4.11 Maintenance Dredging of Channels

(1) Pontianak (Sungai Kapuas Kecil)

A 15 km extension of the navigation channel for Port of Pontianak is maintained by dredging in the estuary of Sungai Kapuas Kecil. Figure 4.11.1 presents the location and standard section of the navigation channel. Port of Pontianak is located along the river about 30 km inside from the river mouth.

The dumping area of the dredged sand/silt is established at a sea area about 15 km from the river mouth of Sungai Kapuas Kecil (00°03'50"N, 109°02'00"E).

The annual average volume of the dredging is around 1.3 million m^3/year and the dredging work has been carried out almost every year in the recent eight years (refer to Table 3.11.1). The public expense for Pontianak channel accounts for about 9 % of the government annual budget for the dredging of commercial ports (refer to Table 3.11.3).

The navigation channel along Sungai Kapuas Kecil belongs to DLKR from the river mouth up to Pontianak Port and the responsibility of the maintenance and dredging of the channel belongs to the public port corporation (IPC2).

(2) Kumai (Sungai Kumai)

The navigation channel for Port of Kumai has a 18.5 km extension in the estuary of Kumai Bay and a 10 km portion of the channel is maintained by dredging (refer to Table 3.11.1).

Figure 4.11.2 presents the location and standard section of the navigation channel. Port of Kumai is located along the river about 25 km from the river mouth. The dumping area of the dredged sand/silt is established at a sea area south of Sampit Bay (03°05'00", 114°40'40"E).

The annual average volume of the dredging is around 440,000 m^3/year and the dredging work was carried out three times in the recent eight years (refer to Table 3.11.1).

The navigation channel belongs to DLKR, and along Sungai Kumai from the bay mouth up to Kumai Port, IPC3 is responsible for the maintenance and dredging of the channel.

(3) Sampit (Sungai Mentaya)

The navigation channel for Port of Sampit has a 10.2 km extension in the Sampit Bay and a 15 km section in the estuary area. Along the river, it is maintained by dredging (refer to Table 3.11.1).

Figure 4.11.3 presents the location and standard section of the navigation channel. Port of Sampit is located along the river about 75 km from the bay mouth. The dumping area of the dredged sand/silt is established at the mouth of Sampit Bay (03°07'52",

113°05’35”E).

The annual average volume of the dredging is around 700,000 m^3/year and the dredging work was carried out for four times in the recent eight years (refer to Table 3.11.1).

The public expense for Sampit channel accounts for about 7 % of the government annual budget for the dredging of commercial ports (refer to Table 3.11.3).

The navigation channel belongs to DLKR, and along Sungai Mentaya from the river mouth up to Sampit Port, IPC3 is responsible for the maintenance and dredging of the channel.

(4) Samarinda (Sungai Mahakam)

The navigation channel for Port of Samarinda has about 65 km extension from the river mouth and a 24 km portion of the channel is maintained by dredging (refer to Table 3.11.1).

Figure 4.11.4 (1) and (2) present the location map at the river mouth of Sungai Mahakam and standard section of the navigation channel. Port of Samarinda is located along the river about 65 km from the river mouth.

The annual average volume of the dredging is around 1.5 million m^3/year and the dredging work has been carried out every year (refer to Table 3.11.1). The public expense for Samarinda channel accounts for about 13 % of the government annual budget for the dredging of commercial ports (refer to Table 3.11.3).

The navigation channel along Sungai Mahakam belongs to DLKR from the river mouth up to Port of Samarinda and the responsibility of the maintenance and dredging of the channel belongs to the public port corporation (IPC4).

Although the expense for the maintenance dredging of the navigation channel should be borne by the public port corporation, according to the general rule, Port of Samarinda earns only enough to cover part of the expense. The annual profit from revenue is calculated as 5 billion Rp/year on average, while the expense for the maintenance dredging reaches 8.5 billion Rp./year.

Due to the constraint from the limited budget, the dredging works in the Samarinda channels have been only partially executed (reduced width and/or reduced depth from the specified standard design section).

In the case of year 2000, the dredging work was carried out with the bottom width 60 m and the water depth LWS-5.7 m, whereas the standard section was originally designed as the bottom width 80 m and the water depth LWS-6.0 m.

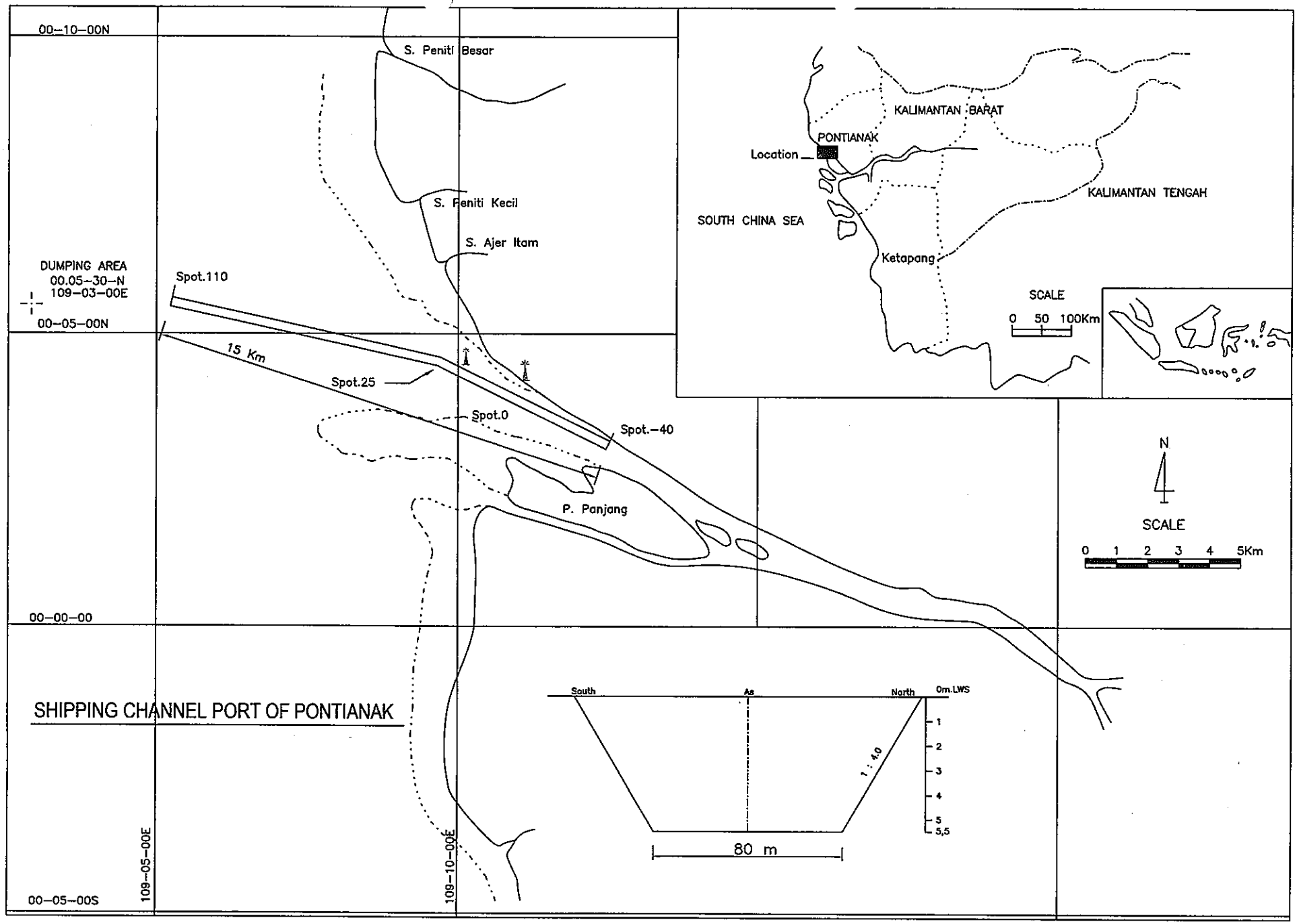


Figure 4.11.1 Navigation Channel maintained by dredging in the Estuary of Sungai Kapuas Kecil (Port of Pontianak)

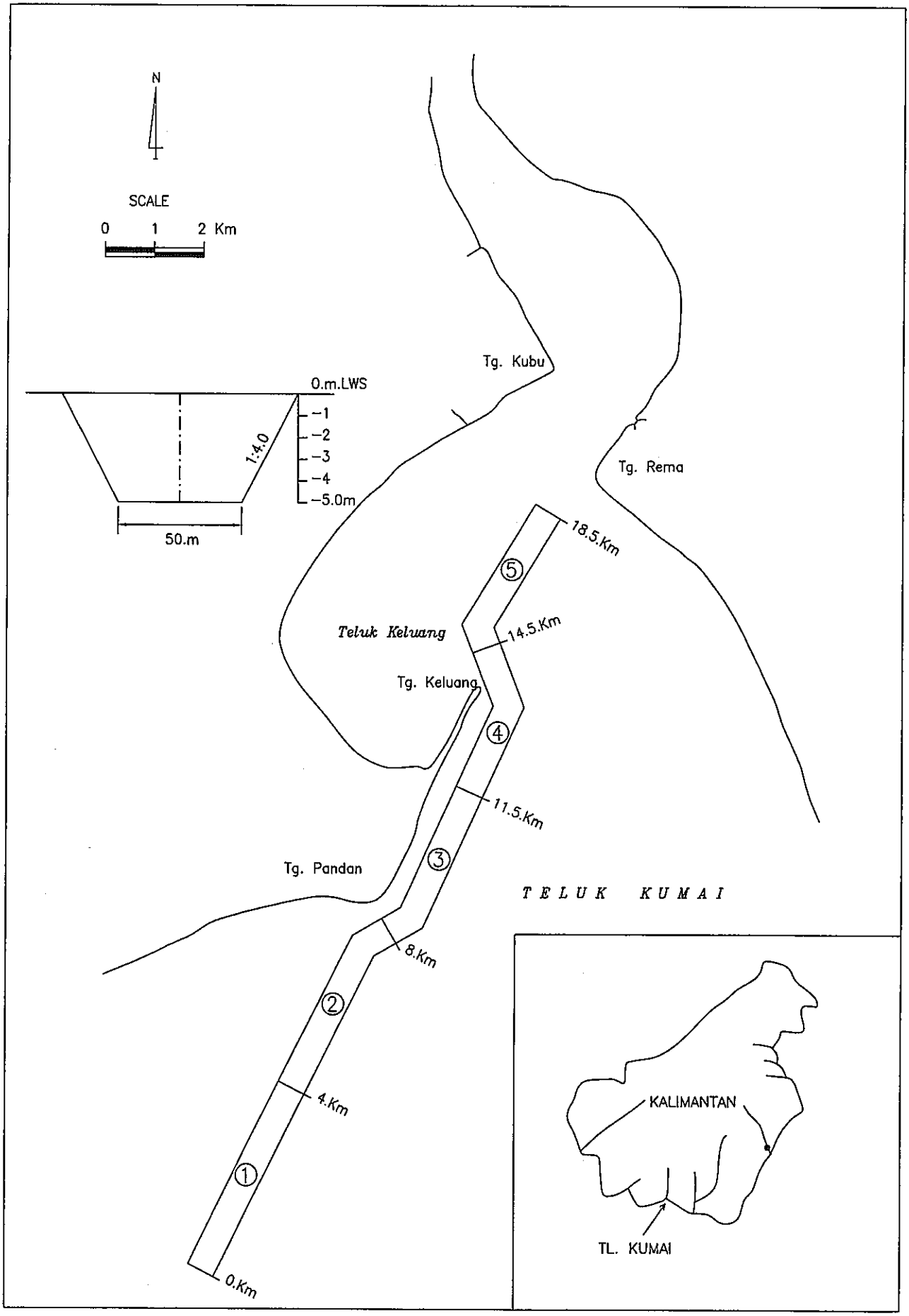


Figure 4.11.2 Navigation Channel maintained by dredging for Port of Kumai

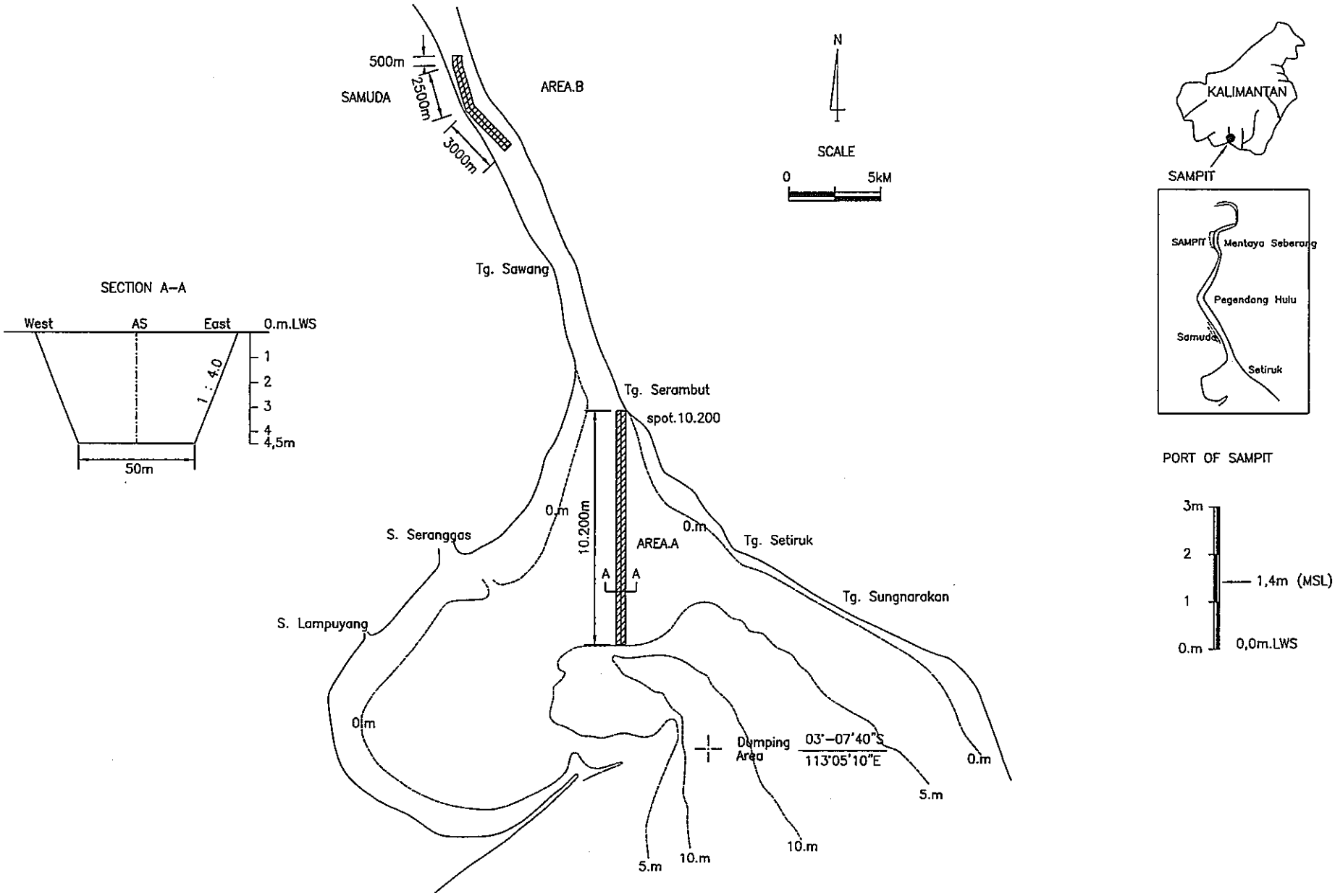


Figure 4.11.3 Navigation Channel maintained by dredging for Port of Sampit

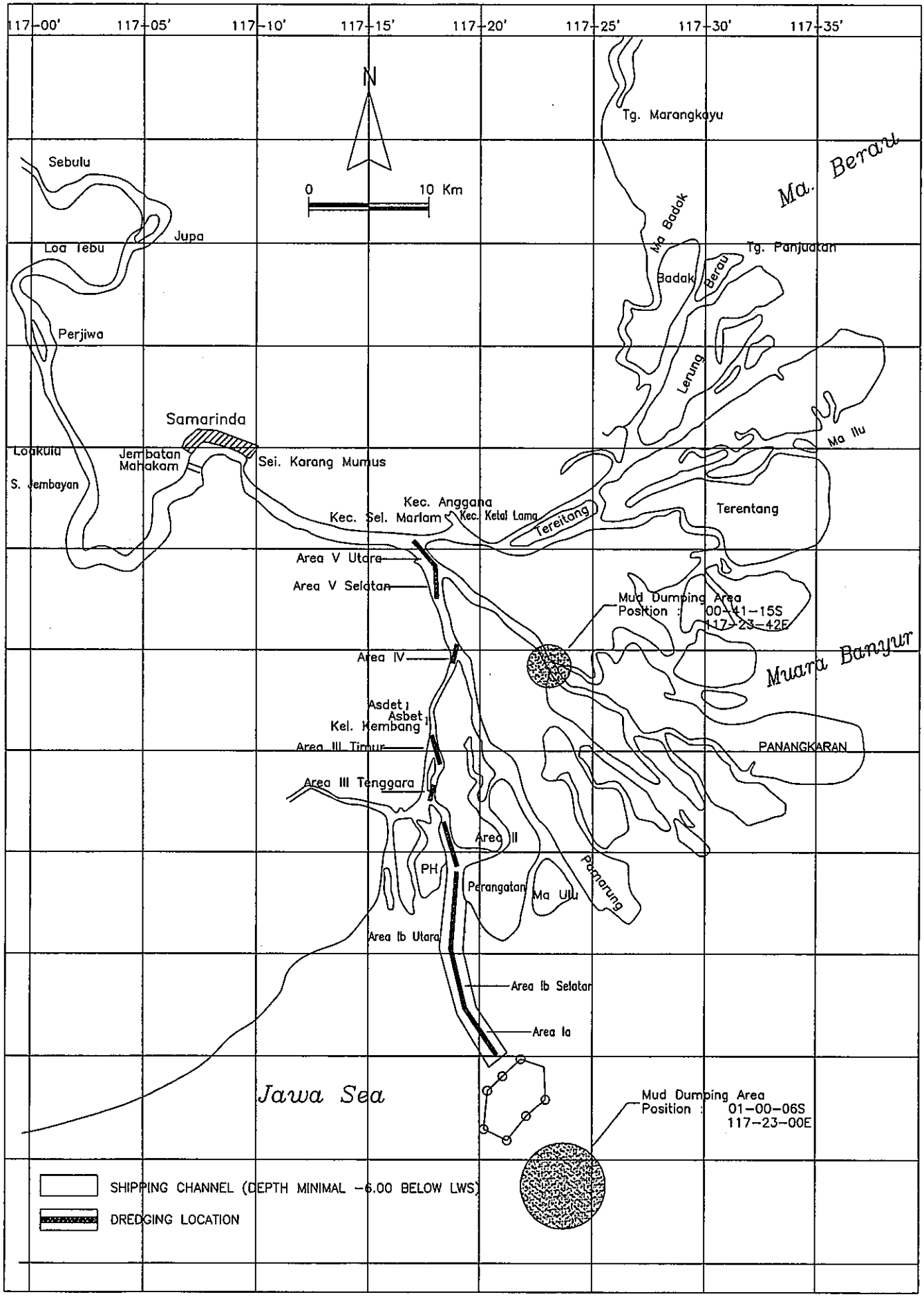


Figure 4.11.4 (1) Location Map of Navigation Chanel and Port of Samarinda

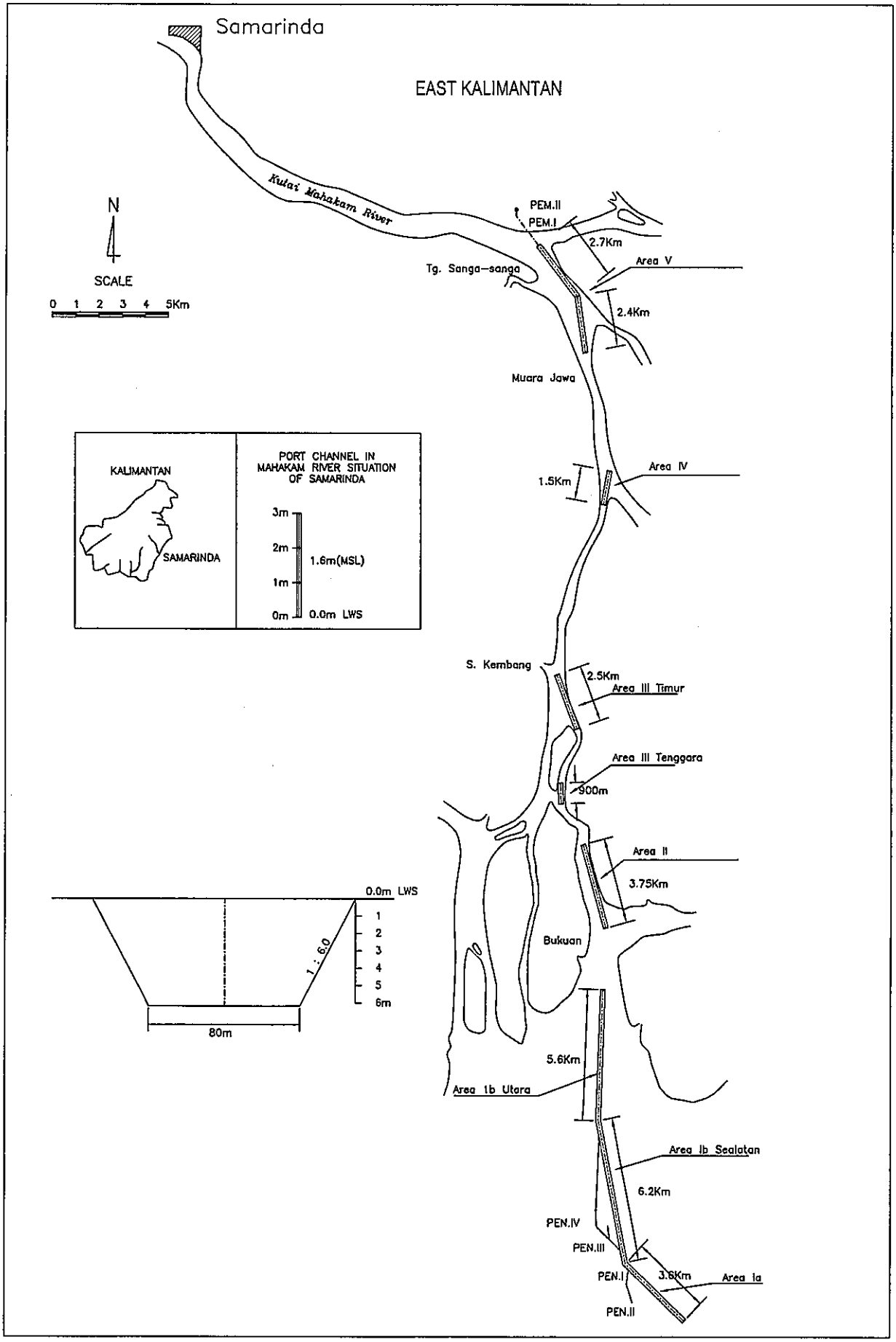


Figure 4.11.4 (2) Navigation Channel maintained by dredging for Port of Samarinda

4.12 Structural Design

4.12.1 General

Table 4.12.1 shows the outline of existing port facilities of objective ports and previously proposed relevant project plans for alternative sites. Similarly to Sumatra Ports, all candidate sites, except for Marang Kayu (Samarinda), are located along the river.

4.12.2 Design Standard

In this report, the basis of the technical overview was the following design standards or technical reference materials.

(1) Standard Design Criteria for Port in Indonesia, Jan 1984, DGSC
(2) Technical Standards for Port and Harbor Facilities in Japan 1991
(3) Port Development for Planners in Developing Countries, UNCTAD

Table 4.12.1 Outline of Port facilities

Location		**Kalimantan**							
		Pontianak		Kumai		Sampit		Samarinda	
Province		West Kalimantan		Central Kalimantan				East Kalimantan	
Port Office		IPC-II		IPC-III				IPC-IV	
Name of Port		**Pontianak**	**Jungkat**	**Kumai**	**Bumiharjo**	**Sampit**	**Bagendang**	**Samarinda**	**Marang kayu**
Situation		Existing	Plan	Existing	Under const.	Existing	Under const.	Existing	Plan
Name of River		Sg. Kapuas Kecil		Sungai Kumai		Sungai Mentaya (Sampit)		Sungai Mahakam	Facing outer sea
Dist. from river mouth		30.5 km	12.5 km	31 km	48 km	68 km	46 km	66 km	-
Navigation channel (dredged)	Length	15 km		11 km		16 km		24 km	
	Width	80 m		50 m		50 m (Outer channel) 90 m (Inner channel)		60 to 70 m	
	Depth (LWS)	-5.5 m		-5.5 m		-4.5 m		-6.0 m	
	Side slope	1:4		1:4		1:4		1:6	
	Volume (x1000)	1700 m^3/year.		700 m^3/2 years		700 m^3/2 years		2200 m^3/yr	
Port area		9.7 ha		1.11 ha	60 ha	1.47 ha	46 ha		N.A.
Berthing facility	Length	710 m	N.A.	190 m (RC)	60 m	316 m	101.5 m	937 m	
				132m (wood)					
	Depth (LWS)	-6 m		-5 m (RC)	-6 m	-7 m	-6 m	-5 m	
				4 m (wood)					
	Width	12 to 35 m		10 m (RC)	6 m	15 m	6 m	15 m	
				6m (wood)					
	max. ship							153 m LOA	

(Cont'd)

(Cont'd, Table 4.12.1)

Name of Port		**Pontianak**	**Jungkat**	**Kumai**	**Bumiharjo**	**Sampit**	**Bagendang**	**Samarinda**	**Marangkayu**
Structure		Concrete deck on Pile (P/C, Steel)		Conc.deck on pile, Wood deck on pile	Conc. Jetty with dolphins on PC piles	Conc. deck on pile	Conc. Jetty with dolphins on PC piles		
Port yard	Gen. Cargo	1.3 ha	N.A.	0.27 ha	(Future)		(Future)	0.25 ha	N.A.
	Container	1.9 ha		N.A.	(Future)	0.3 ha	(Future)	2.0 ha	
	CPO				26 ha				
CFS(unit/m2)		2/1750 m2		N.A.		N.A.			
Warehouse(unit/m2)		2/4450 m2		1/900 m2		1310 m2		3/4400 m2	
CPO tank					included		included		
Passenger terminal(person)		1/2000 m2		1/480 m2		1/780 m2		1/800 m2	
Power supply (KVA)		20							
Water supply	(m3/Reservoir)			200		100		380	
	m3/hour							70	
Road access		Applicable		Applicable	Applicable	Applicable	Applicable	Applicable	

Source: 1) Information of IPC-II
2) "KUMAI", IPC III
3) "Pelabuhan yang diusahakan"
4) Marine charts
5)"Facilitas Pelabuhan Samarinda"IPC-IV
6)Pekerjaan pengerukan alur Pelayaran didalam DLKr/DLKP untuk pelabuhan yang diusahakan

4.12.3 Sub-soil Conditions

Some available information of existing soil boring is summarized in Table 4.12.2.

4.12.4 Water Level

The approximate water level ranges at each river mouth and proposed port site are summarized in Table 4.12.3.

Table 4.12.2 Sub-soil Conditions of some existing Ports in Kalimantan

	Pontianak	Bumiharjo(Kumai)	Bagendang(Sampit)
Upper stratum	N-value (SPT) 0 to 30 sandy silt to silty sand up to –30 m LWS, At – 40 m SPT shows 23 to 35	N-value(SPT) 3 to 20, Silty clay with sand, to Silty sand	Clay: settlement is anticipated. Wooden piles with diameter of 8 to 10 cm, 10 m long will be driven at 50 cm intervals for soil improvement purpose of port yard area.
Bearing stratum	By – 60 m firm stratum was not confirmed	- 24 to 25 m below LWS	- 38 m below LWS

Source: 1) Information of IPC-III, 2) Soil boring data for Quay 7 of Pontianak Port

Table 4.12.3 Tidal range at each river mouth

Name of Port	**Pontianak**	**Kumai**	**Sampit**	**Samarinda**
Location of tide prediction	Sungai kapuas Kecil	Sungai Kotawaringin	Teluk Sampit	
Mean High Water Spring(m)	1.9	1.4		2.0
Zo (m)	0.9	1.0	1.4	1.3
Mean Low Water Spring(m)	0.1	0.6		0.6

Source: 1) Daftar Pasang Surut 2001, 2) Marine chart 3271, 1964, 159,

4.12.5 Design Criteria

(1) Live loads

The design load conditions of existing and planned facilities are summarized in Table 4.12.4. The data in the Table will be examined and referred to for preparing recommendations of the Study in a later stage.

Table 4.12.4 Load Conditions of existing facilities

Location		Jambi				Tg. Apiapi	Pontianak	Samarinda
		Jambi	Talang Duku	Muara Sabak			Quay No.7	
		Existing	Existing	Existing	Plan	Plan	Existing	Existing
Uniform load on concrete deck	Ton/m2	3.0	3.0		5.0	5.0 (C/C) 3.0 (G/C)	4.0 (C/C)	3.0
Uniform load on wooden deck	Ton/m2			0.5				
Uniform load on warehouse floor	Ton/m2							3.0
Top loader (concentration on 60x60 cm)	Ton						40.0	
Container Gantry Crane load (sea side)	Ton/m						36.4	
Container Gantry Crane load (land side)	Ton/m						26.4	
Wind load (kg/m2)					40			
Ship berthing velocity	cm/sec				15 to 20		12.5	
Ship berthing angle	o						10	

Source: 1) “Port of Jambi” IPC-II 2) “Alternative of Samarinda Port Development”IPC-IV
3) ”Facilitas Pelabuhan Samarinda”IPC-IV 4) Information of IPC-II
5) ”Review Study kelayakan Plabuhan Tanjung Api-api”, BAPPEDA Sumatra Selatan

Notes 1) G/C: general cargo, 2) C/C: container cargo

(2) Seismic Load

Estimated seismic coefficient for each port is summarized in following Table.

Table 4.12.5 Estimated Seismic Coefficient for each Port

Name of Port	**Pontianak**	**Kumai**	**Sampit**	**Samarinda**
Number of Seismic Zone	6	6	6	4
Regional Seismic Coefficient	0	0	0	0.05
Factor for subsoil condition 1/	1.2	1.2	1.2	1.2
Coefficient of Importance 2/	1.5	1.5	1.5	1.5
Design seismic coefficient	0	0	0	0.09

Notes: 1/ Class 3 subsoil (poor or deep deposits), 2/ Classification of structure(Special class)

(3) Ship berthing velocity

As to the ship berthing velocity, a little bit higher speed is recommendable to secure safe berthing against the momentum of the ship mass resulting from the river stream. So far as budget or quay structure (strength) allows, 15 to 20 cm cm/sec of design berthing speed is preferable.

4.12.6 Dimension of Navigation Channel

The width of existing navigation channels are summarized in previous Table 3.12.1. Hence, for example, if container vessels of the size 3000 to 4000 DWT were assumed to ply the navigation channel, the following details would be determined.

Average 3000 to 4000 DWT container ships:

1) L_{OA} (length overall): 85 to 95 m
2) Beam: 13.2 to 14.4 m
3) Draft (full): 5.9 to 6.4 m
4) Loading capacity: 200 to 250 TEU

The required width of a safe navigation channel (W) will be obtained by one of following three methods:

1) Japanese design standard: W= 1.0 x LOA=1.0 x (85 to 95 m)=85 to 95 m (infrequent trips)
2) Indonesian Design Criteria: W=(4B to 7B)+30 m=83 to 131 m
3) UNCTAD handbook: W=6B+ 30 m=109 to 116 m

The above required width can be compared with that of the existing channel, which is good only for a one-way voyage. Considering the rather long length of the existing navigation channels, the width of some channels is insufficient for unrestricted access to the port and prevention of accidents mid channel.

4.12.7 Structural Type of Port Facilities

As summarized in Table 4.12.1, most existing quay facilities are “Concrete deck on piles” type. Some use batter/raking piles to resist lateral force. Many variations on

materials of foundation piles were observed such as: 1) Square section R/C (reinforced concrete) pile, 2) Square section P/C (pre-stressed concrete) pile, 3) Cylindrical section centrifugal P/C pile, and 4) Steel pipe pile. A determination will be made on the materials of the foundation piles taking the effects of steel corrosion by seawater into consideration during the succeeding study.

In some ports, steel sheet pile walls are being utilized for retaining wall and quay structure. In Pontianak, concrete U-shaped sheet pile type was adopted for retaining wall on landside of Quay wall. In Pekanbaru and Sungai Lais a steel sheet pile wall was adopted for local ship quay structures.

Some typical cross sections of the existing and proposed quay structures are shown in Figures 4.12.1 to 4.12.3.

4.12.8 Cargo Handling Equipment and Port Service Boats

The number of existing cargo handling equipment and port service boats are summarized by capacities in Table 4.12.6.

Table 4.12.6 Existing Equipment

Location			Kalimantan							
			Pontianak		Kumai		Sampit		Samarinda	
Province			West Kalimantan		Central Kalimantan				East Kalimantan	
Port Office			IPC-II		IPC-III				IPC-IV	
Name of Port			**Pontianak**	**Jungkat**	**Kumai**	**Bumi harjo**	**Sampit**	**Bagendang**	**Samarinda**	**Marangkayu**
Existing/Plan			Existing	Plan	Existing	Under const.	Existing	Under const.	Existing	Plan
Cargo Handling equipment (unit)	Mobil crane (unit)	15 ton		N.A.	Cargo handling equipment is owned by shipping company	N.A.	Available	N.A.	1	N.A.
		25 ton	1							
		35 ton							1	
		50 ton	1							
	Forklift (unit)	2 ton	6				Available			
		3 ton	2						2	
		5 ton	2						1	
	Side loader	15 ton	2							
	Top loader	40 ton	3							
	Head truck	40 ton	4				Available			
	Chassis	20 ton	2							
		40 ton	4							
	Gantry crane(unit)	30.5 ton	1							

Service vessel (unit)	Tug Boat	1x1740HP									1x800HP
	Pilot Boat	3x165-354 HP									2x225HP
	Mooring Boat	1x125HP									1x80HP
	Line Boat										1x240HP
	Speed Boat										2
	Pontoon										2

Source: 1) Information of IPC2
2) "KUMAI", IPC 3
3)"Pelabuhan yang diusahakan
4)"facilitas Pelabuhan Samarinda"IPC-4

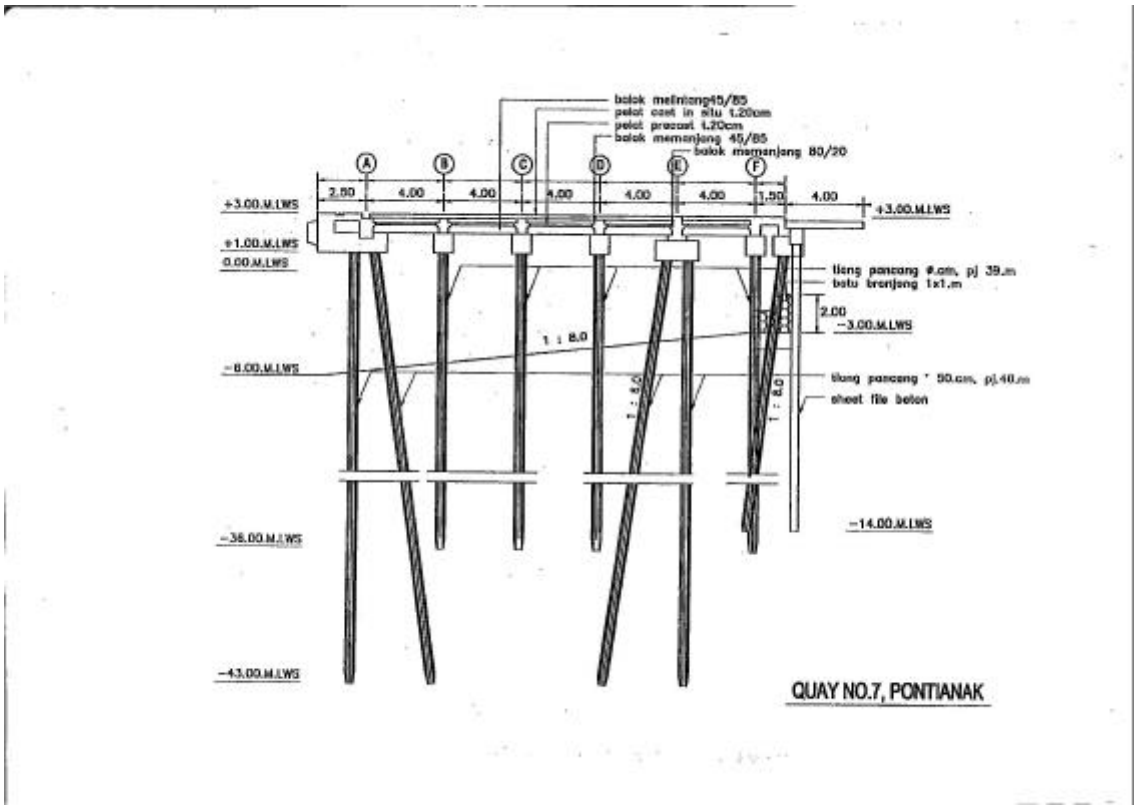


Fig 4.12.1 Typical section of existing Quay No.7, Pontianak Port

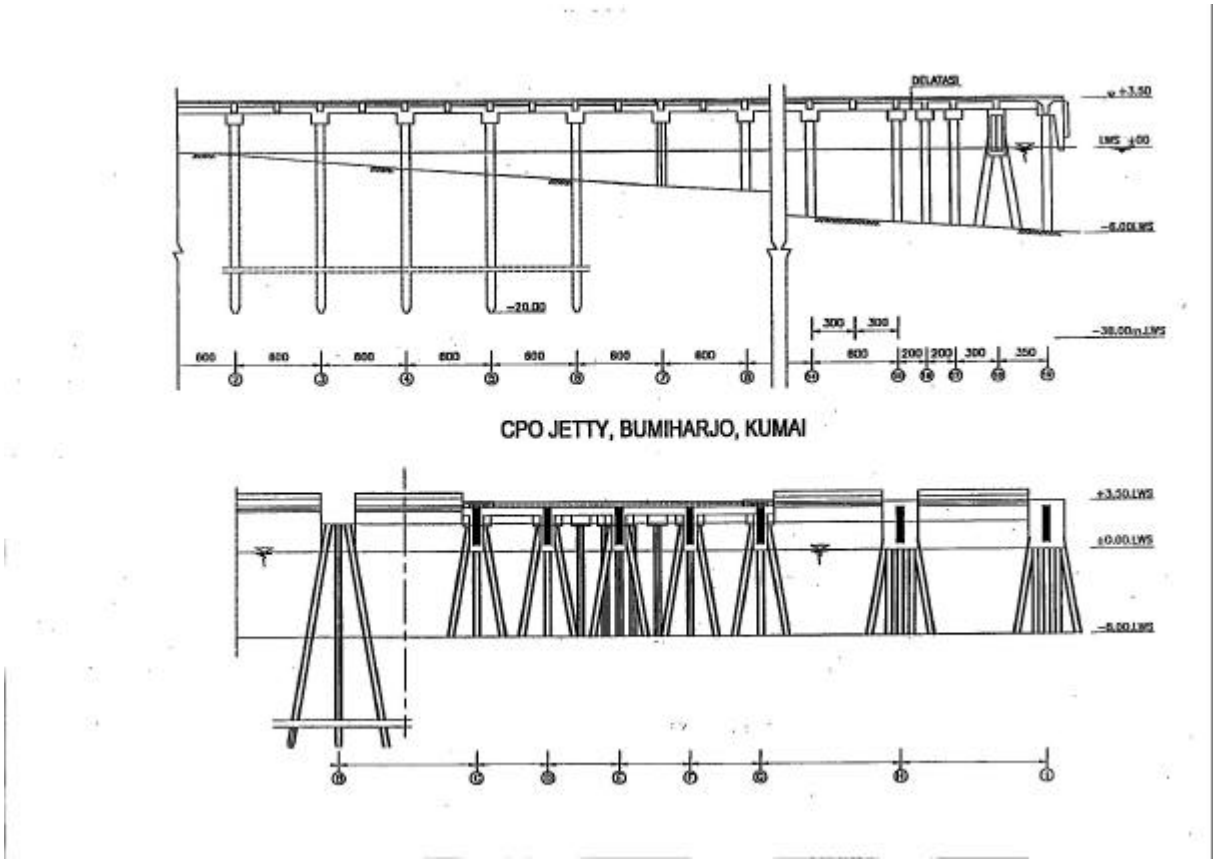


Fig 4.12.2 CPO Jetty for Bumiharjo Port (Kumai; under construction)

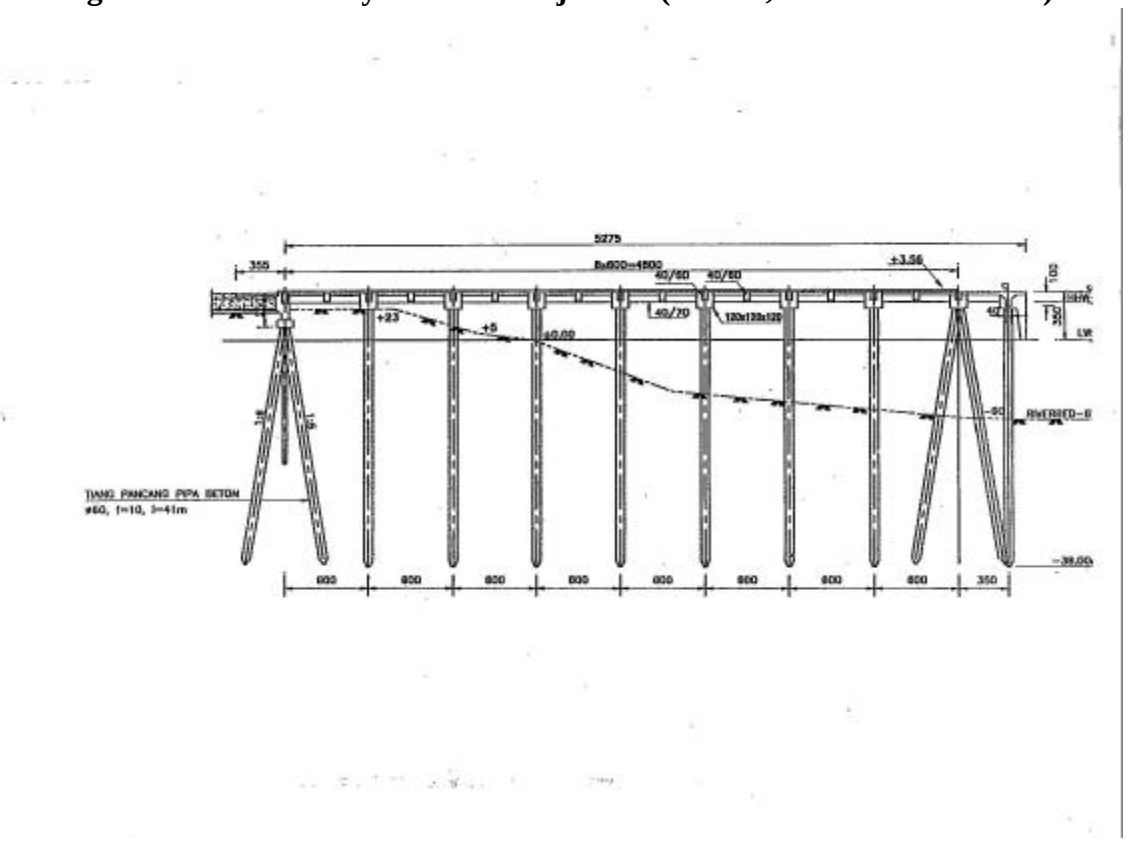


Fig 4.12.3 CPO Jetty of Bagendan Port (Sampit; under construction)

4.13 Conditions of Construction Procurement

4.13.1 General

For the purpose of estimation of construction cost, unit price of each element such as labour, major construction material and equipment are to be determined on the basis of the regional unit prices collected in the field survey in the Study Areas.

The basic costs of imported products are to be estimated using the average exchange rate of the currencies (Rupiah, Japanese Yen, US Dollar, etc.) based on the fluctuation of the half-year period prior to the estimation.

The basic costs of the construction works and unit prices are to be studied and the differences are compared among the provinces concerning the availability of materials, labor, construction equipment and accessibility to the sites.

The capacity and capability of the local contractors are to be checked with respect to their experiences of marine construction works considering the dimensions of the development and port facilities.

4.13.2 Findings in the Each Region

(1) Jakarta and Surabaya (Java

Many construction companies exist which have experiences in the construction of the port facilities. Those contractors have large numbers of construction equipment, experienced engineers and skilled workers. Almost all the construction materials are available in the Java region.

In the most cases, the construction material/equipment/labour will be mobilized from this region to the construction site in the local region.

(2) East Coast of Sumatra, West, Central and East Kalimantan

Some branch offices of the construction companies in this region exist which have experiences in port facilities. The large-scale construction equipment will be mobilized from Jakarta Medan or Surabaya. The major construction materials such as structure steel, cement and sheet piles will be provided from the Java region.

4.13.3 Basic Cost of Construction Work

(1) Basic Cost of the Works

The breakdown of unit costs of the construction works are to be prepared by accumulating costs of labour, materials, equipment and also the indirect costs such as general temporary works, overheads profit and so on.

While, the cost of the works such as building works, fabrication of cargo handling

equipment, supply of utilities and demolition works are to be hindcast on the basis of the empirical prices collected from the major contractors which have experiences in the regions. The unit cost of cargo handling equipment will include the costs of design, manufacturing, workshop tests, delivery and installation.

Price of imported products such as fender systems, bollard and navigation aids are to be estimated based on the CIF Jakarta price and adjusted considering import tax and some mobilization fee to the construction site.

(2) Depreciation Periods of Port Facilities

The depreciation periods of port facilities are to be assumed based on the report "Taksiran Umur Ekonomis Tetap" (source: PELINDO II, 1995) summarized below.

Table 4.13.1 Depreciation Period of Port Facilities

Port Facilities	Year	Remarks
Revetment and Quay	50	
Cargo Handling Equipment	20	
Building	50	Permanent
Navigation Aids	10	
Fender System	10	

4.14 Natural Conditions of Study Areas

4.14.1 Pontianak (Sungai Kapuas Kecil)

(1) Position

Port of Pontianak is located in West Kalimantan Province at the confluence of Sungai Kapuas Kecil (a branch of Sungai Kapuas) and Sungai Landak and is about 30 km upstream from the river mouth (00º01'00"S, 109º20'00"E).

The entrance and navigation channel to the port is via South China Sea and Sungai Kapuas Kecil. The river entrance is fronted by a bar of silt and sand which extends about 10 km offshore. A shipping channel is maintained through the bar by dredging. The minimum water depth is about 5 m in the outer bar area of the channel.

(2) River basin and discharge

Topography around Pontianak is flat lowland formed by alluvial soil with the altitude 0.5-2 m above mean sea level (MSL). The vegetation in this area is swamp forest and also mangrove and nipa are found along the river.

The water depth of the river channel along Sungai Kapuas Kecil is generally more than 5 m below LWS and the width of the river channel is 300 - 600 m.

Sungai Kapuas is the biggest river in Borneo Island; it has a catchment area of 95,557 km^2 and the total extension of the main stream (including the branch) is 869 km (see Figure 4.14.1). The river basin accounts for 65 % of the area of West Kalimantan Province.

The average yearly discharge is given as 121,644 x 10^6 m^3/year (Source: Kantor Menteri Negara Pekerjaan Umum; 2000).

The merged catchment area of Sungai Landak and Kapuas Kecil is about 11,600 km^2.

(3) Climate (Figure 4.14.5)

The whole area of the delta of Sungai Kapuas is subject to heavy rains, squalls. This area in West Kalimantan seldom experiences dry season. The strong rainfall occurs in August – February at 250-350 mm per month.

Off the west coast of Kalimantan the winds are variable and light in March and November.

(4) Tide and current

Average tidal range is 1.30 m at spring tide and 0.25 m at neap tide. The tidal form is diurnal. Amplitude (in cm) of tidal constituents at Sungai Kapuas Kecil is as follows (source: Tide Table; Dinas Hidro-Oseanografi, 2001).

M_2: 16, S_2: 9, N_2: , K_2: , K_1: 39, O_1: 32, P_1: 10,
Number of tidal type F = $(K_1 + O_1)/(M_2 + S_2)$ = 2.840 (Diurnal)

A record of observed tide at Pontianak Port is shown in Figure 4.14.8.

Maximum speed of tidal current (2.5 knots) in the river channel occurs at ebb tide. At flood tide, maximum current is 0.6 knots.

4.14.2 Kumai (Sungai Kumai)

(1) Position

Port of Kumai is located on Sungai Kumai (Central Kalimantan Province) about 25 km upstream from the river mouth (02º45'S, 111º43'E).

The entrance channel to the port is facing Teluk Kumai (Kumai Bay) from Java Sea. The river channel has around 690 m in width at Port of Kumai.

(2) Topography and river basin

The south coast of Kalimantan between Tanjung Puting and Tanjung Sambar is low and flat land and covered by dense, tall woods. The west shore of Teluk Kumai consists of a narrow sandy beach backed by high trees.

Sungai Kumai has a catchment area of 8,200 km^2 and the extension of the stream is 175 km (Figure 4.14.2).

There is no hydrographic or hydrological station along this river. The average yearly discharge is estimated as 7,671 x 10^6 m^3/year (Source: Kantor Menteri Negara Pekerjaan Umum; 2000).

(3) Climate

Climate data is given in Pangkalan Bun (Figure 4.14.6). The SE monsoon prevails from May to October and the NW monsoon from December to March. Squalls are most frequent in November and December. A moderate swell develops during the NW monsoon in January and February.

(4) Tide and current

The horizontal movement of water along the south coast of Kalimantan is a mixture of tidal streams and monsoon currents.

The tidal streams in Teluk Kumai are semi-diurnal and off the mouth of Sungai Kumai change fairly regularly every six hours. The maximum rate of the out-going stream observed was 3 knots and the in-going stream 2 knots.

4.14.3 Sampit (Sungai Mentaya)

(1) Position

Port of Sampit is located on Sungai Mentaya (Central Kalimantan Province) about 35 miles (55 km) upstream from the river mouth (02º33'20"S, 112º58'16"E).

The entrance channel to the port is facing Teluk Sampit (Sampit Bay) from Java Sea. Teluk Sampit is a bay occupied by shallow silty sand bar and the minimum water depth is about 2.5 m below LWS.

(2) Topography and river basin

Topography around Sampit is flat lowland with swamp forest.

Sungai Mentaya has a catchment area of about 16,200 km^2 and the extension of the stream is 400 km (see Figure 4.14.3).

The average yearly discharge is estimated as 16,200 x 10^6 m^3/year (Source: Kantor Menteri Negara Pekerjaan Umum; 2000).

(3) Climate (refer to Figure 4.14.6, Pangkalan Bun)

Rainy season occurs in the season of west wind in this area, that is, from September to March. In the season of east wind (June – September) there is little rain. Average annual rainfall is about 2,000 – 2,500 mm.

(4) Tide

Average tidal range is 1.20 m at spring tide and 0.7 m at neap tide. The tidal form is diurnal. Amplitude (in cm) of tidal constituents at Teluk Sampit is as follows (source: Tide Table; Dinas Hidro-Oseanografi, 2001).

M_2: 49, S_2: 11, N_2: 14, K_2: , K_1: 60, O_1: 31, P_1: 20,
Number of tidal type $F = (K_1 + O_1)/(M_2 + S_2) = 1.517$ (Diurnal)

4.14.4 Samarinda (Sungai Mahakam)

(1) Position

Port of Samarinda is located on Sungai Mahakam (East Kalimantan Province) about 39-mile (75 km) upstream from the river mouth (00º32'00"N, 107º09'00"E). The entrance channel to the port is facing Makassar Strait from Mahakam Delta.

(2) River basin and discharge

Sungai Mahakam is one of the most important rivers in the east coast of Borneo and forming a large Mahakam Delta with 30 km from east to west and 60 km from south to north in the river mouth area. Four trunk waterways and a large number of small waterways exist among the islands forming the delta. The small islands of the delta are swamp with mangrove vegetation.

Sungai Mahakam is the second biggest river in Borneo Island; it has a catchment area of 92,641 km^2. The river basin accounts for 44 % of the area of East Kalimantan Province.

The average yearly discharge is given as 82,400 x 10^6 m^3/year (Source: Kantor Menteri Negara Pekerjaan Umum; 2000).

(3) Climate (Figure 4.14.7)

Average rainfall is about 140 mm per month all through the year. The months with rainfall more than 200 mm are February, April, May, September and July.

(4) Tide

Average tidal range at Samarinda is 1.80 m at spring tide and 0.5 m at neap tide. The tidal form is mixed semi-diurnal, and semi-diurnal is rather dominant. Amplitude (in cm) of tidal constituents at Samarinda is as follows (source: Tide Table; Dinas Hidro-Oseanografi, 2001).

M_2: 42, S_2: 26, N_2: , K_2: 10, K_1: 19, O_1: 24, P_1: ,

Number of tidal type $F = (K_1 + O_1)/(M_2 + S_2) = 0.632$ (Mixed semi-diurnal)

(5) Current

Strong offshore-ward current and/or onshore-ward current is found even in fairly distant water area from the delta. A steady southward current is found in Makassar Strait where the influence of the river flow and the delta have no affect.

Tidal current is experienced in the season from September to December with 2.5 knots at ebb tide and 2 knots at flood tide. Current by ebb tide is dominant in the rainy season and neap tide in the dry season.

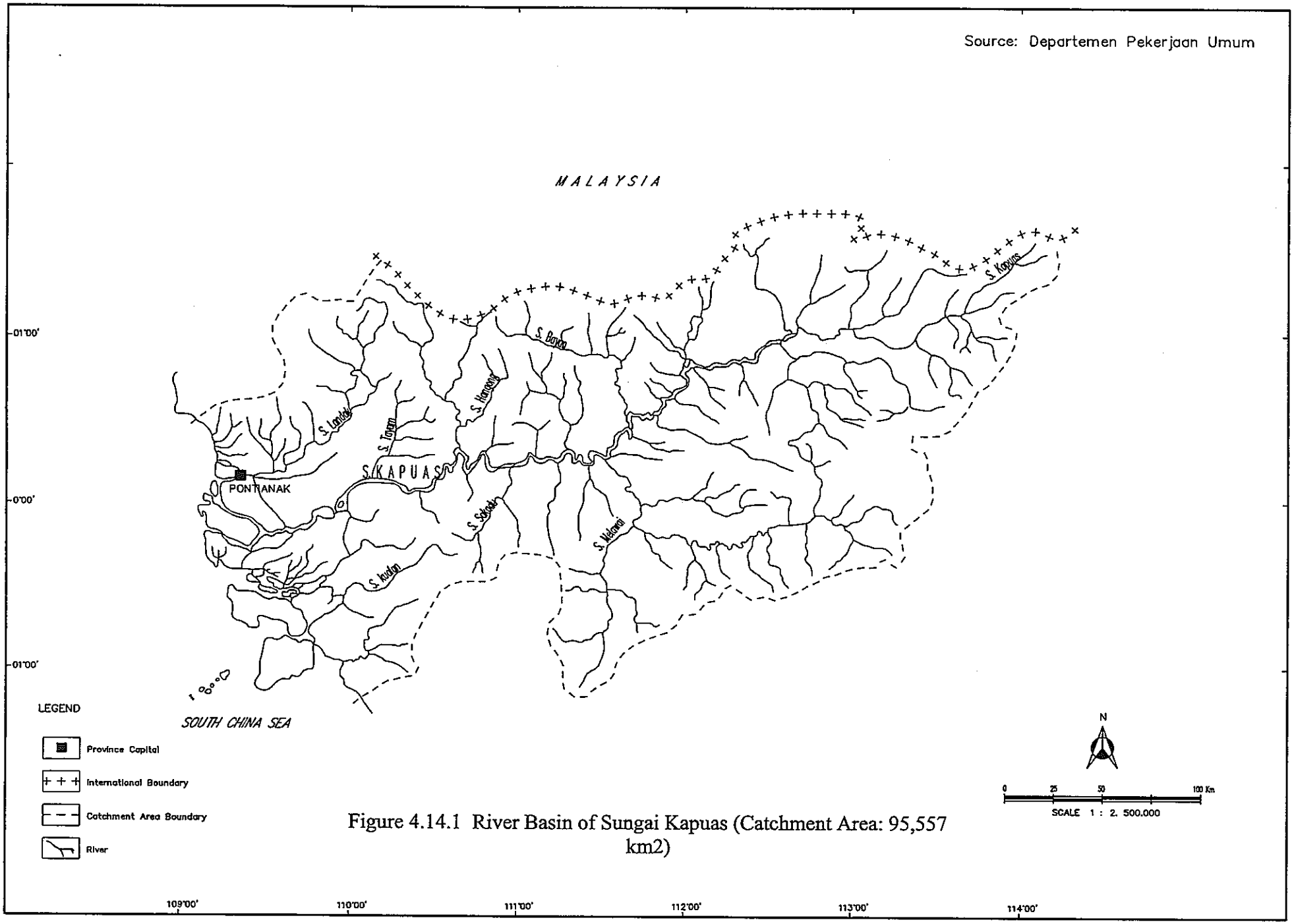


Figure 4.14.1 River Basin of Sungai Kapuas (Catchment Area: 95,557 km2)

Source: Departemen Pekerjaan Umum

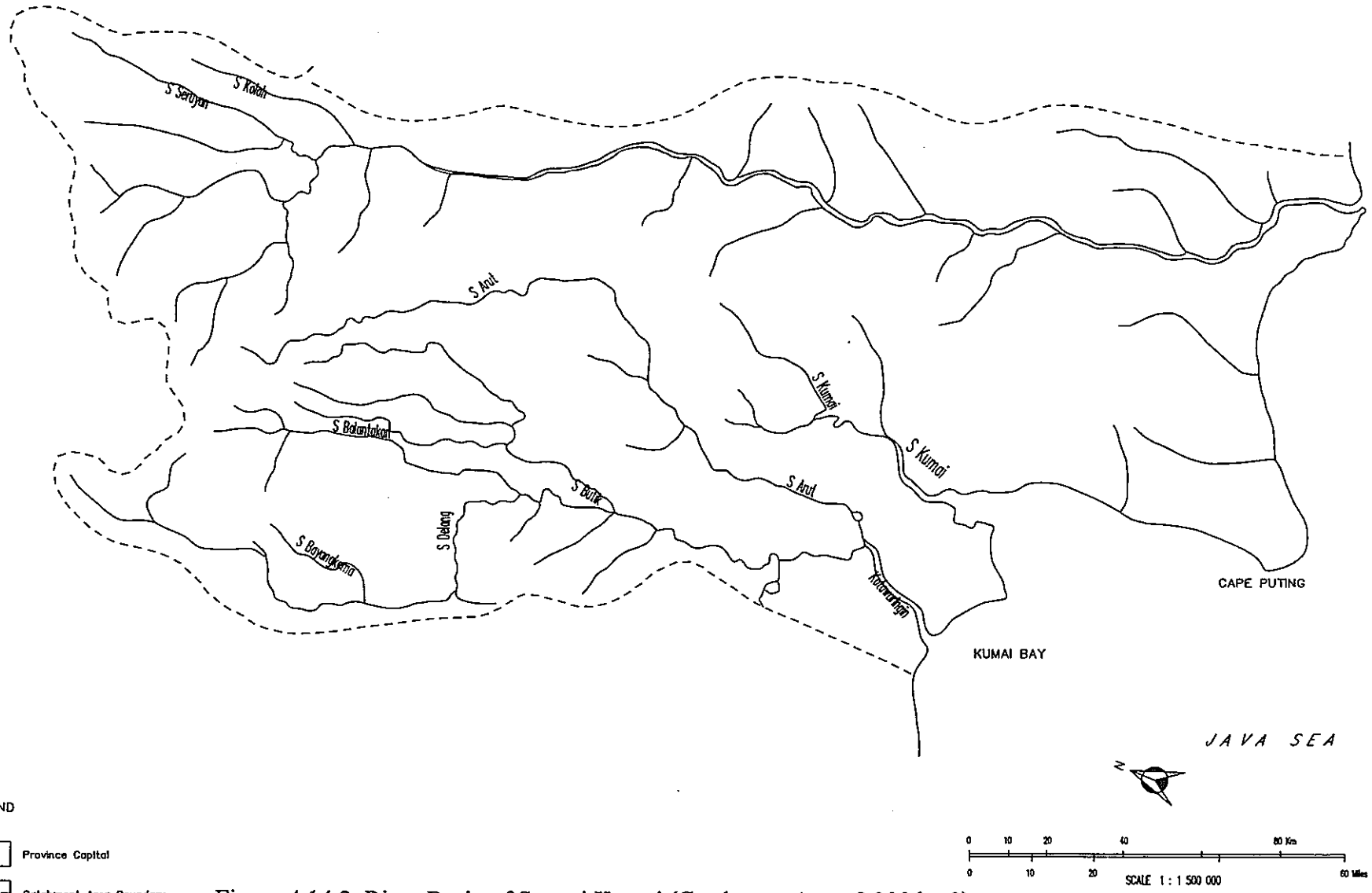


Figure 4.14.2 River Basin of Sungai Kumai (Catchment Area: 8,200 km2)

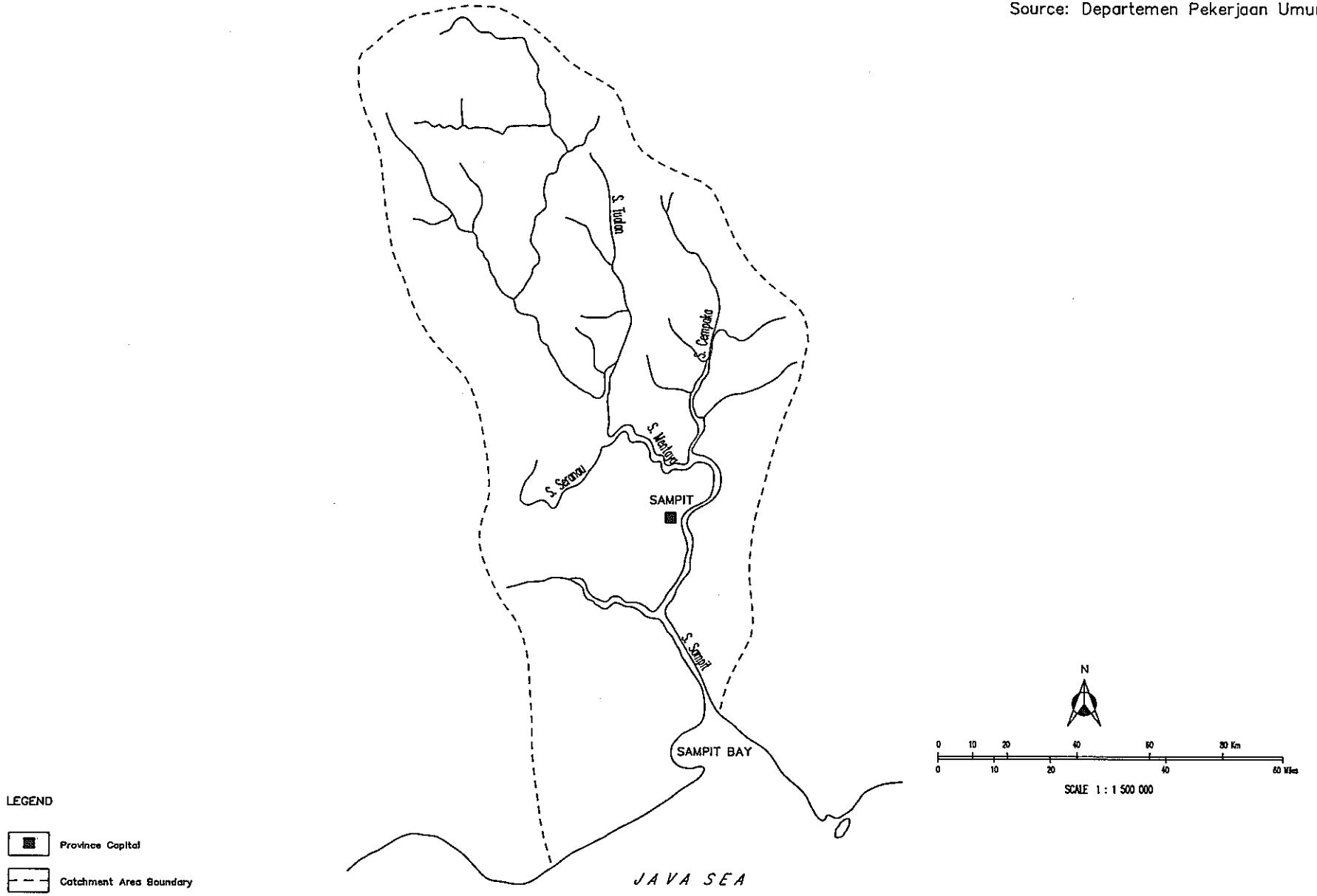


Figure 4.14.3 River Basin of Sungai Mentaya (Sampit; Catchment Area: 16,200 km2)

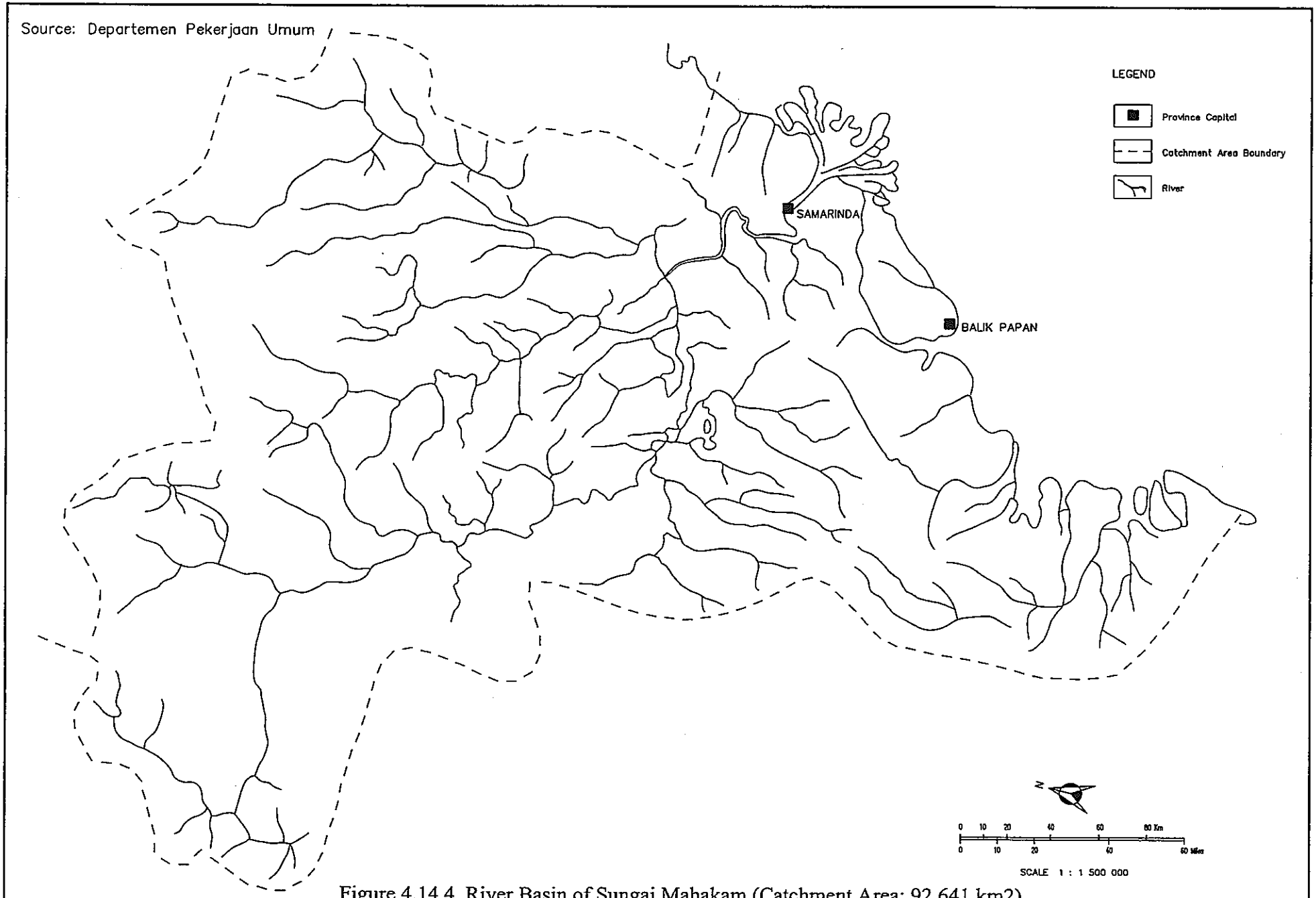


Figure 4.14.4 River Basin of Sungai Mahakam (Catchment Area: 92,641 km2)

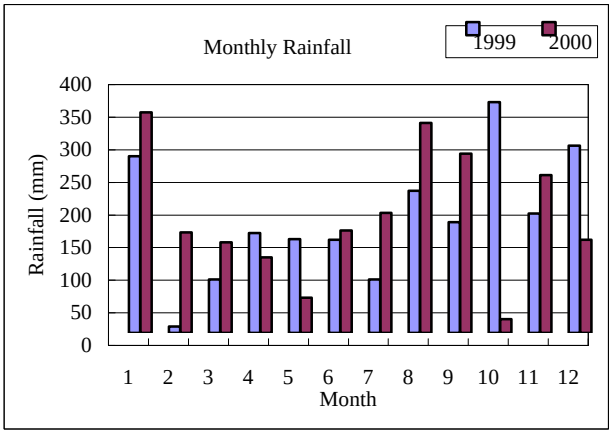
Pontianak

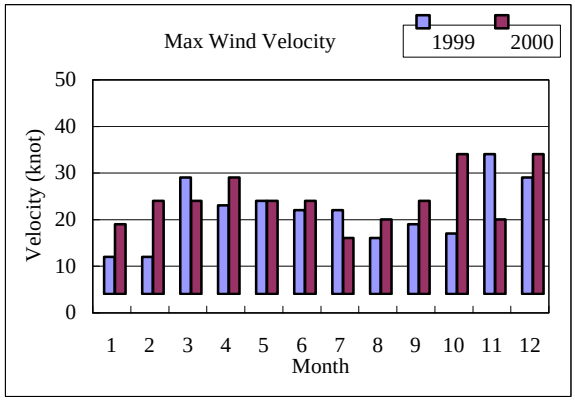
Item	Unit	1999												Total	Average
		1	2	3	4	5	6	7	8	9	10	11	12		
Temparature (Max.)	°C	31.9	33.7	29.6	33.6	32.6	32.9	32.4	32.6	32.6	31.8	31.4	31		32.2
Temparature (Min.)	°C	23.1	23.3	23.1	23.2	23.1	22.7	22.4	22.4	22.5	22.8	22.8	23		22.9
Humidity (Max.)	%	98	97	98	97	98	98	98	98	98	98	98	98		97.8
Humidity (Min.)	%	64	63	69	64	66	66	67	68	67	74	72	77		68.1
Rainfall	mm	271	10	82	153	144	143	82	218	170	354	183	287	2,097	174.8
Wind velocity (Max.)	knot	8	8	25	19	20	18	18	12	15	13	30	25		17.6
Dominant Wind Direction		W	W	W	SW	SW	E	S	E	W	W	W	W		

Item	Unit	2000												Total	Average
		1	2	3	4	5	6	7	8	9	10	11	12		
Temparature (Max.)	°C	31.7	31.8	33.1	32.4	33.3	32.4	33.1	32.3	32.3	33.3	31.9	31.8		32.5
Temparature (Min.)	°C	23.2	23.2	23	23.1	23.3	22.7	22.4	22.3	22.2	22.7	23.1	22.8		22.8
Humidity (Max.)	%	97	98	98	98	98	98	98	97	97	98	98	97		97.7
Humidity (Min.)	%	74	74	66	70	66	69	63	66	69	66	70	67		68.3
Rainfall	mm	338	154	139	116	54	157	184	322	275	21	242	143	2,145	178.8
Wind velocity (Max.)	knot	15	20	20	25	20	20	12	16	20	30	16	30		20.3
Dominant Wind Direction		W	W	W	W	NE	E	SE	W	SW	SW	W	W		

Note -- No data

Data source Badan Meteorologi dan Geofisika, Departemen Perhubungan





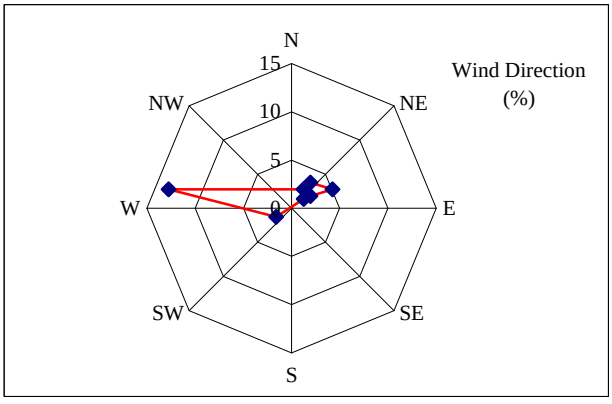


Figure 4.14.5 Climate in Pontianak

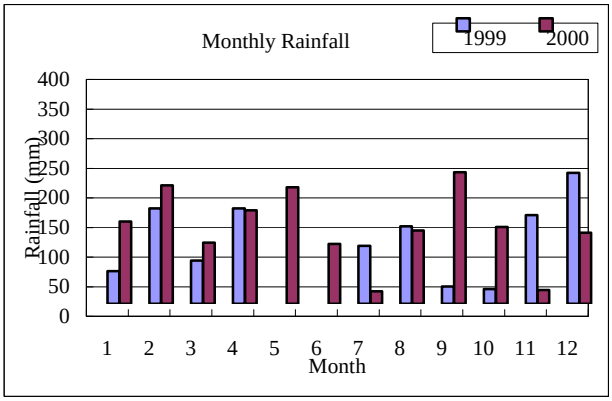
Pangkalan Bun

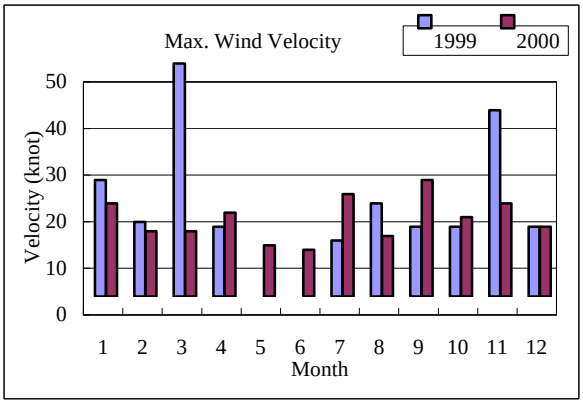
Item	Unit	1999												Total	Average
		1	2	3	4	5	6	7	8	9	10	11	12		
Temparature (Max.)	°C	31.0	32.4	31.8	35.0	--	--	30.9	31.4	31.3	31.8	32.0	31.2		31.9
Temparature (Min.)	°C	22.8	23.1	23.3	23.3	--	--	22.0	21.5	22.5	23.3	23.4	22.3		22.8
Humidity (Max.)	%	98	96	98	98	--	--	98	97	97	99	98	99		97.8
Humidity (Min.)	%	68	62	66	63	--	--	65	60	64	68	68	69		65.3
Rainfall	mm	55	161	73	161	--	--	98	131	29	25	150	221	1,104	110.4
Wind velocity (Max.)	knot	25	16	50	15	--	--	12	20	15	15	40	15		22.3
Dominant Wind Direction		W	N	N	N	S	S	S	S	S	S	N	N		

Item	Unit	2000												Total	Average
		1	2	3	4	5	6	7	8	9	10	11	12		
Temparature (Max.)	°C	30.8	31.9	32.0	32.5	32.6	31.8	31.2	31.8	32.5	32.0	32.7	32.5		32.0
Temparature (Min.)	°C	22.8	22.9	23.1	23.4	23.2	23.3	21.8	22.2	22.6	22.8	23.5	22.4		22.8
Humidity (Max.)	%	98	98	98	99	94	99	98	99	99	98	92	98		97.5
Humidity (Min.)	%	72	65	65	71	74	73	73	73	70	73	67	67		70.3
Rainfall	mm	139	200	103	158	197	101	21	124	222	130	23	120	1,538	128.2
Wind velocity (Max.)	knot	20	14	14	18	11	10	22	13	25	17	20	15		16.6
Dominant Wind Direction		N	N	N	N	E	N	S	S	S	N	N	N		

Note -- No data

Data source Badan Meteorologi dan Geofisika, Departemen Perhubungan





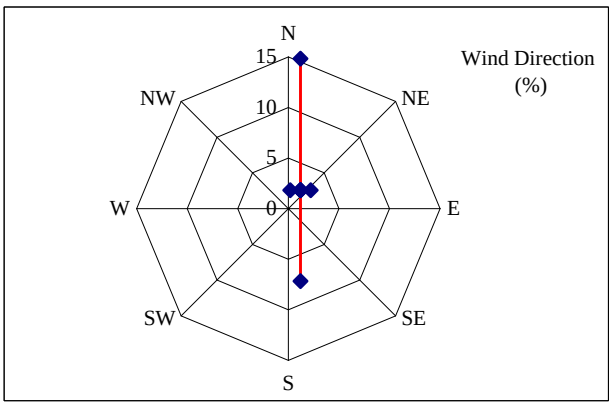


Figure 4.14.6 Climate in Pangkalan Bun (Kumai)

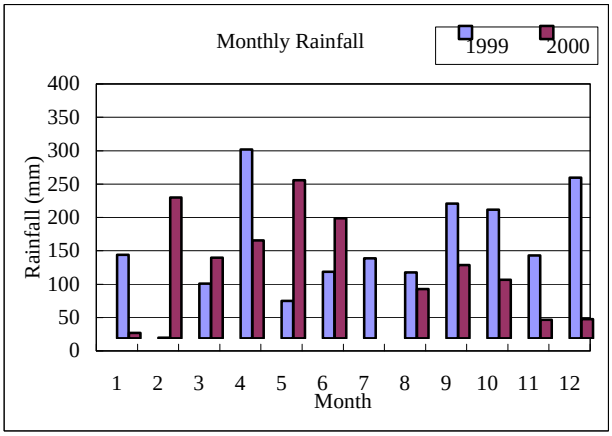
Samarinda

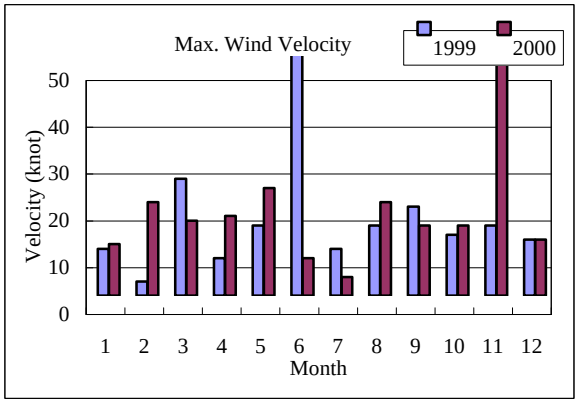
Item	Unit	1999												Total	Average
		1	2	3	4	5	6	7	8	9	10	11	12		
Temparature (Max.)	°C	31.9	32.0	29.6	32.2	31.7	31.6	31.1	31.6	32.0	32.2	32.7	32.2		31.7
Temparature (Min.)	°C	22.4	24.0	23.0	23.0	23.5	23.1	22.8	22.9	22.6	23.4	23.2	23.3		23.1
Humidity (Max.)	%	94	89	98	94	97	96	96	94	95	96	94	95		94.8
Humidity (Min.)	%	64	68	68	61	65	66	65	61	62	64	49	61		62.8
Rainfall	mm	125	1	82	283	56	100	120	99	202	193	124	241	1,626	135.5
Wind velocity (Max.)	knot	10	3	25	8	15	74	10	15	19	13	15	12		18.3
Dominant Wind Direction		NW	W	NW	W	S	SE	S	W	S	SE	W	NW		

Item	Unit	2000												Total	Average
		1	2	3	4	5	6	7	8	9	10	11	12		
Temparature (Max.)	°C	31.5	31.7	31.6	32.3	32.8	31.1	29.0	31.0	31.8	31.5	32.3	32.3		31.6
Temparature (Min.)	°C	22.2	22.5	22.3	23.0	23.0	22.8	22.0	21.7	22.3	22.4	22.9	23.8		22.6
Humidity (Max.)	%	96	95	94	94	94	95	97	94	95	92	95	94		94.6
Humidity (Min.)	%	72	65	65	65	62	65	75	66	62	61	64	61		65.3
Rainfall	mm	8	211	121	147	237	180	0	74	110	88	28	29	1,233	102.8
Wind velocity (Max.)	knot	11	20	16	17	23	8	4	20	15	15	65	12		18.8
Dominant Wind Direction		NE	NW	NW	W	W	NW	--	S	S	S	NW	W		

Note -- No data

Data source Badan Meteorologi dan Geofisika, Departemen Perhubungan





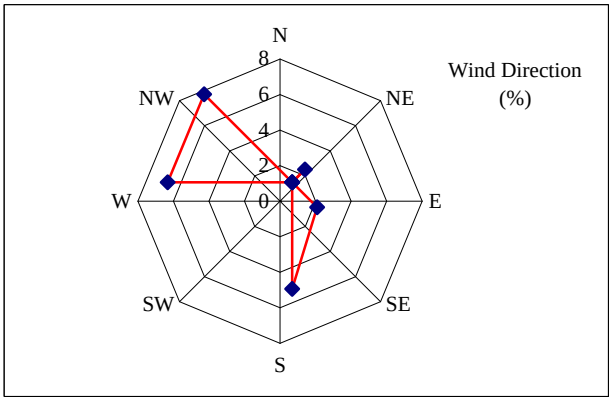
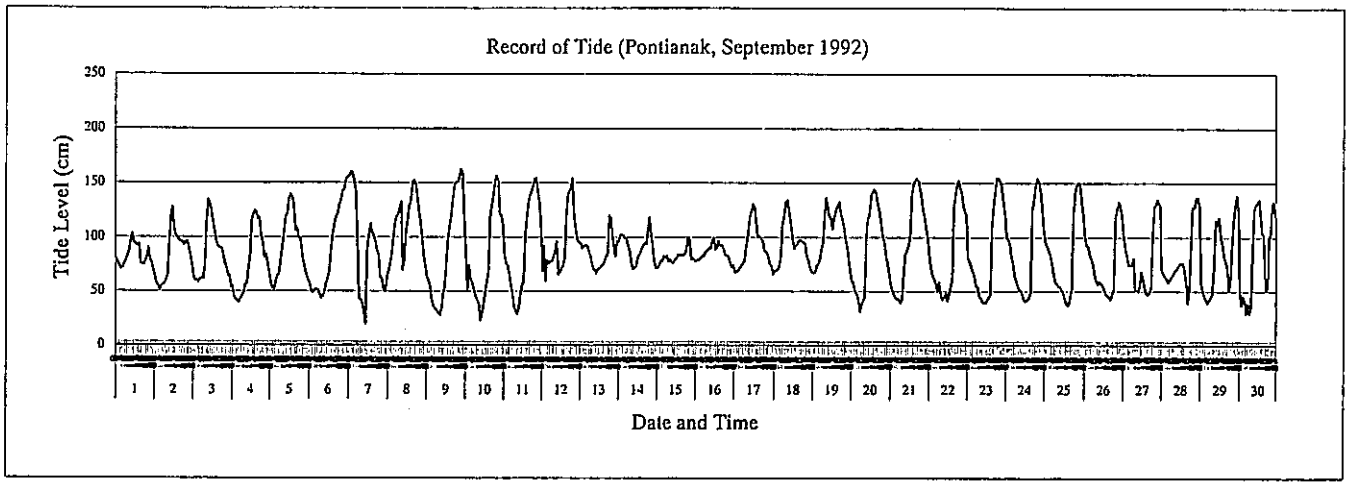
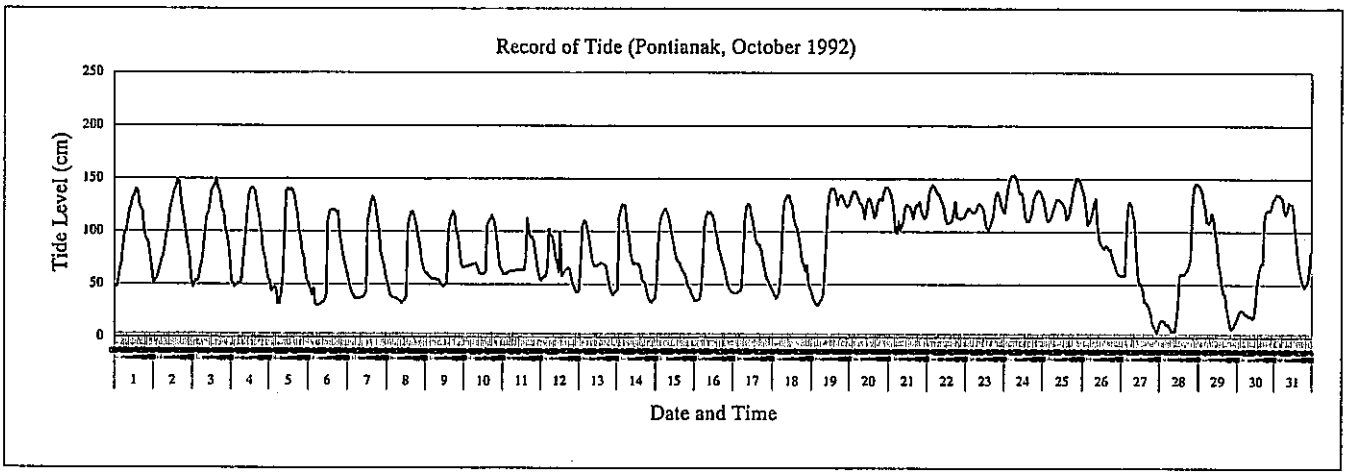
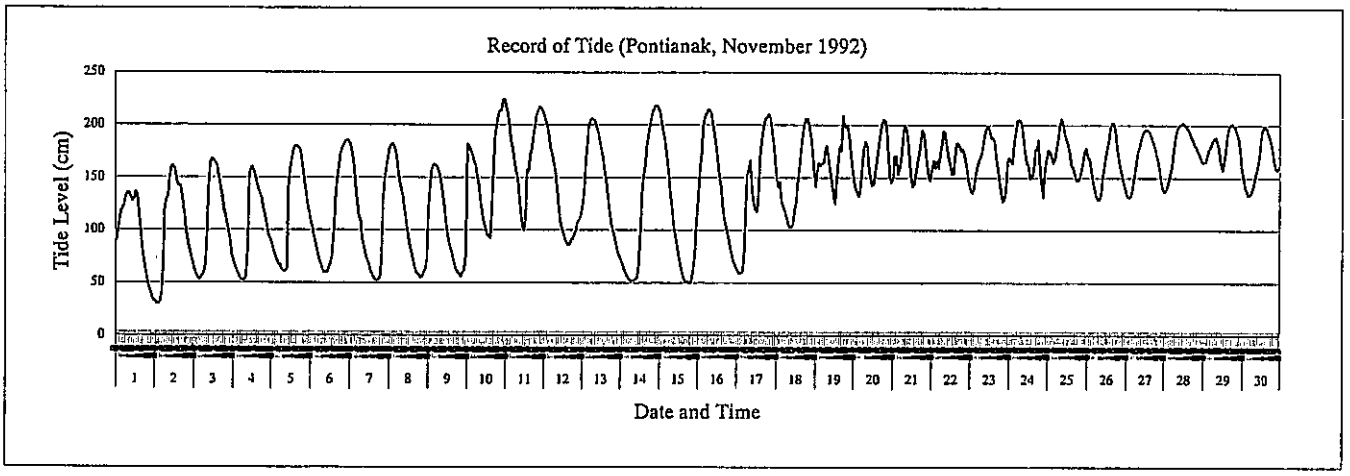


Figure 4.14.7 Climate in Samarinda







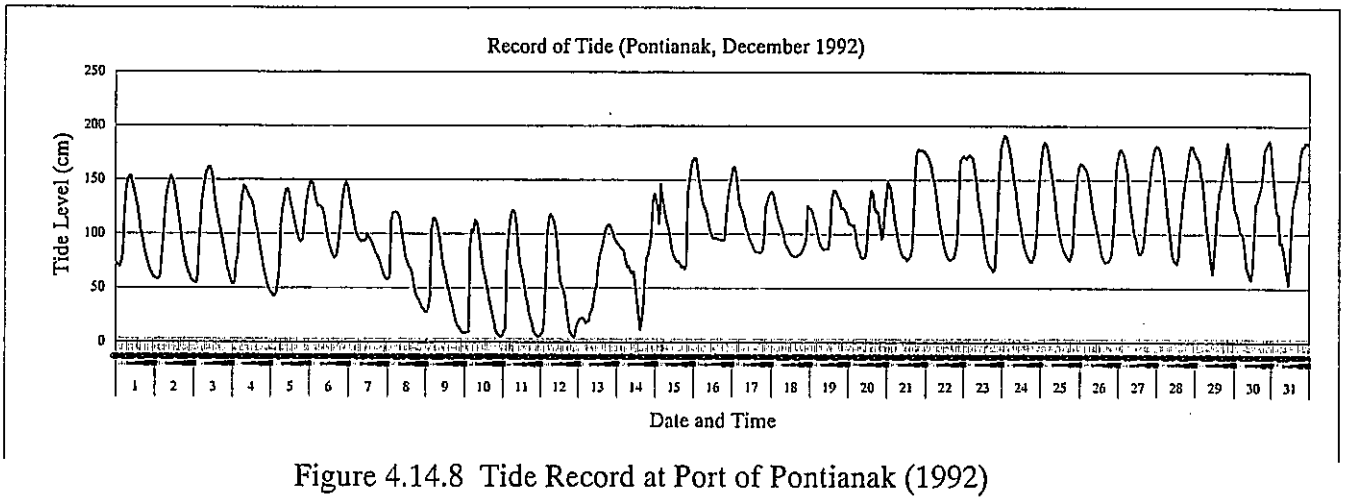


Figure 4.14.8 Tide Record at Port of Pontianak (1992)

4.15 Environmental Outline of Kalimantan Study Areas

4.15.1 Formation Process of the Configuration

Large area of Central, East, and South Kalimantan are composed of sedimentary rocks such as sandstone and shale. Most sedimentary formations are relatively young. The southern part of Borneo consists mainly of loosely consolidated sand and gravel terraces, often the Quarterly, surface deposits of peat and alluvial fans deposited by flooding rivers.

The three longest Indonesian rivers are Kapuas (1,143 km), Barito (900 km) and Mahakam (775 km). The studied rivers include 1) Kapuas Kecil (Pontianak Port) flowing west from Mount Cemaru, 2) Kumai river (Kumai Port), 3) Mentaya river (Sampit Port) flowing south from the north mountainous range, and 4) Mahakam river (Samarinda Port) flowing east from the north mountainous area.

Regarding vegetation in Kalimantan, mangroves occur along the coast, nipa communities along the brackish areas, and fresh water swamp forests in upper area of river basins. Apart from these forest communities, Depterocarpus dominated forests spread in the lowland areas.

Forest areas in Kalimantan have been exploited from 1970's intensively. According to the World Bank's estimation of forest area reduction, forest area in Kalimantan was 50 million hectares in 1900, but it is estimated that it will be reduced 25 million hectares by 2010. Figure 4.15.1 shows the deforestation process in Kalimantan.

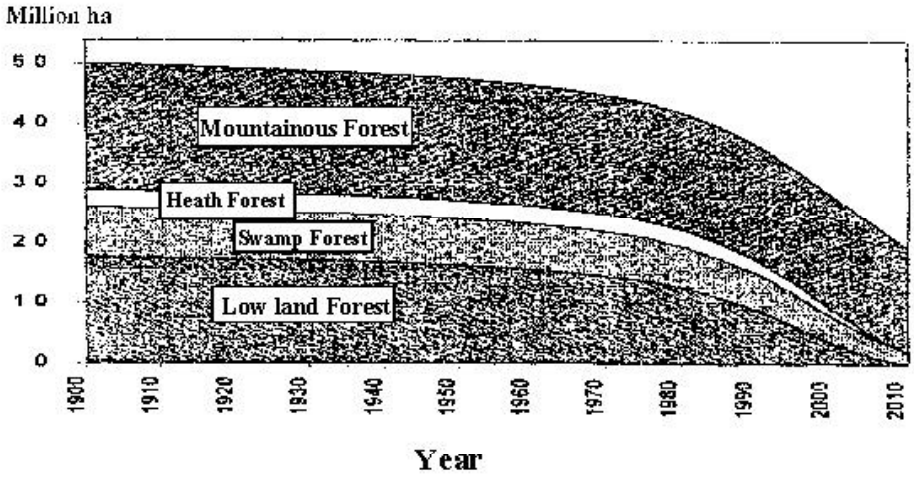


Figure 4.15.1 Deforestation process in Kalimantan

Source: World Bank

Mountainous forest is defined as forest communities occurring in mountain areas higher than 2000m. Swamp forest occurs in peat swamps, Heath forest consists of dwarf trees like bushes in the arid areas. Vast Peat Swamps Spread in the Provinces along the east

coast of Sumatra mentioned previously. Some kinds of Depterocarpus, Legminosae (pea family) are dominant in this type of forest.

Regarding the Fauna and Flora aspects, their movements are blocked by mountains and rivers; consequently, Borneo Island is divided into 9 biological regions. Three study areas Pontianak, Sampit, and Kumai basins belong to one biological region which is enclosed by Kapuas River, Barito River and the northern mountains. Diverse Fauna in peat swamps and fresh water swamps is characteristic in the area. The other study area Samarinda in the Mahakam basin belongs to a biological region, which is enclosed by Mahakam river, Barito river, and the northern mountains. Many endemic plant species, especially a variety of Orchid, are characteristic in the area.

4.15.2 Environmental outlines in each study areas

(1) Pontianak (Kapuas Kecil River)

Mangroves and Nipa communities occur along coastline, estuary and brackish area affected by seawater in West Kalimantan. In its landward area, peat swamps occupy most of the areas of the plains. The basis of the city of Pontianak is peat swamp. Since Pontianak port is closer (30 km) to the river mouth compared with other study ports, Mangroves and Nipa palm communities exist along the area from river mouth up to the port.

Three areas are specified as the natural protected areas in West Kalimantan, and peat swamp forests and fresh water forests are protected in the study areas.

Moreover, rubber plantations are operated in the basin. The rivers are used for its transport.

(2) Kumai (Kumai River)

Since Kumai port is the closest to the mouth of river among the study ports, mangroves are distributed in the estuary and nipa palm is seen in brackish area near Kumai port. Tanjung Puting is on the left bank at the estuary of Kumai River.

Three areas are specified as natural protected areas in Central Kalimantan province where peat swamp forest and freshwater swamp forest are conserved. Endangered species include: Orangutan, freshwater dolphin, dugong, turtles which are conserved in Tanjung Putting Natural Protected Area close to Kumai river with a long seashore. Precious bird sea eagle’s nest are found around Kumai port.

(3) Sampit (the Mentaya)

Mentaya river flows to Sampit bay. Mangroves are distributed along the bay coast. Depterocarpus forest distribute behind the mangrove forest. This formation, mangroves and Depterocarpus, are remarkable and different from any other area’s vegetation

characteristics.

Rattan products are loaded at Sampit port as well as Kumai's.

(4) Samarinda (the Mahakam)

Mahakam River is the third longest river in Indonesia, and forms vast deltas at its estuary. The pioneer species Api-Api inhabit the estuary having high salinity affected by seawater. Nipa palm forests are distributed along the riverbank in the upper stream of the Api-Api area.

Fresh water plant distribute around Samarinda Port with its low salinity freshwater. Mahakam Lake is situated at the upper stream from Samarinda Port, which is specified as a natural protected area inhabited by endangered freshwater dolphins.

There are 4 natural protected areas in East Kalimantan province. Kutai natural protected area is situated north of Samarinda, which conserves precious species such as Orangutan.

Waterborne traffic, especially physical distribution in Mahakam River, is well developed. Also wood processing is highly developed around Samarinda city. There are more than 50 wood processing or plywood factories along Mahakam River. Felled lumber from the mountain area is transported by Mahakam River. Wood products are famous in this district.