Tg. Manis Area	12,800	31,600	44,400	Timber
	-	25,000	25,000	Coal
T O T A L	12,800	56,600	69,400	

Table-5.2.7.3 Short-term Plan for Cargo Handling Equipment and Crafts

(1997)

Equipment	Nos
Tractor Head + Chassis	5
Forklift (25/42t)	4
Forklift (3t)	6
Dump Truck (10t)	4
Shovel Loader ($3m^3$)	2
Shovel Loader ($1m^3$)	2
Shiploader (250t/h)	1
Tugboat (2000ps)	1
Tugboat (1000ps)	1

Table-5.2.7.4 Master Plan of Mooring Facilities

(2010)

Wharf	Depth	Length	Remarks
Sibu Center	-		
Sibu South	-6.0m	440m	
Sarikei	-5.5m	75m	
Bintangor	-		
Sungei Merah	-5.0m	1 jetty	
Tg. manis Area	-10.0m	750m	Timber Products Terminal
	-5.0m	300m	Timber Products Terminal
	-10.0m	200m	Coal Terminal
	-5.0m	235m	Coal Terminal

Table-5.2.7.5 Master Plan of Storage Facilities

(2010)

Wharf	Shed/CFS m^2	Open Storage Yard /Container Yard m^2	Total m^2	Remarks
Sibu Center	-	-	0	
Sibu South	9,600	36,700	46,300	
Sarikei	-	2,800	2,800	
Bintangor	-	-	0	
Sungei Merah	-	-	0	
Tg. Manis Area	39,200	147,700	186,900	Timber
	-	55,000	55,000	Coal
T O T A L	48,800	242,200	291,000	

Table-5.2.7.6 Master Plan for Cargo Handling Equipment and Crafts

(2010)

Equipment	Nos
Mobile Crane (150t)	1
Tractor Head + Chassis	8
Forklift (25/42t)	6
Forklift (3t)	71
Truck (5t)	6
Dump Truck (10t)	9
Shovel Loader ($3m^3$)	2
Shovel Loader ($1m^3$)	2
Shiploader (250t/h)	1
Tugboat (2000ps)	2
Tugboat (1000ps)	1

5.3 Preliminary Facility Plan for Coastal and Riverine Transportation

5.3.1 Vessels

We set design vessels for coastal and riverine transportation according to the "Master Plan Study for Coastal and Riverine Transport in Sarawak" as follows:

Table-5.3.1.1 Dimension of Design Vessels for Coastal and Riverine Transport

	DWT	Length (m)	Berth Length (m)	Remarks
Coastal Transport	200 - 500	25 - 50	30	2 berths used for large vessels
Riverine Transport	200	125	30	

5.3.2 Required berth length

We calculated the required berth length so that each wharf can be used under proper berth occupancy. Berth occupancy is obtained as follows:

$$BO = Ts / Do$$

$$Ts = Th = Vg/Rg + Vr/Rr + Vc/Rc$$

where,

BO: berth occupancy

Ts: total service days

Do: annual berth open days

Th: total cargo handling days (from/to vessels)

Vc: DWT of vessel

Vg, Vr and Vc: cargo handling volume of general cargo, rice and cement (ton/year)

Rg, Rr and Rc: cargo handling rate of general cargo, rice and cement (ton/day)

We used the same cargo handling rates for general cargo, rice and cement as those employed in the "Master Plan Study for Coastal and Riverine Transport in Sarawak" (**Table-5.3.2.1**).

Table-5.3.2.1 Cargo Handling Rate

	Handling Rate (ton/day)	
	1997	2010
General Cargo		
coastal	175	200
riverine	120	135
Rice	175	200
Cement	250	300

And we used the limits of berth occupancy rate for each berth number in group that UNCTAD recommended (**Table-5.3.2.2**).

Table-5.3.2.2 Maximum Berth Occupancy Rate

Number of Berth in Group	Recommended Maximum Berth Occupancy
1	0.4
2	0.5
3	0.55
4	0.6
5	0.65
6 - 10	0.7

General cargo transported between Sibu and Kuching and rice shipped out of Sibu are handled at the private wharves of Sibu, and this situation is expected to continue. Therefore, the required berth number is calculated based on the cargo at government wharves.

Table-5.3.2.3 Required Number of Berths for Coastal and Riverine Transport (1997)

WHARF	Annual Service Days	Annual Berth Open Days	Required Berth Nos	Berth Occupancy
Sibu	904	350	6	0.43
Sarikei	140	350	1	0.4
Bintangor	57	350	1	0.16
Tg. Sebubal	31	350	1	0.09

Table-5.3.2.4 Required Number of Berths for Coastal and Riverine Transport (2010)

WHARF	Annual Service Days	Annual Berth Open Days	Required Berth Nos	Berth Occupancy
Sibu	1213	350	7	0.5
Sarikei	179	350	2	0.26
Bintangor	71	350	1	0.2
Tg. Sebubal	40	350	1	0.11

Consequently, we can get the required number of berths as follows:

Table-5.3.2.5 Required Berths for Coastal and Riverine Transportation at Sibu, Sarikei, Bintangor and Tg. Sebubal

WHARF	Present		Required				To be Constructed			
			1997		2010		1997		2010	
	L	N	L	N	L	N	L	N	L	N
Sibu	135.5	4	180	6	210	7	60	2	90	3
Sarikei	26	1	30	1	60	1	0		30	1
Bintangor	45.6	1	30	1	30	1	0		0	
Tg. Sebubal	0		30	1	30	1	30	1	30	1

L: length, N: number

5.3.3 Facility layout

(1) Sibu

The entire front of central Sibu town has been fully used. So, the additional coastal and riverine wharf should be located in front of the JKR equipment base (**Figure-5.3.3.1**).

Figure-5.3.3.2 shows the facility layout plan up to 1997 and 2010.

(2) Sarikei

Sarikei has a room for expanding the existing coastal cargo wharf. **Figure-5.3.3.3** shows a 30m expansion plan of the existing coastal cargo wharf up to 2010.

(3) Tg. Sebubal

A coastal cargo wharf as well as a passenger wharf needs connection with land transportation. Therefore the wharf should be located next to the road which runs from Belawai to Tg. Sebubal through Rajang village and the TPZ. **Figure-5.3.3.4** shows a plan for a new coastal cargo wharf.

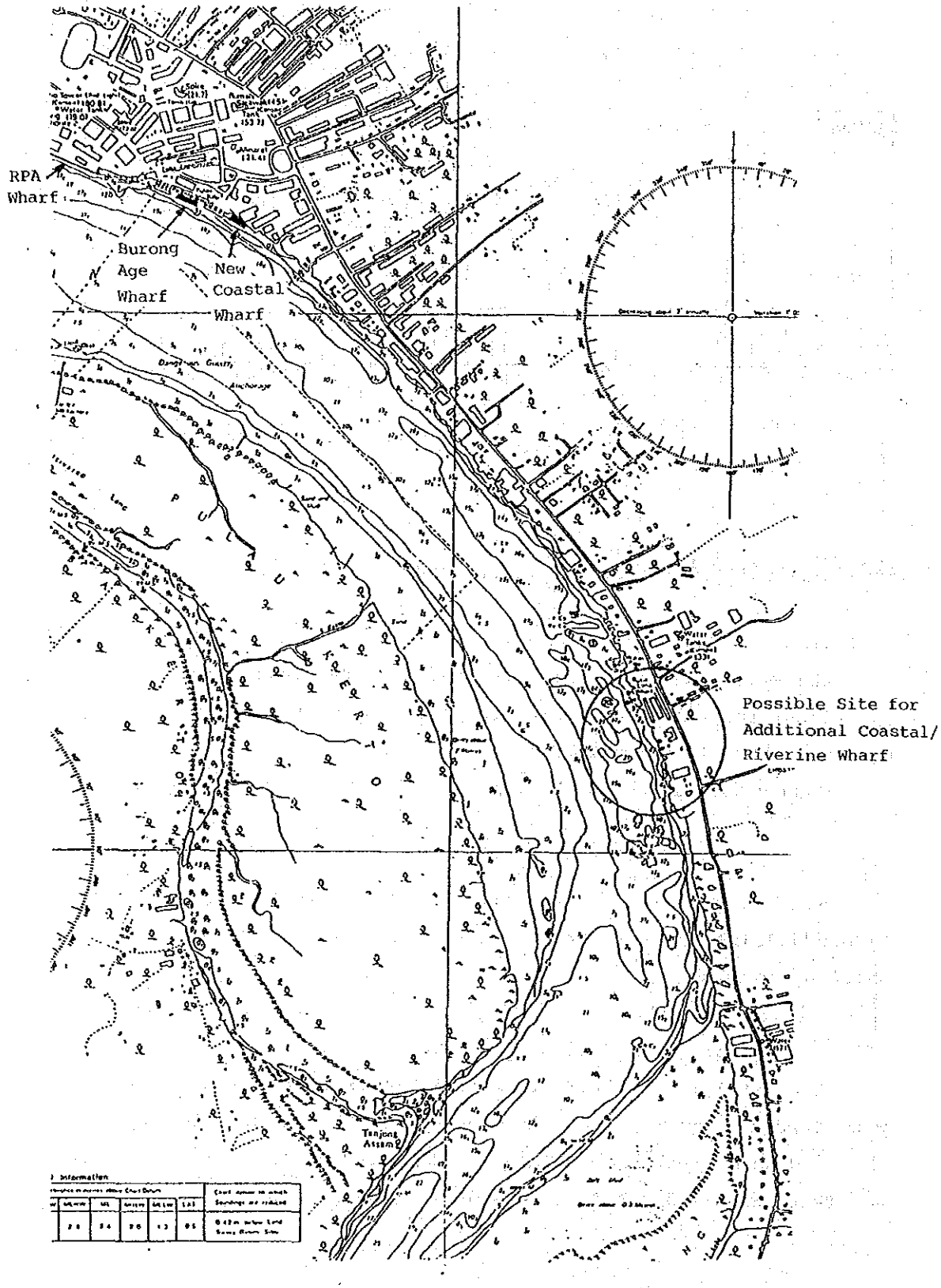


Figure-5.3.3.1 Location of Additional Coastal and Riverine Wharf at Sibu

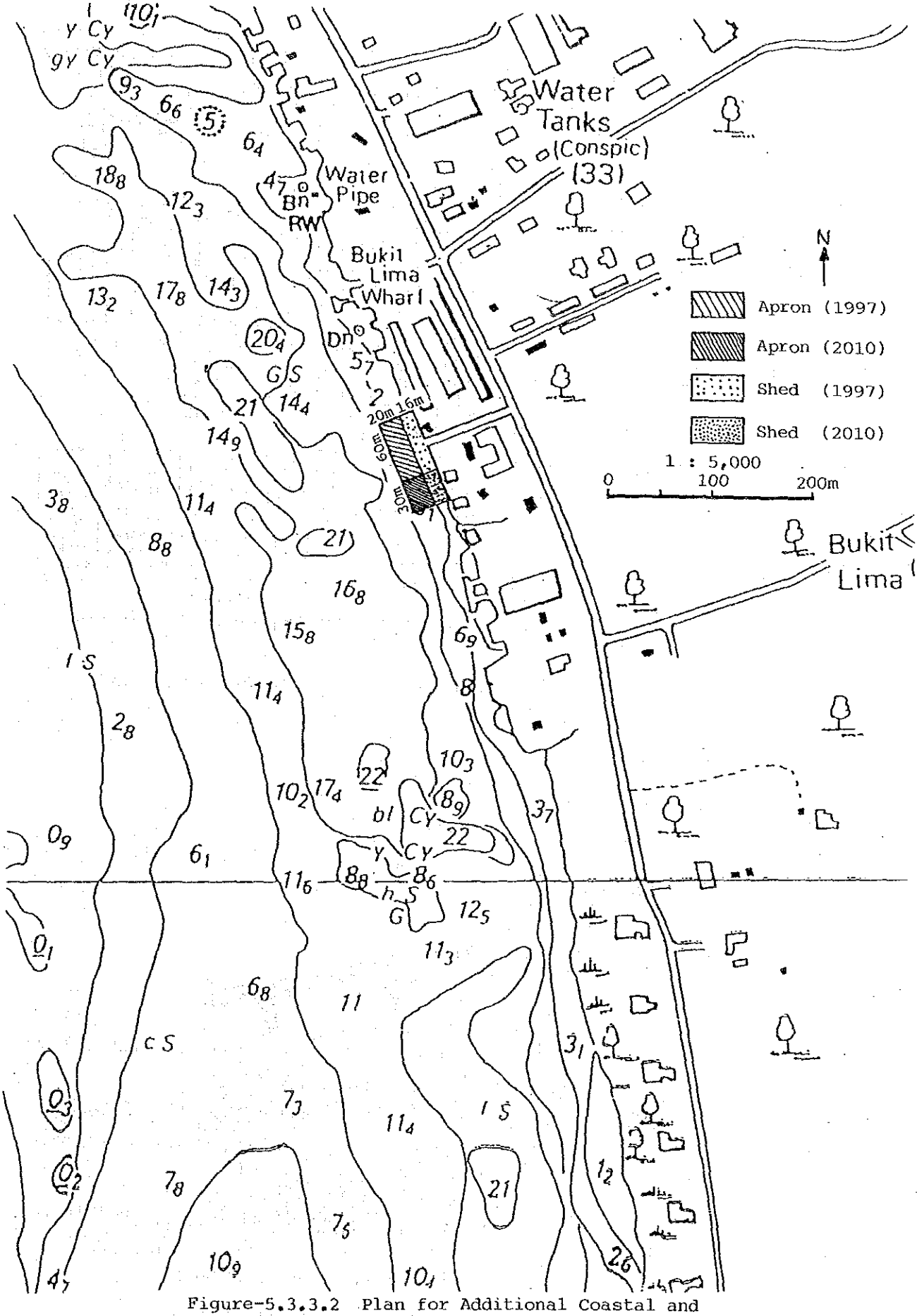


Figure-5.3.3.2 Plan for Additional Coastal and Riverine Wharf at Sibu