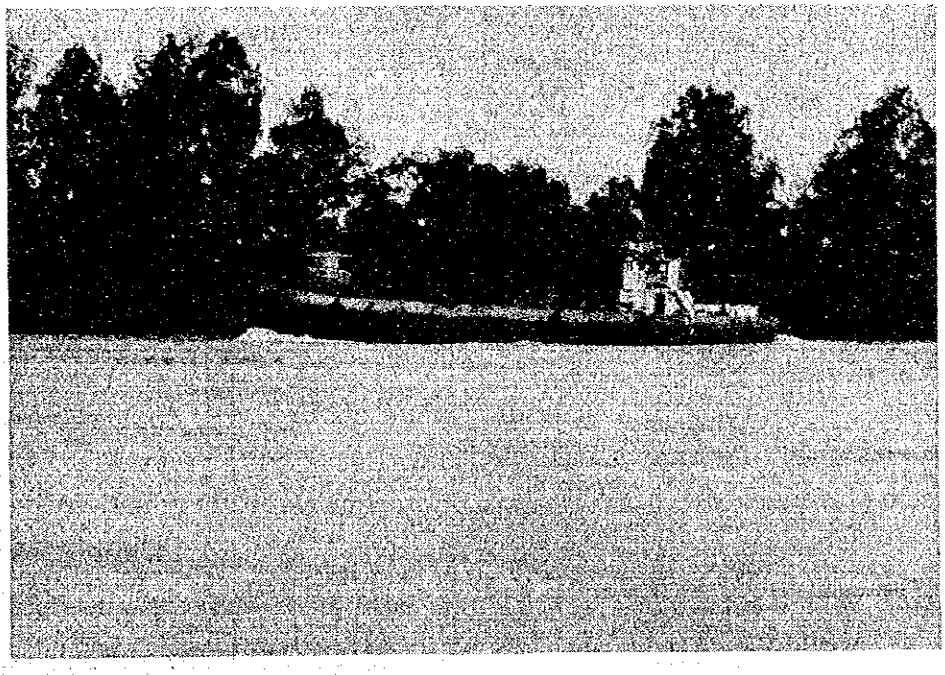
Sample 4



2) Examination of the topographical change in shoreline and river bed.

The change in the shoreline and river bed was examined in three areas. Location of the three areas is shown in 1.3.1.13 of the following page.

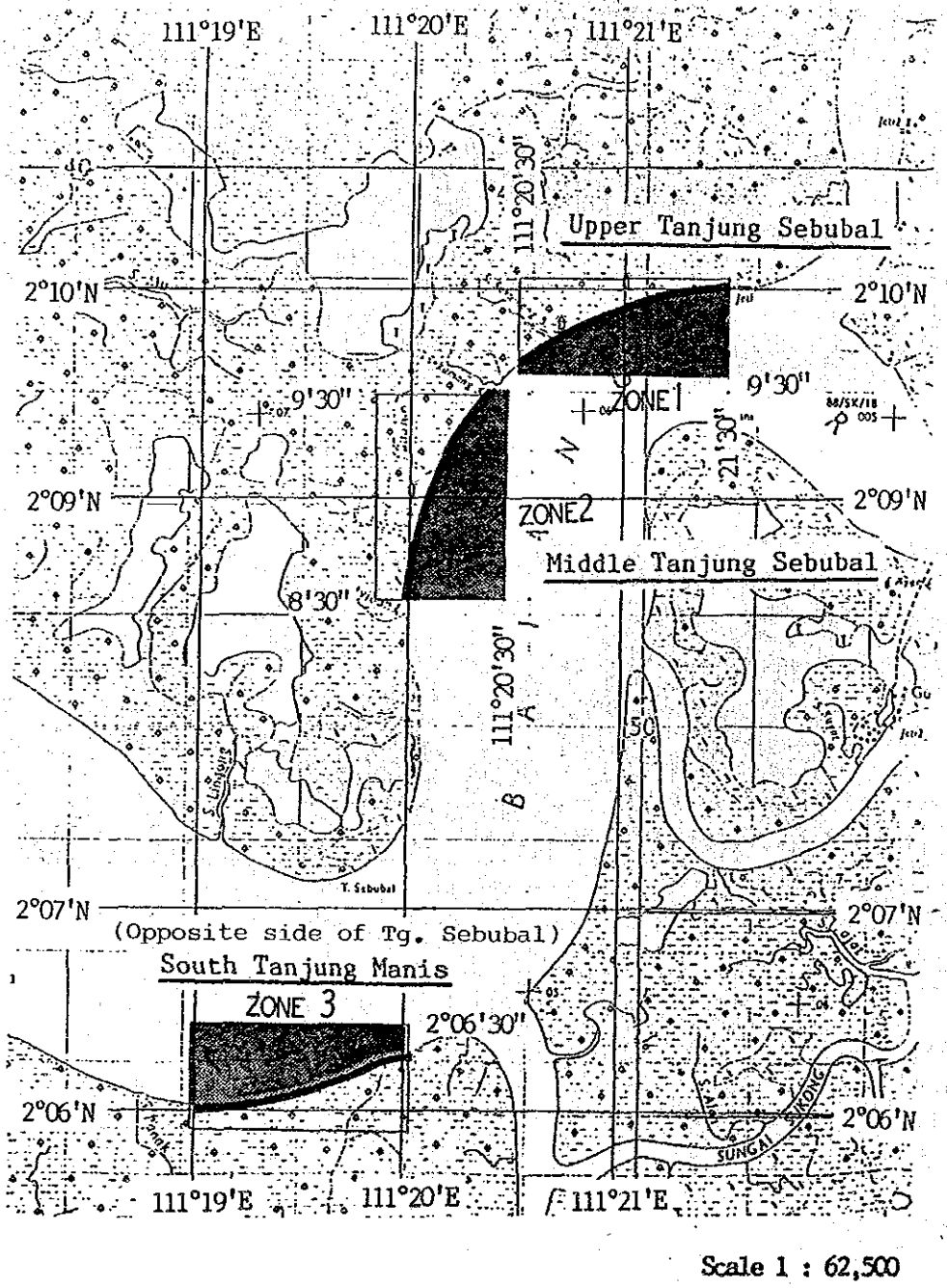


Figure-1.3.1.13 Location map of the study area for erosion and sedimentation

Following analyses were performed for the three areas.

① Comparison of river bed profile
② Horizontal change of shoreline and river bed
③ Vertical change of river bed
④ Change in the edges of deep waterway of more than C.D. -10m
⑤ Accumulated areas and eroded areas.

Note) The following examination was made compared with maps of 1979, 1985 and the result of observation in 1991. However, it is difficult to make a accurate examination because these old maps are small scale and the method of the surveys were not clear. Therefore, only a qualitative examination is described in the following sentences.

i) Upper Tg. Sebubal

Upper Tanjung Sebubal (Eastward from 111°20'30" E) has three conspicuous features in relation to erosion and sedimentation ---- a sedimentated area, stable or eroded area originating in the east.

The shoreline between 111°20'45"E and 111°21'30"E has remained fairly constant, judging from **Figures-1.3.1.14** and **1.3.1.15.**

The shoreline around 111°20'37.5", where the river sharply weaves at Tanjung Sebubal, is the first impact point of current energy during ebb tide and the last impacting point during flood tide. (See **Figure-1.3.1.24, 25**)

The erosion begins here and continues up to the south fringe of Middle Tanjung Sebubal.

Comparing the data of 1979 and 1990, the area close to the shore has a large volume of sedimentation. On the other hand, a large amount erosion has arisen at about 250m offshore from the area of sedimentation.

According to the information from the Marine Department, the erosion at the opposite bank of Tg. Manis was about 20ft in past three years in the surface zone in the river bank of the project area.

ii) Middle Tg. Sebubal

At Middle Tg. Sebubal, most of the shoreline has been eroded. (Please see **Figure-1.3.1.17, 18**) There are three sedimented places in the area.

Two of them are located in the deep waterway (deeper than CD-10m). Please refer to **Figure-1.3.1.19.**

Another is located in the shallow area close to the opposite side (Tanjung Manis).

iii) Opposite side of Tg. Sebubal

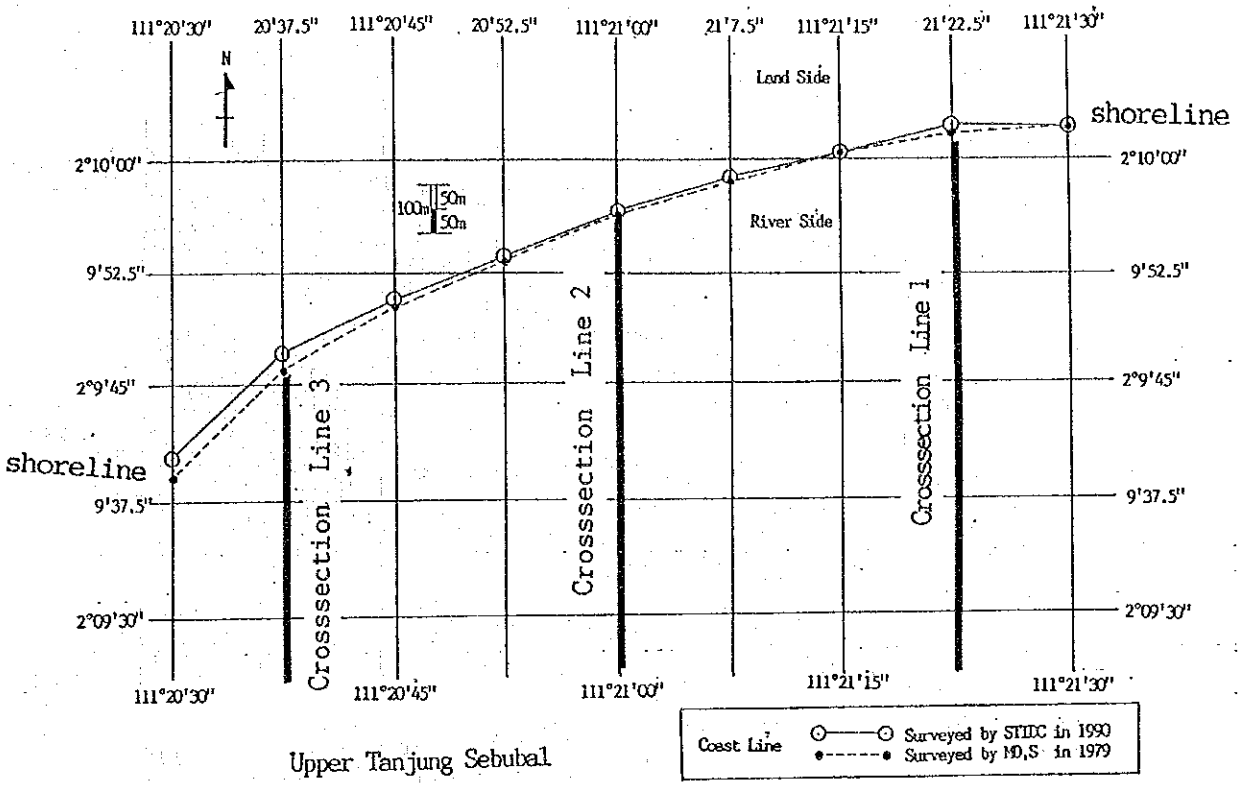
Opposite side of Tg. Sebubal (111°19'E - 111°20'E) is located near the estuary of Sungai Limut river. In this area, sedimentation occurs in the eastern half and slight erosion occurs in the western half. and slight erosion occurs in the western half. Additionally, at the coast close to the estuary area, sedimentation prevails over erosion.

The following are considered to be the main reasons for the receding shoreline:

① Water comes up to deeper inland and goes out during high tide because the land levels are comparatively low.
② Discharging water brings out the soil, because the surface of the bank consists of soft cohesive soil.
③ Due to reasons ① and ②, new creeks are easily made up or the stream changes itself. Thus the surface soil is eroded and the coast line recedes.

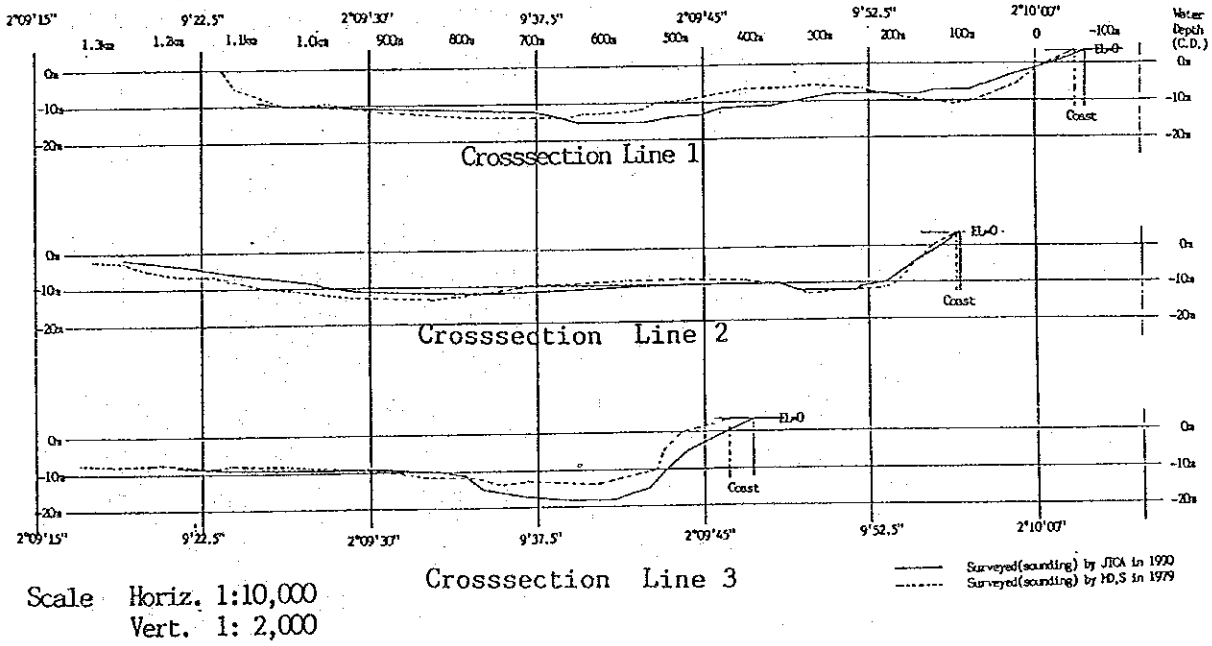
When the river meanders, the main stream collides against the outer bank. (See **Figure-1.3.1.23, 24**) Deep waterway and the erosion area are, therefore, observed along the outer side. (Please See **Figure-1.3.1.16, 19**)

The opposite side (inner side) of the river is shallow, which results in sedimentation. (See **Figure-1.3.1.16, 19, 22**)



Location map of crosssection lines Scale 1 : 15,000

ZONE 1



Scale Horiz. 1:10,000
Vert. 1: 2,000

Figure-1.3.1.14 River bed profile at Upper Tg. Sebubal

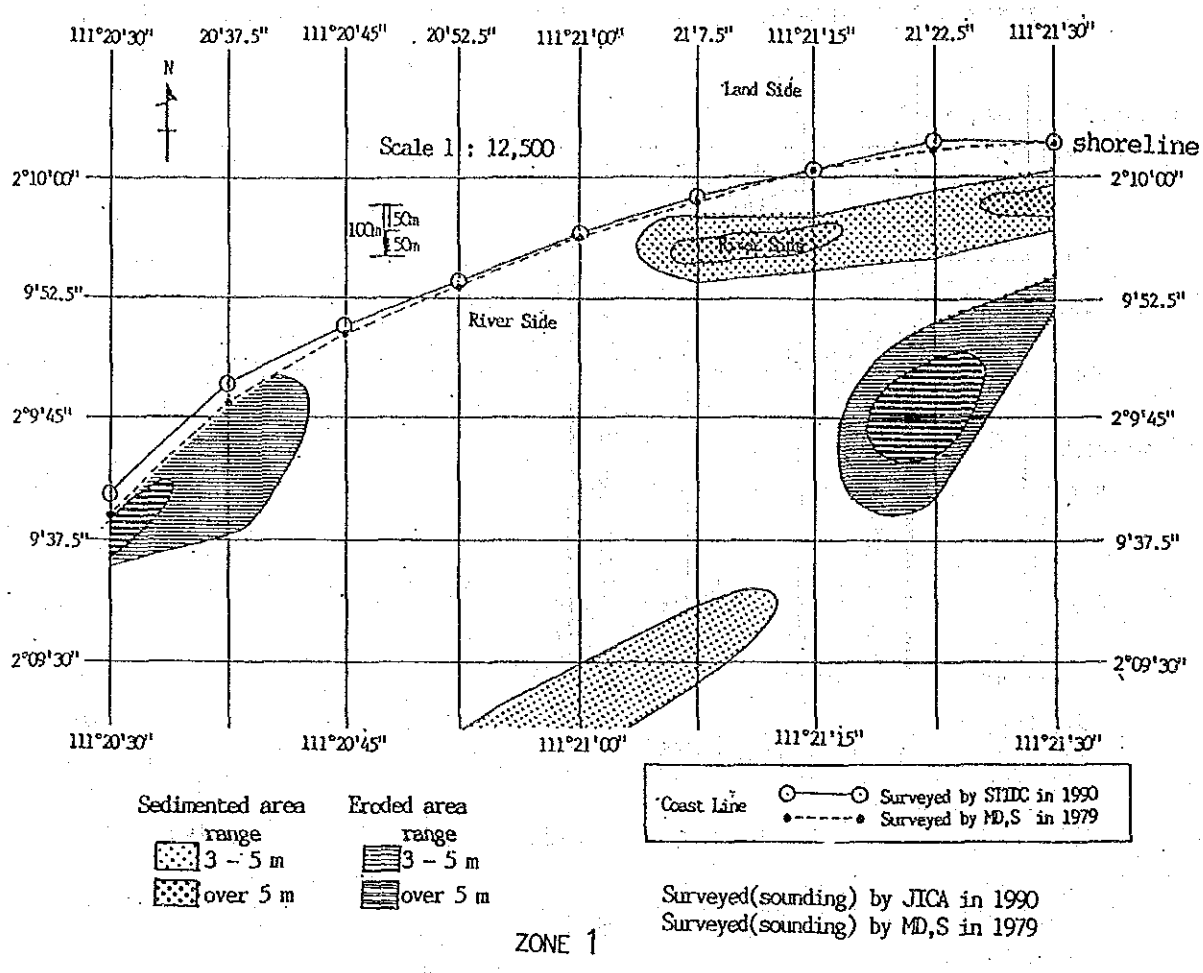
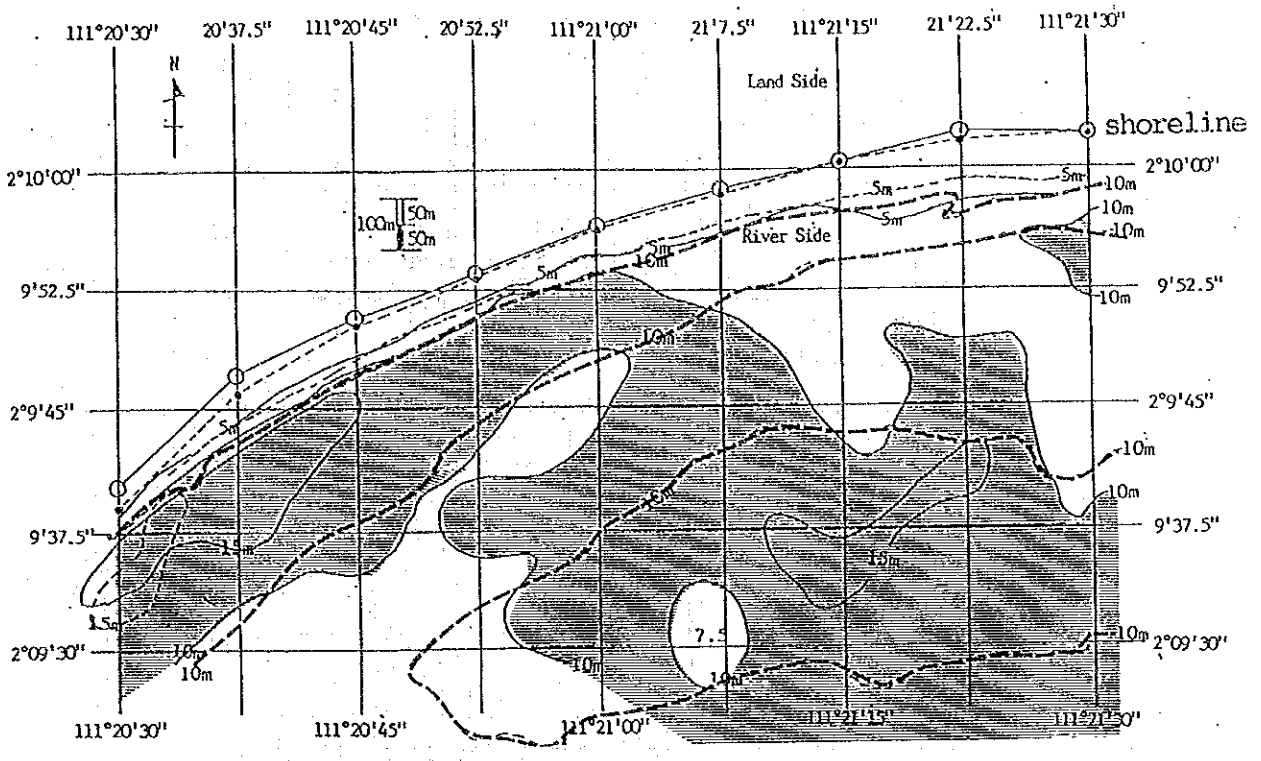


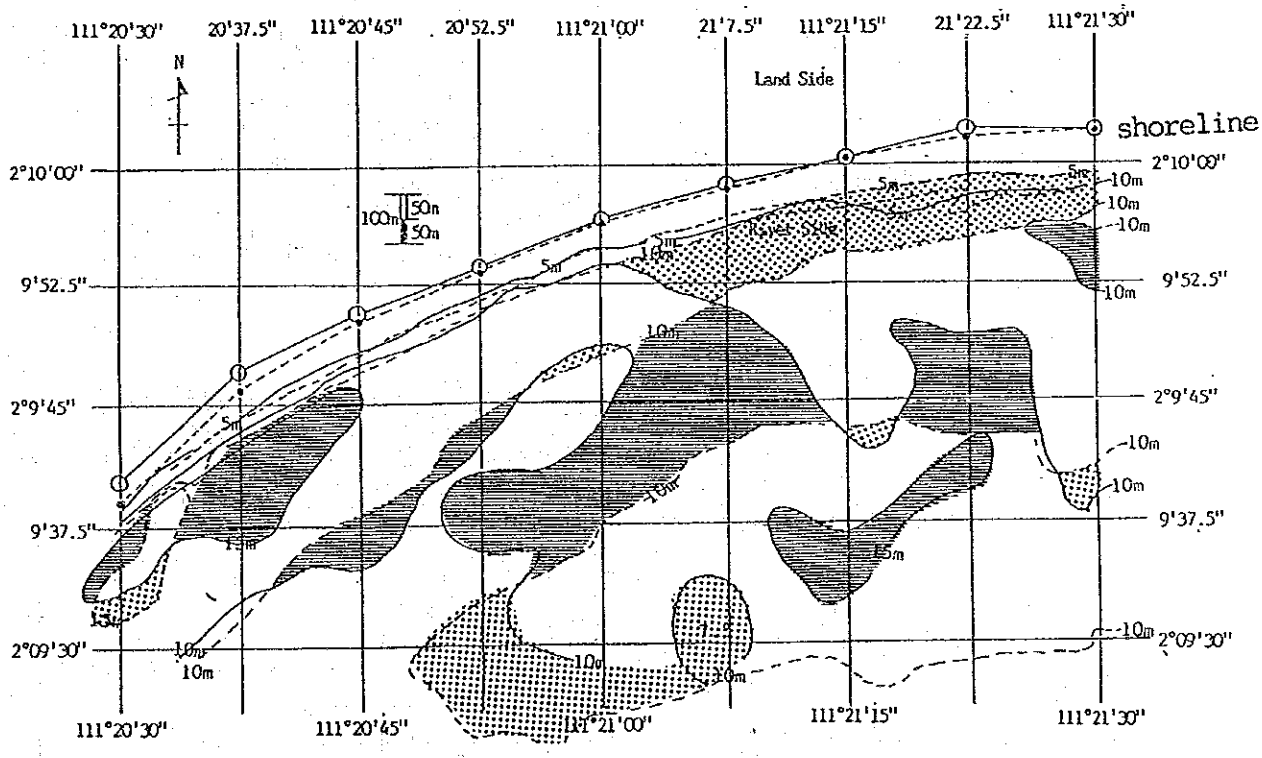
Figure-1.3.1.15 Changes with the passage of time regarding the shoreline and river bed at Upper Tg. Sebubal



Deep waterway more than C.D.-10m in 1990

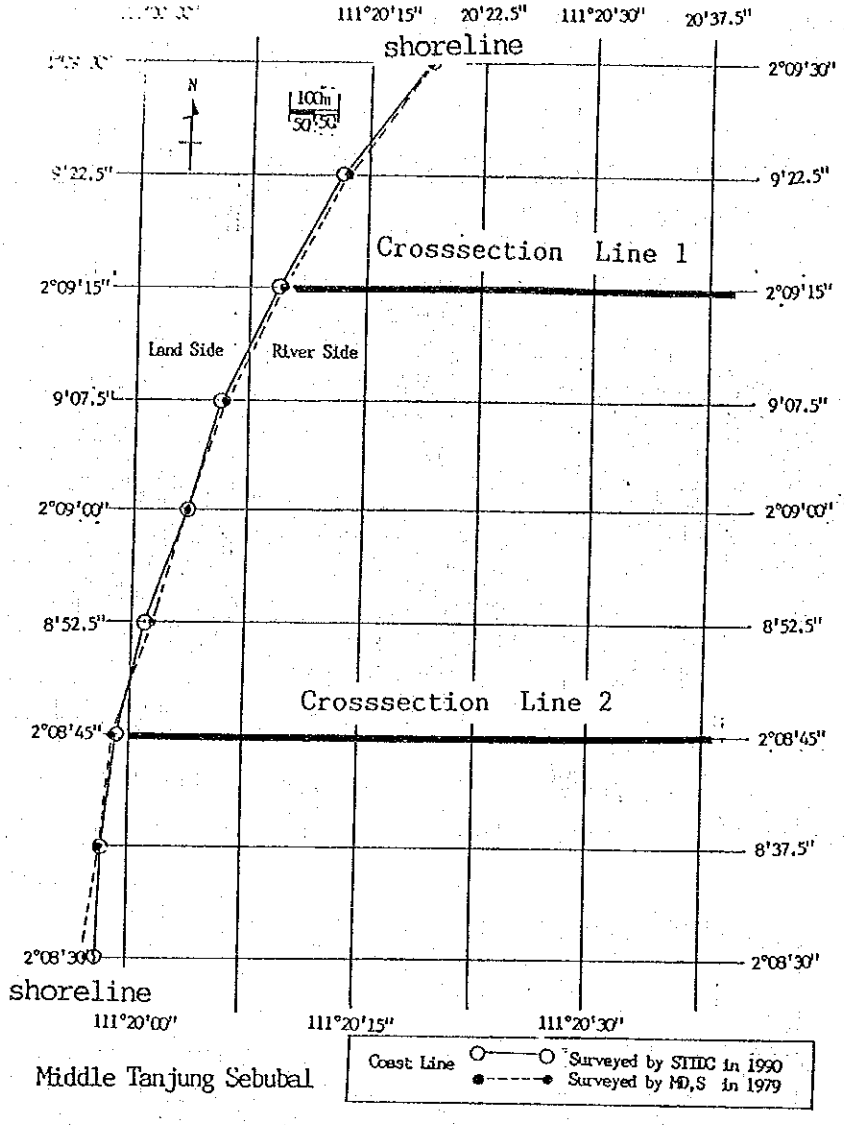
ZONE 1

Contour line of C.D.-10m in 1979



Eroded area Sedimented area

Figure-1.3.1.16 Comparison of deep waterway and river bed between in 1979 and 1990 at Upper Tg. Sebubal



Location map of crosssection lines Scale 1 : 15,000

ZONE 2

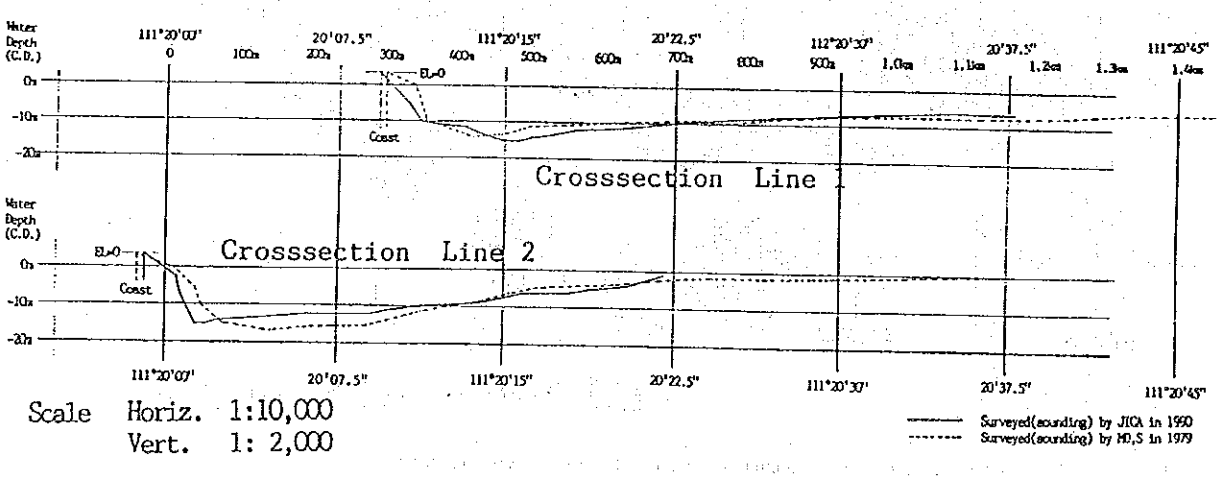
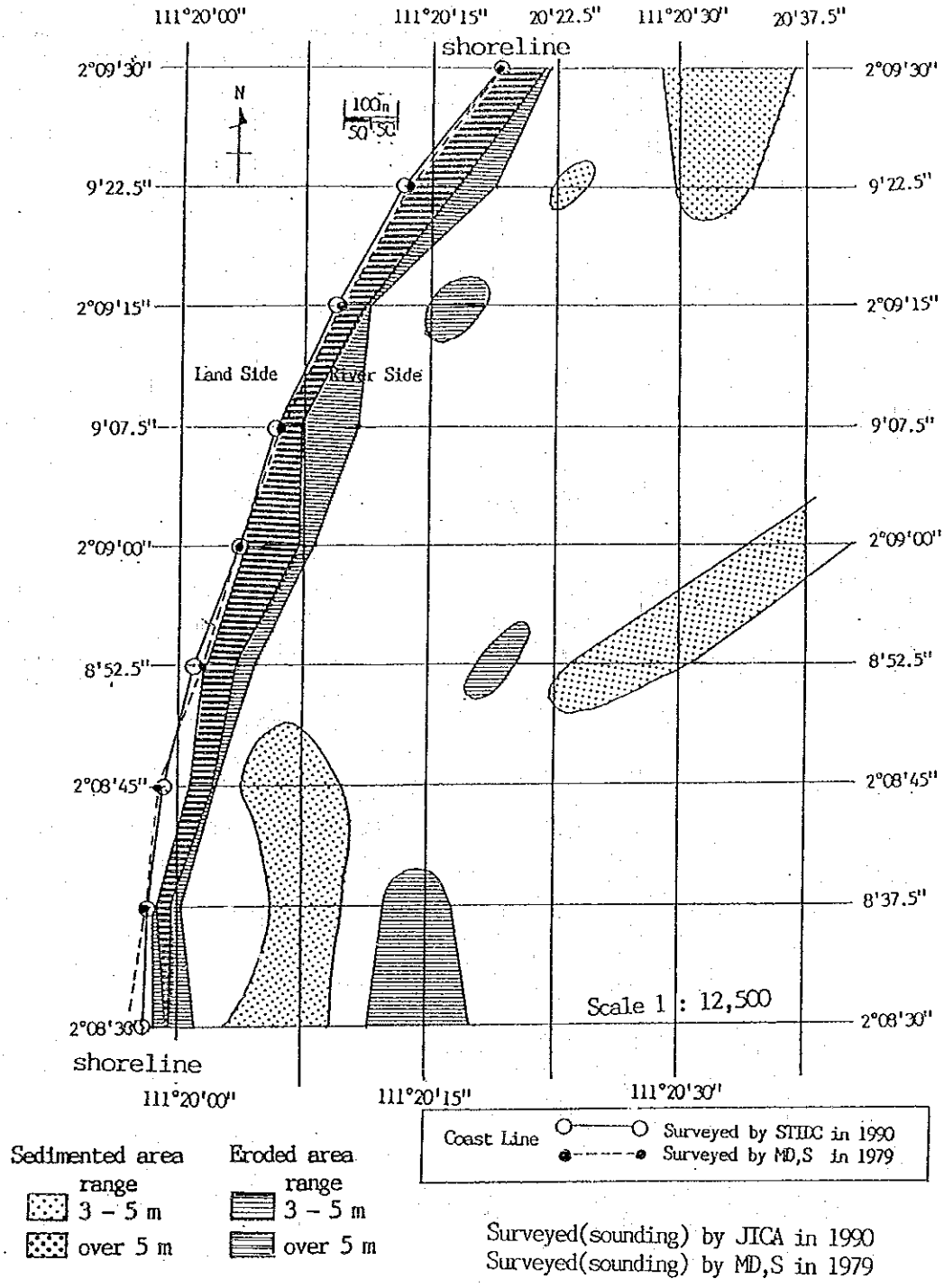
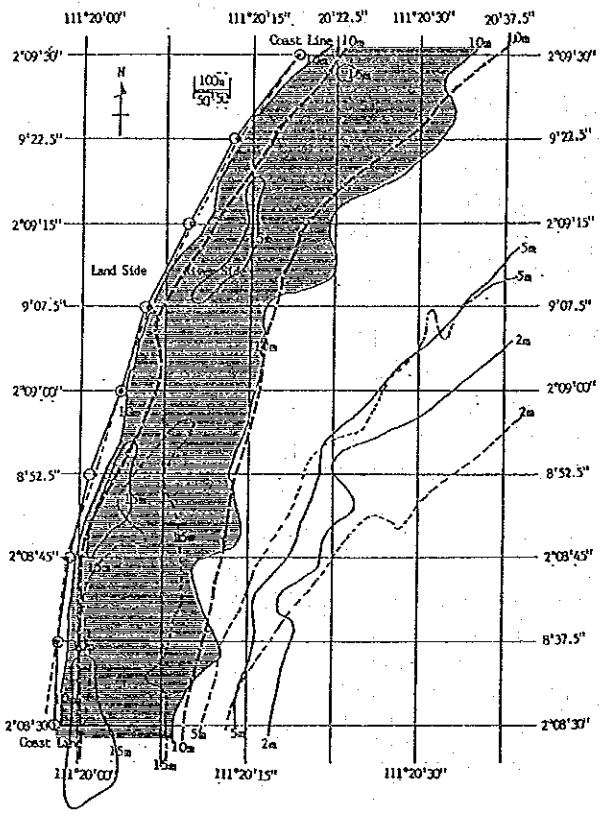


Figure-1.3.1.17 River bed profile at Middle Tg. Sebubal



ZONE 2

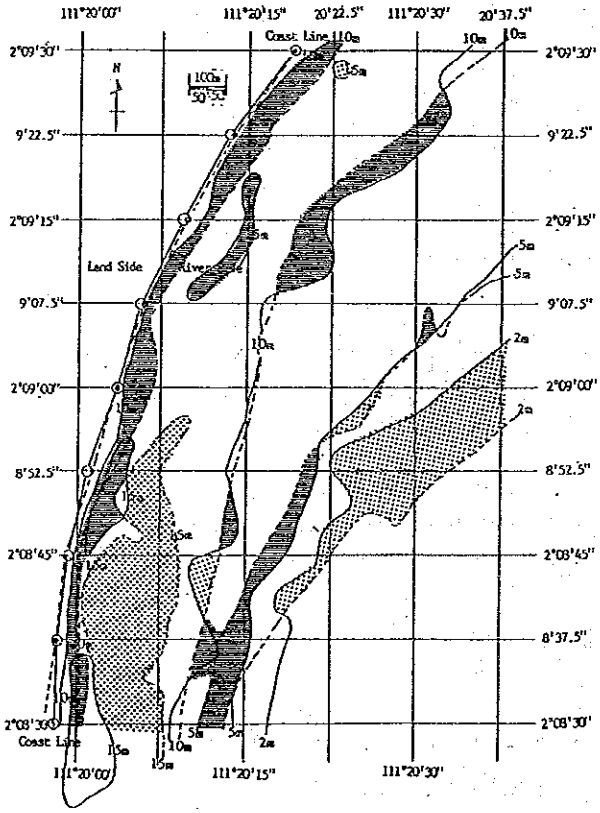
Figure-1.3.1.18 Changes with passage of time regarding shoreline and river bed at Middle Tg. Sebubal



Deep waterway more than C.D.-10m in 1990

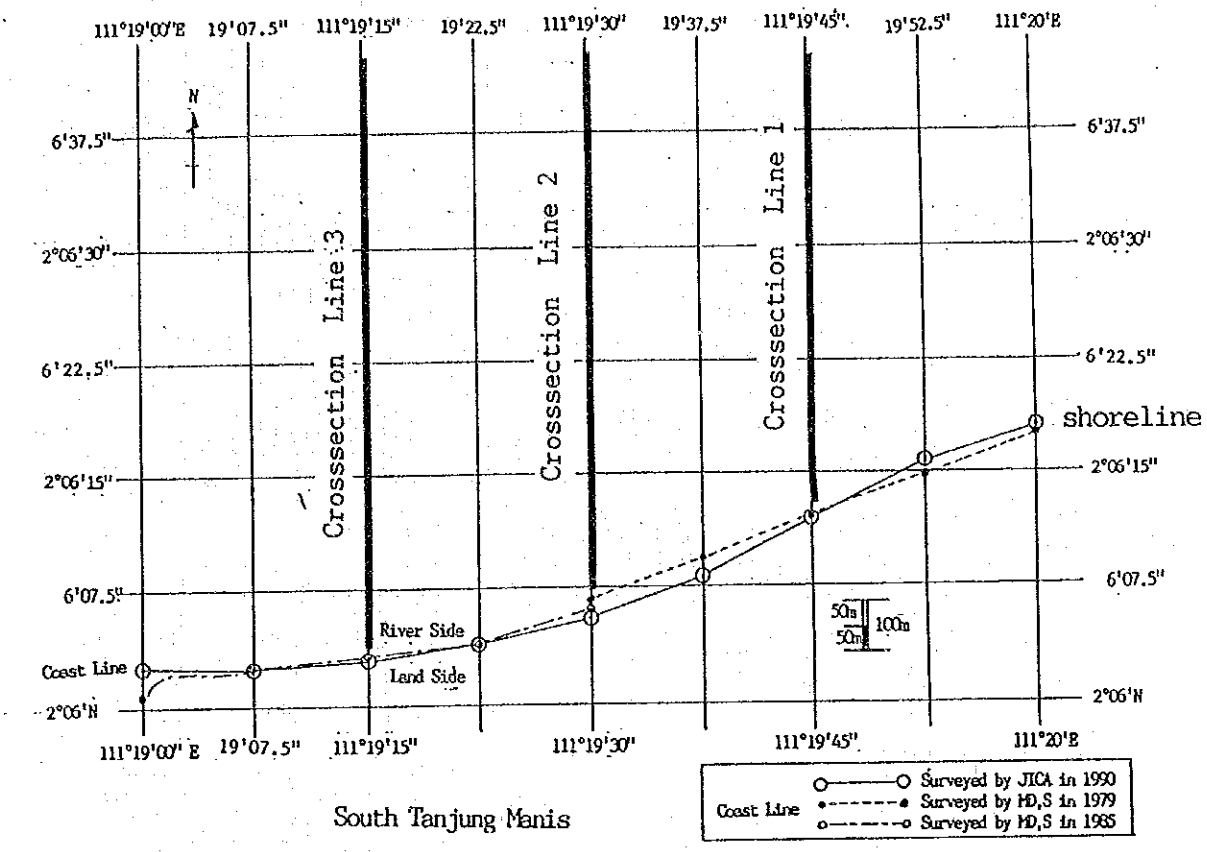
Contour line of C.D.-10m in 1979

ZONE 2



Eroded area Sedimented area

Figure-1.3.1.19 Comparison of deep waterway and river bed between in 1979 and 1990 at Middle Tg. Sebubal



Location map of crosssection lines Scale 1 : 15,000

ZONE 3

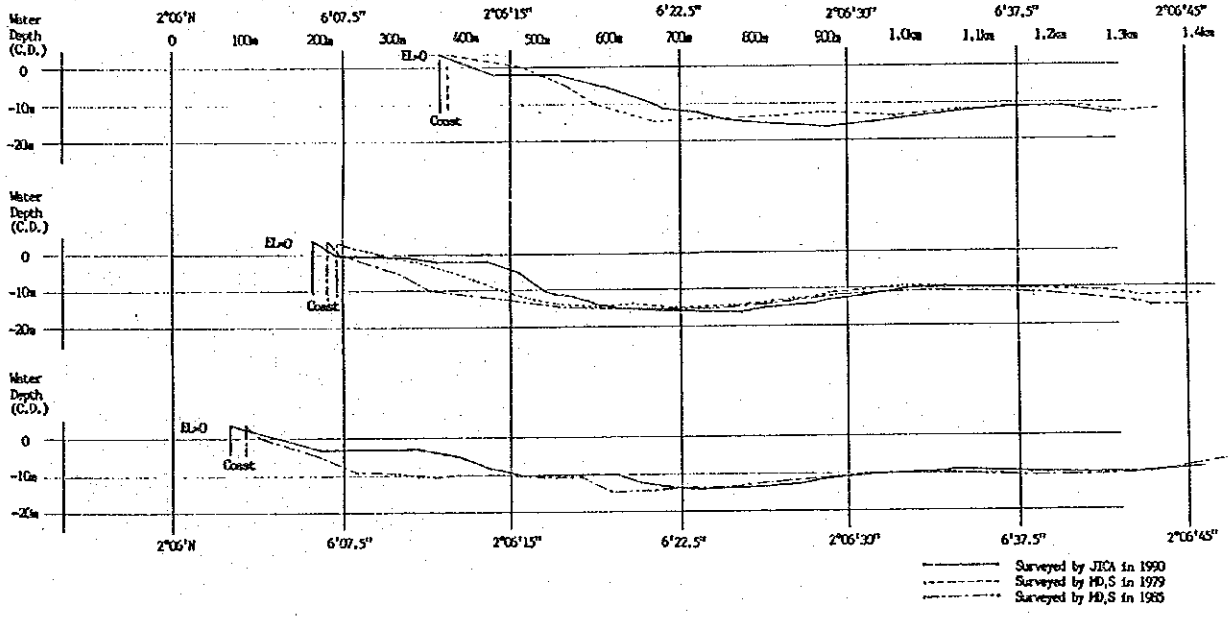


Figure-1.3.1.20 River bed profile at opposite side of Tg. Sebubal

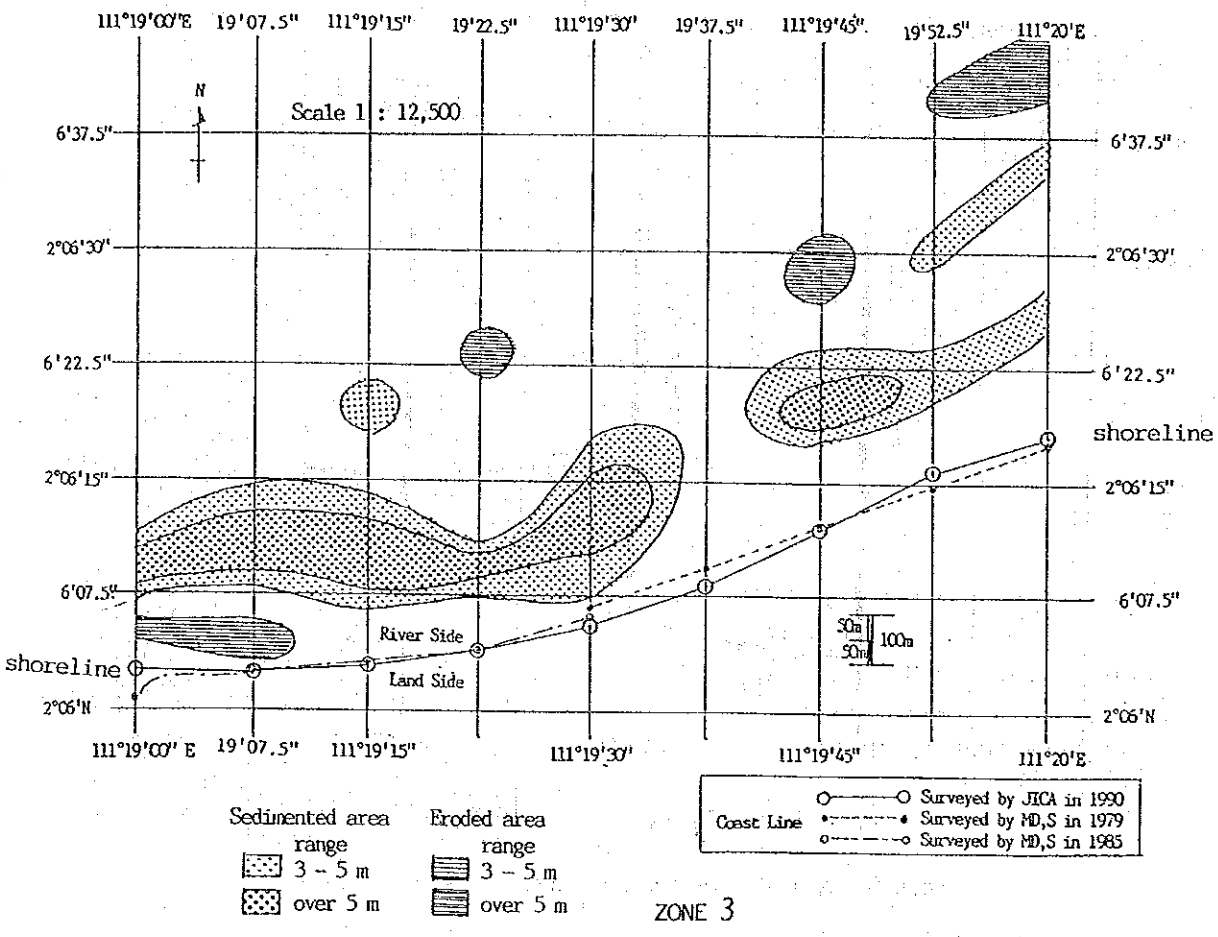
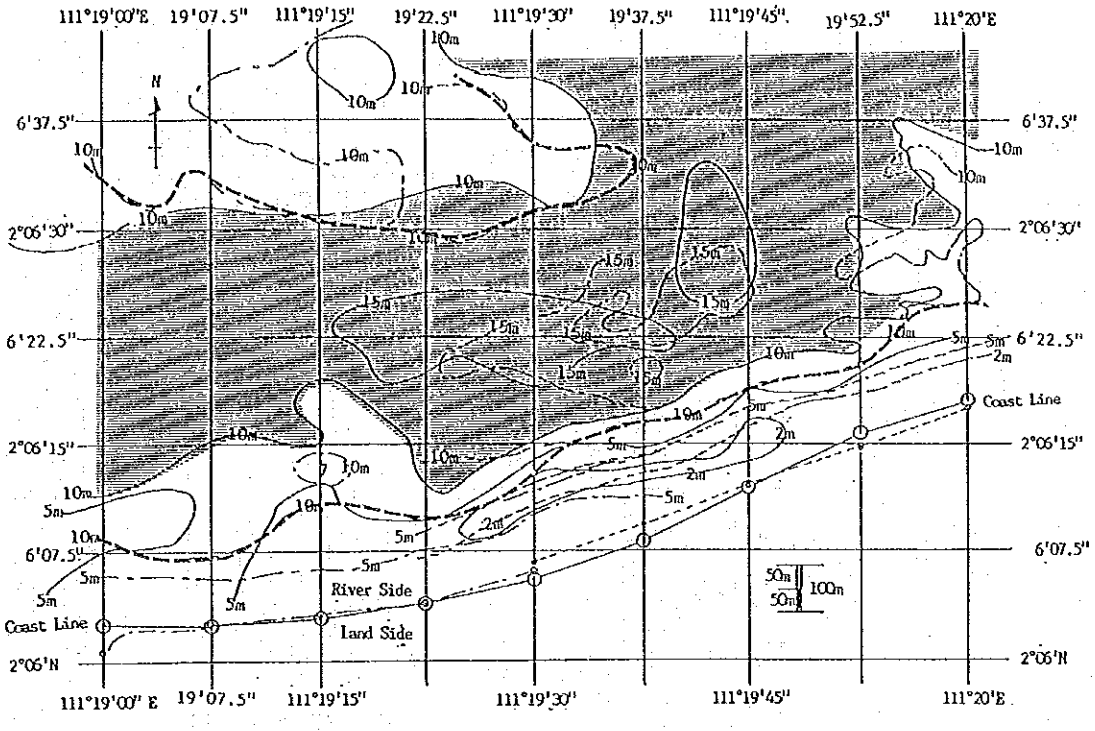


Figure-1.3.1.21 Changes with the passage of time regarding shoreline and river bed at opposite side of Tg. Sebubal



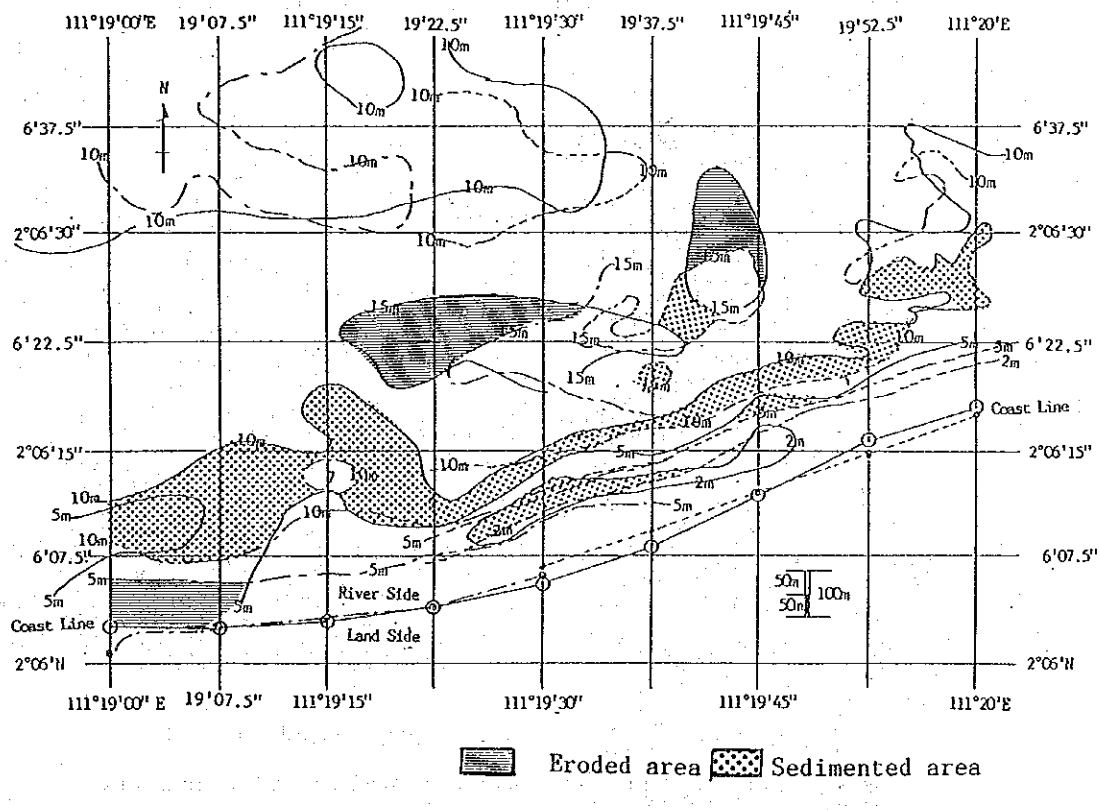


Figure-1.3.1.22 Comparison of deep waterway and river bed between 1979, 1985 and 1990 at opposite side of Tg. Sebubal

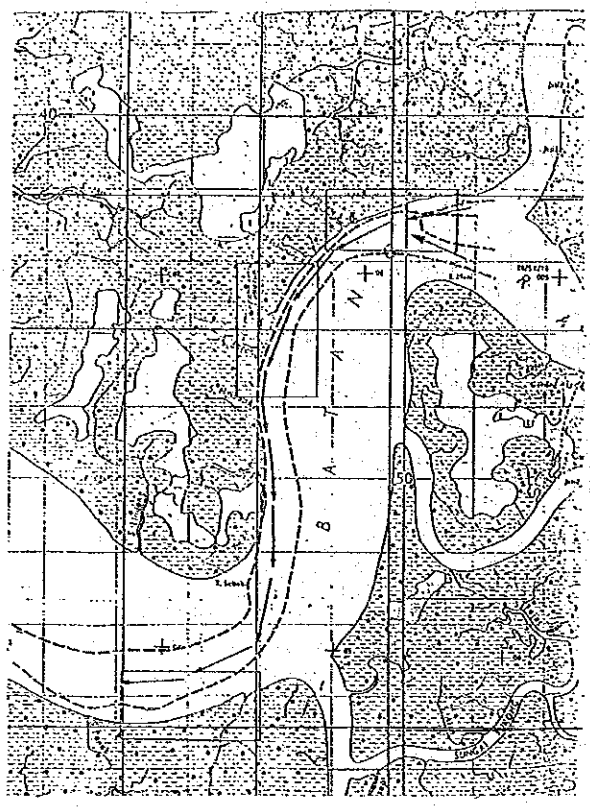


Figure-1.3.1.23
Deep waterway more than C.D.-10m and rough gravity center in the deep waterway

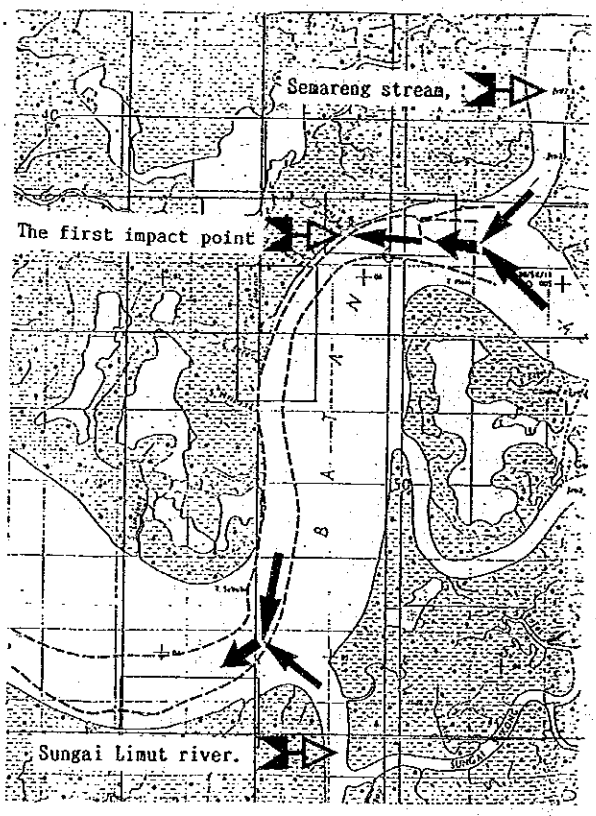
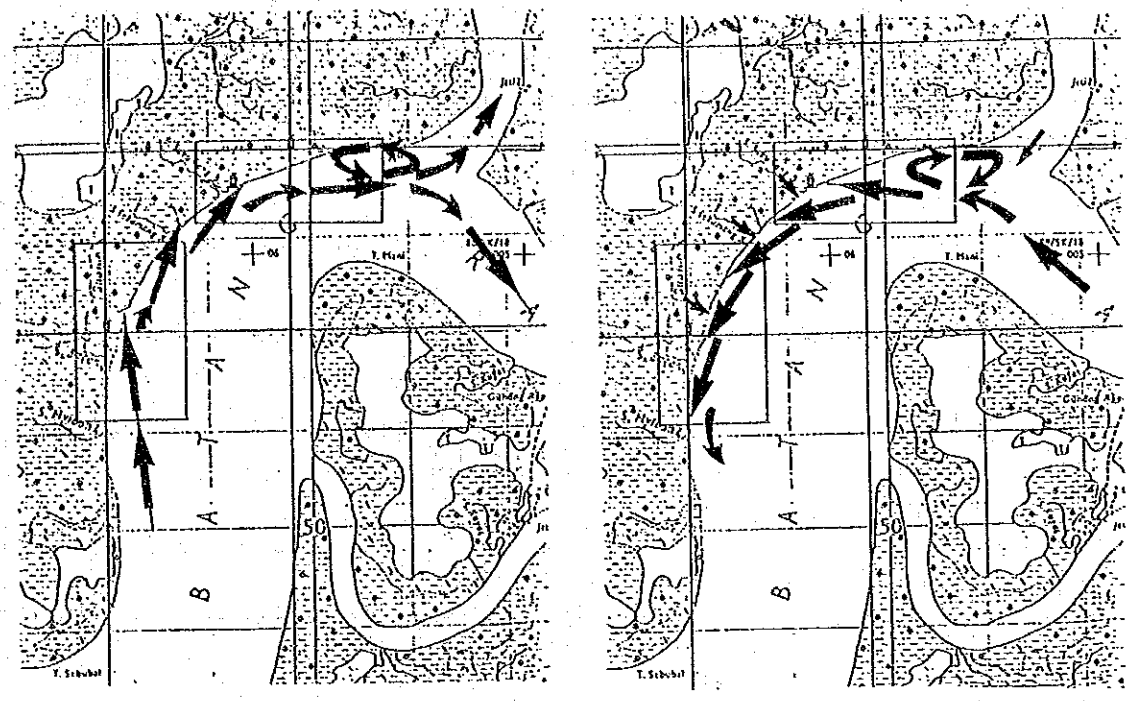
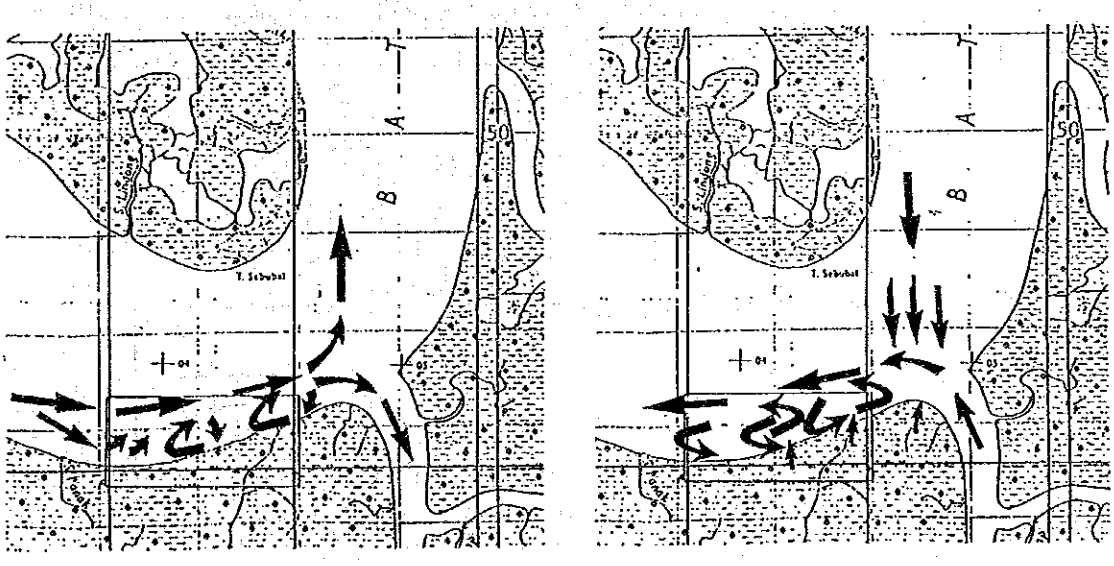


Figure-1.3.1.24
Sketch of the tidal current crossing at estuaries during ebb tide



During flood tide　　During ebb tide

Major river current at Tanjung Sebubal



During flood tide　　During ebb tide

Figure-1.3.1.25 Major river current at opposite side of Tg. Sebubal

(6) Seisimicity

In Sarawak, there has never been an earthquake. Therefore, according to the Indonesian Standard, the seismic coefficient (k) is given by the following formula:

K = kr x Ci

kr: Regional seismic

Ci: Coefficient of Importance

Regional seismic coefficient is shown in **Figure-1.3.1.29** and **Table-1.3.1.2.** Coefficient of importance is given in **Table 1.3.1.3.**

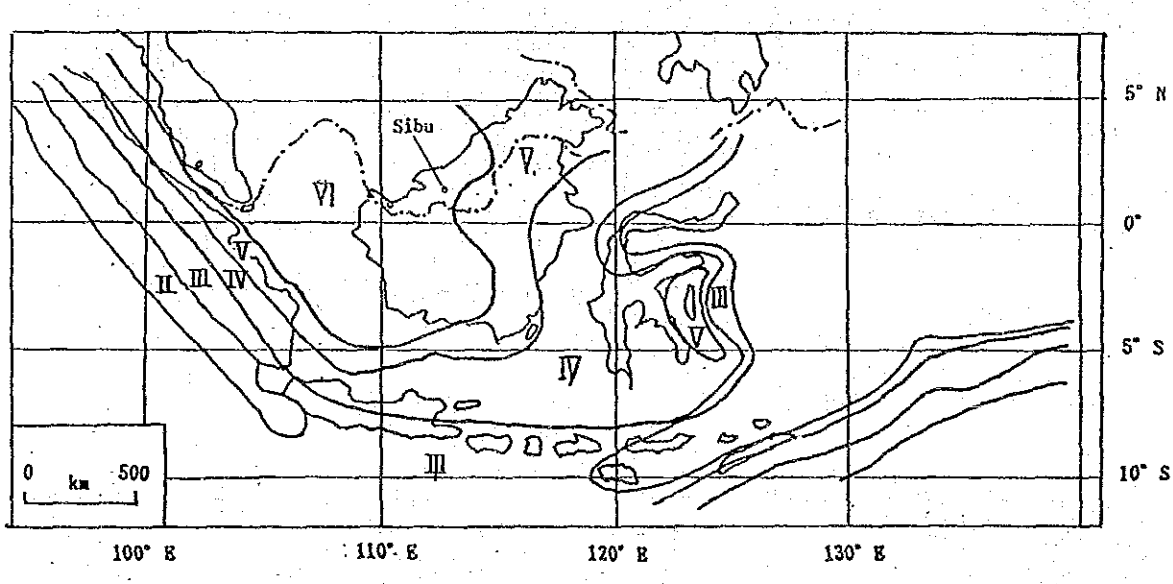


Figure-1.3.1.29 Regional Seismic Coefficient

Table-1.3.1.2 Regional Seismic Coefficient

Soil Type	Zone					
	I	II	III	IV	V	VI
Stiff soil	0.09g	0.07g	0.05g	0.03g	0.01g	0
Soft soil	0.13g	0.09g	0.07g	0.05g	0.03g	0

[Note] Gravity(g)

According to the above Figure and Table, the seismic coefficient in Btg. Rajang area is 0 as the area is in zone VI.

Table 1.3.1.3 Coefficient of importance

Classification of Structure	Characteristics of stuctures	Coefficient of importance
Special Class	Structures for which the charactaristics 1-3 of class A are strongly evident	1.5
Class A	1. Structures tending to cause loss of life and property upon seismic damage. 2. Structures playing an important role in reconstruction after earthquake disaster. 3. Structures handling hazardous materials and tending to cause seismic damage to life or property upon seismic damage. 4. Structures which have serious consequence for the economic and social activities of the areas concerned upon seismic damage. 5. Structures for which considerable difficulty is envisaged to reconstruct upon seismic damage.	1.2
Class B	Structures other than the special class or class A.	1.0
Class C	Small structures permitting easy reconstruction.	0.5

(7) Flood Plains/Swamps

The swamp forest area according to the map shown in **Fig-1.3.1.3** is as marked in **Fig-1.3.1.30.**

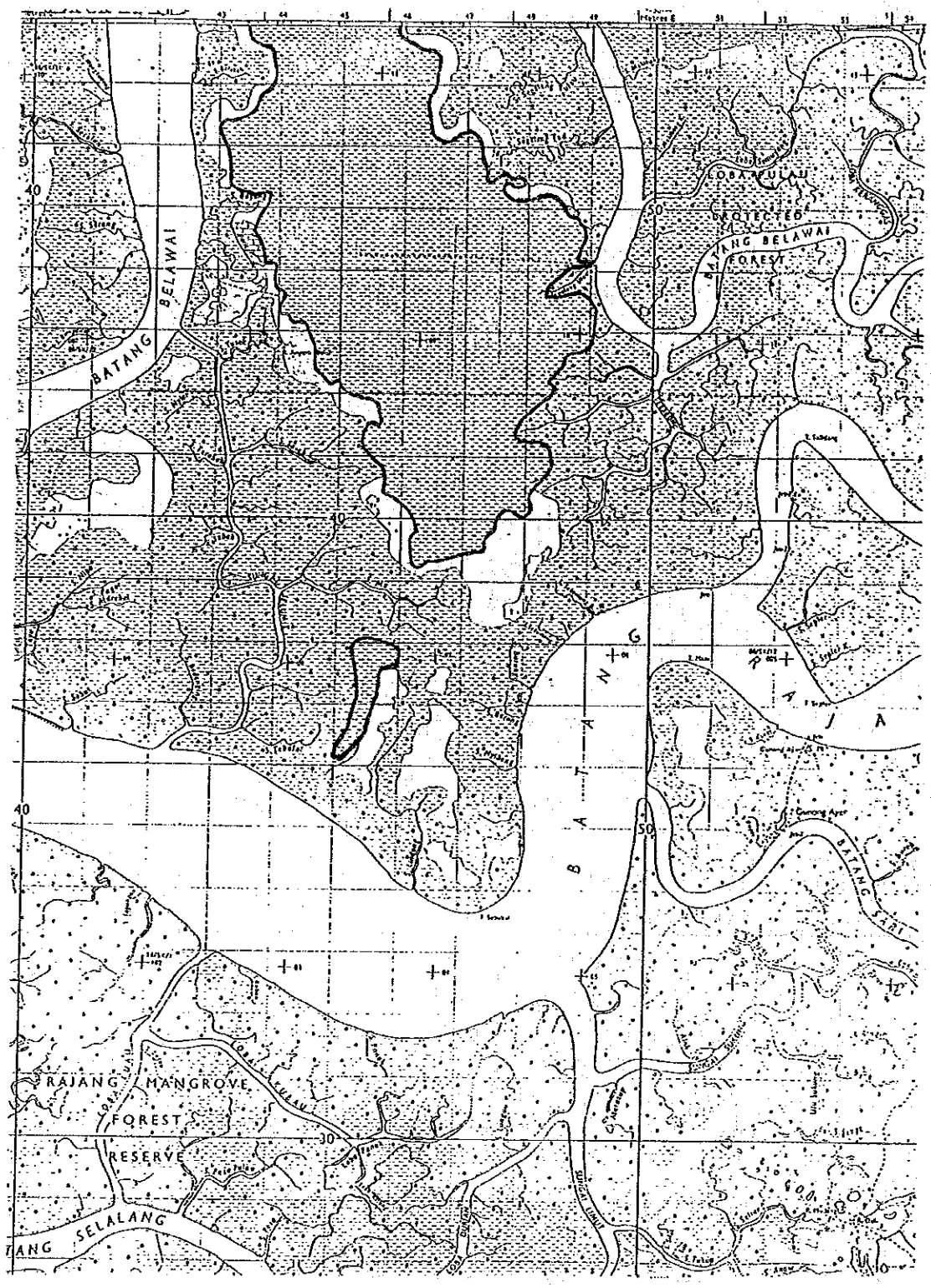


Figure-1.3.1.30 Swampy area near the project site

(8) Land Use

The Rajang River Valley below Sarikei is dominated by swamps, marshlands and wetland forests, while cropland, tree, palm and other permanent crops are dominant in the valley from Sarikei to Sibu.

Land use in the lower Rajang River is shown in **Fig-1.3.1.32.**

The Tanjung Manis area is dominated by mangrove forests. Populated areas are limited in this area and some timber factories are located here. Moreover, almost the entire area of Tanjung Sebubal is owned by the STIDC.

The opposite site of the Tanjung Sebubal is designated as the Rajang Mangrove Forest Reserve, which belongs to the state government.

Categorical Map of Tg. Manis area is shown in **Fig-1.3.1.31.**

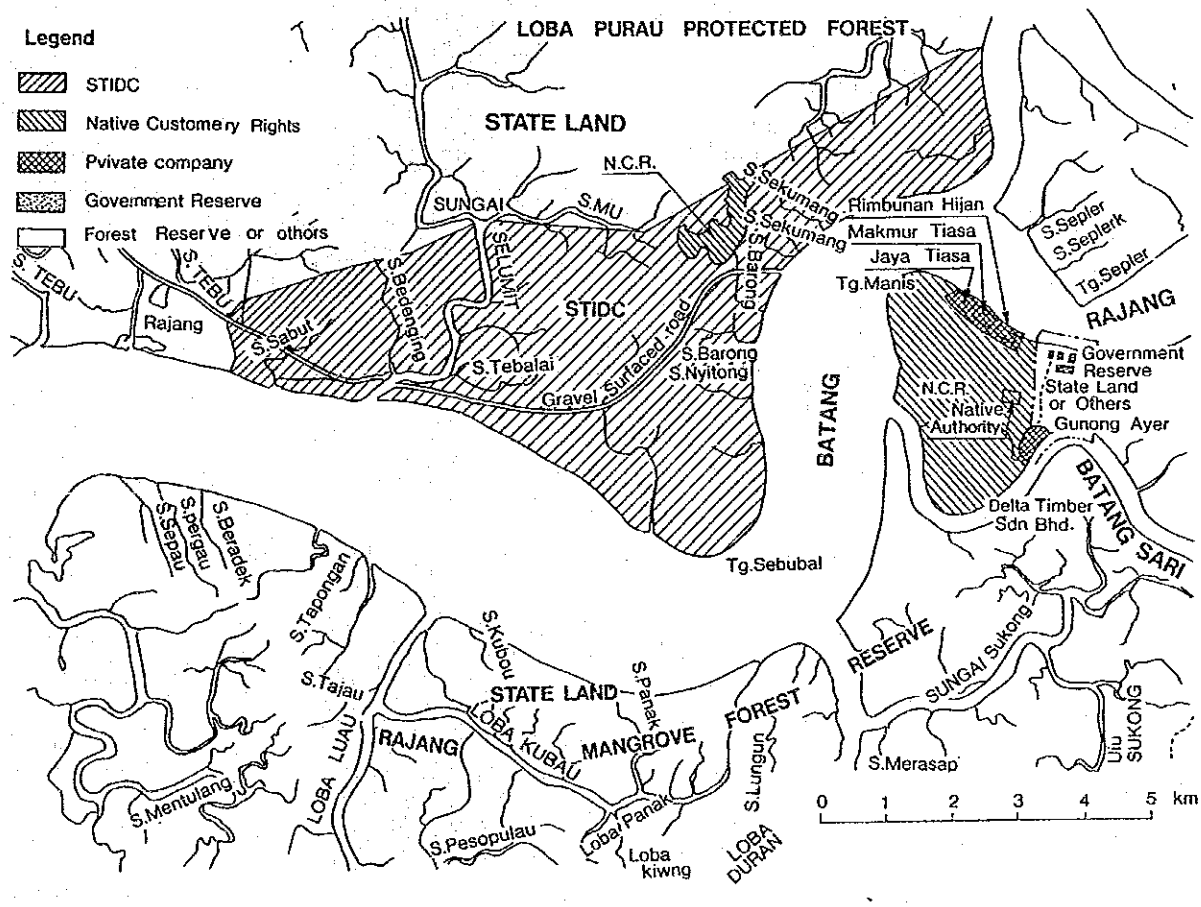
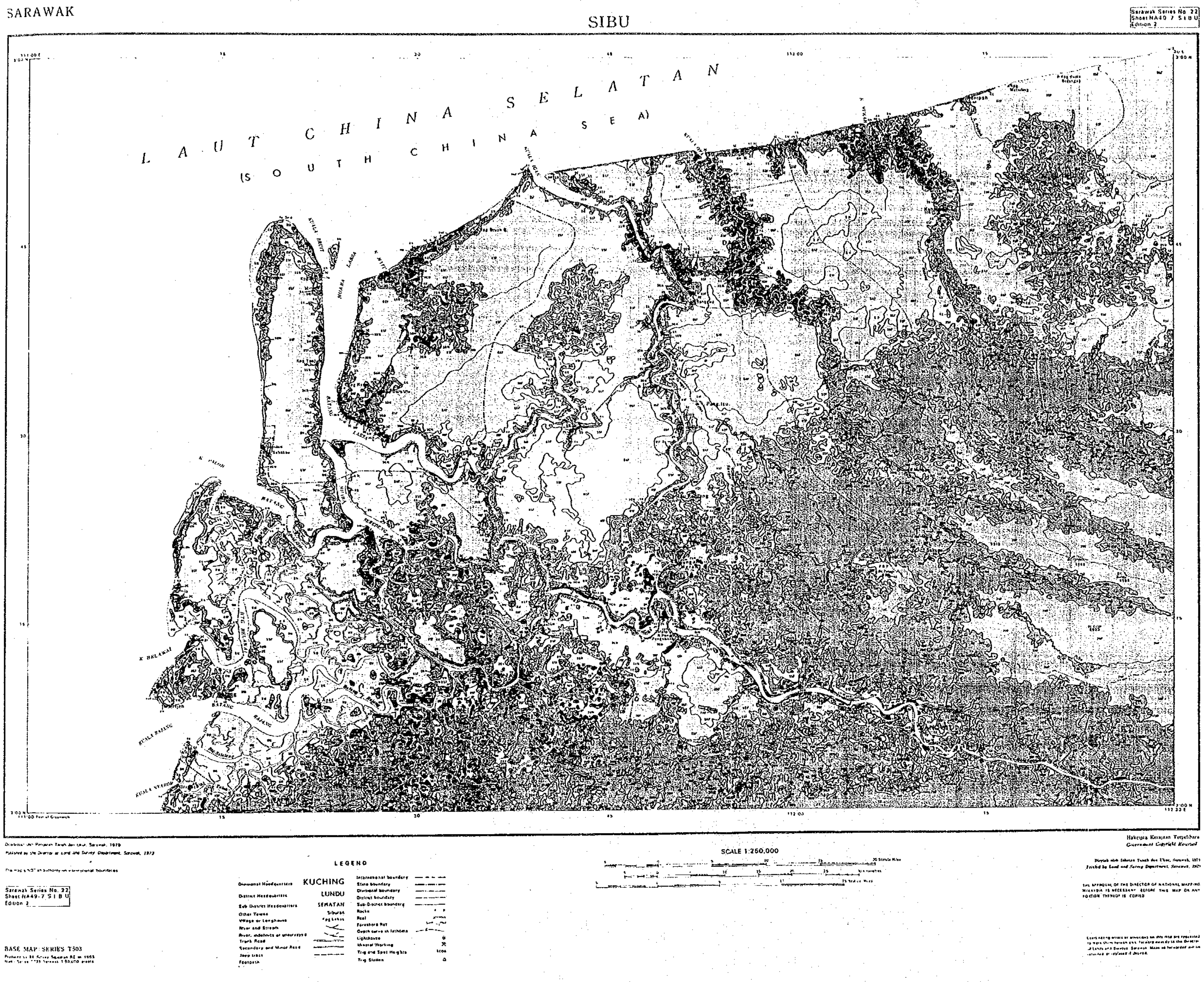


Figure-1.3.1.31 Categorical Map of Tg. Manis area



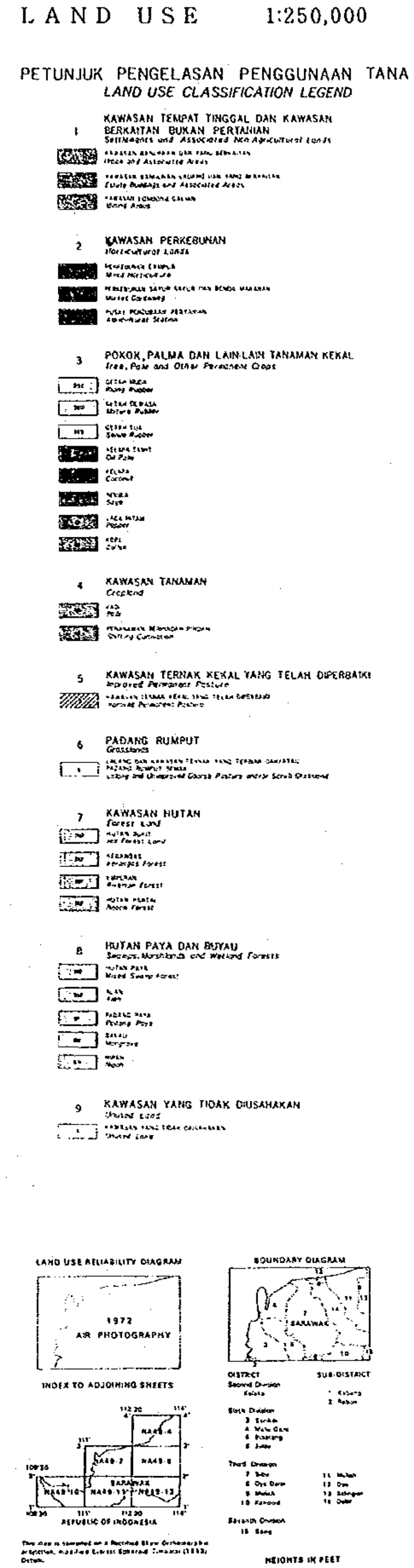


Figure-1.3.1.32

Land use map

(9) Engineering and Mineral Resources

The mineral resources around the project site are small but profitably mined in the current circumstances. Numerous deposits of terrace gravel and sand are found in the coastal and foothill areas and may be of value in manufacturing bricks and pottery near Sibu.

The mineral resources map is shown in **Fig-1.3.1.33.**

PETA HASIL GALIAN SARAWAK, MALAYSIA

MINERAL RESOURCES MAP OF SARAWAK, MALAYSIA

FIRST EDITION, 1976

SCALE 1:500,000

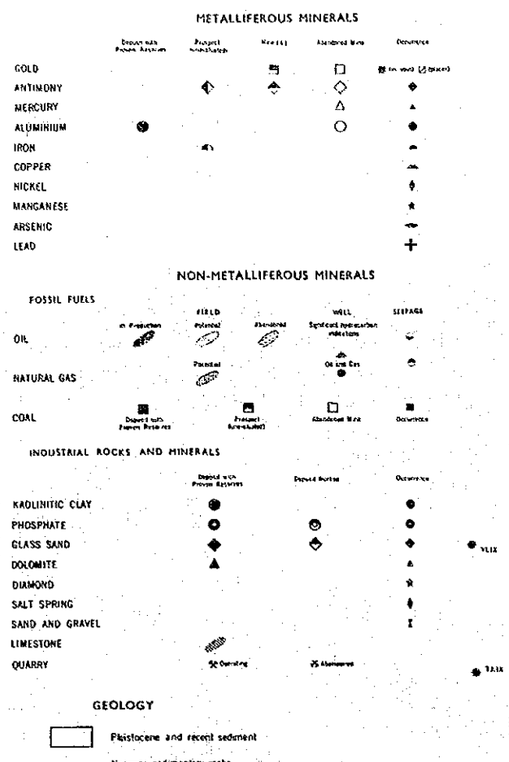
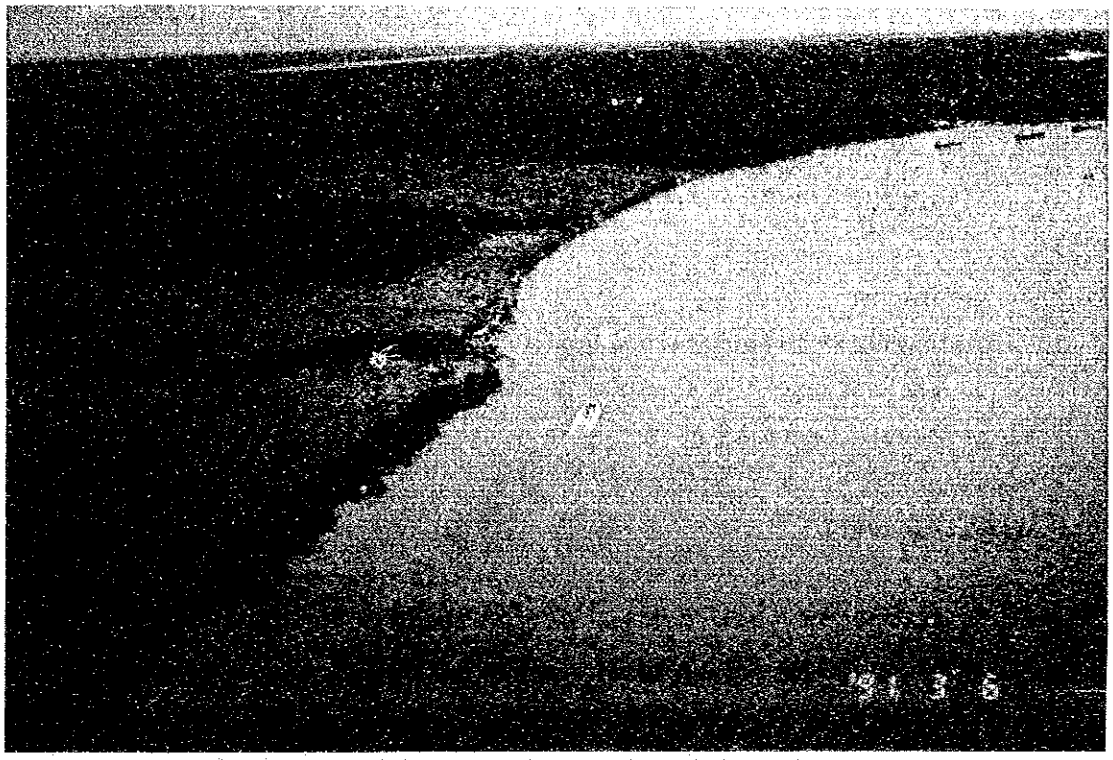


Figure-1.3.1.33
Mineral Resources Map

Published by the Director General of Geological Survey, Malaysia (Geological Survey Map Series No. 7)

(10) Buffer Zone

Currently there is no forested buffer zone in the area. However, at the STIDC site being developed now, some degree of natural forest (Mangroves, Nipas) is being maintained to protect the shoreline.



1.3.2 Surface Water

(1) Shoreline

With regard to the shoreline, please refer to Chapter 1.3.1(1) Landforms.

(2) Bottom Interface

As for the soil characteristics, please see Chapter 1.3.1(2) Soil Profile.

Data regarding the chemical characteristics of the bottom interface are not available.

(3) Flow Variation

The following oceanographical site surveys were carried out in the area between the estuary and Tanjung Manis.

- tidal level observation
- tidal current observation
- wave observation

The locations of each survey are shown in **Figure-1.3.2.1**, and a schedule for the surveys is shown in **Figure-1.3.2.2.**

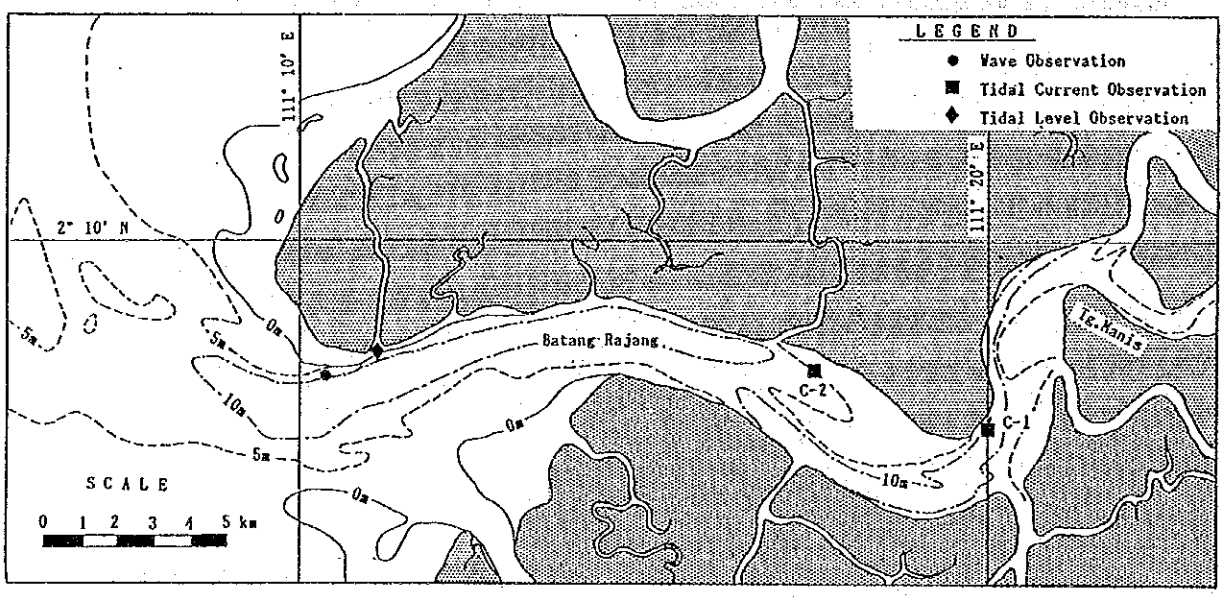


Figure-1.3.2.1 Location of Oceanographical Survey

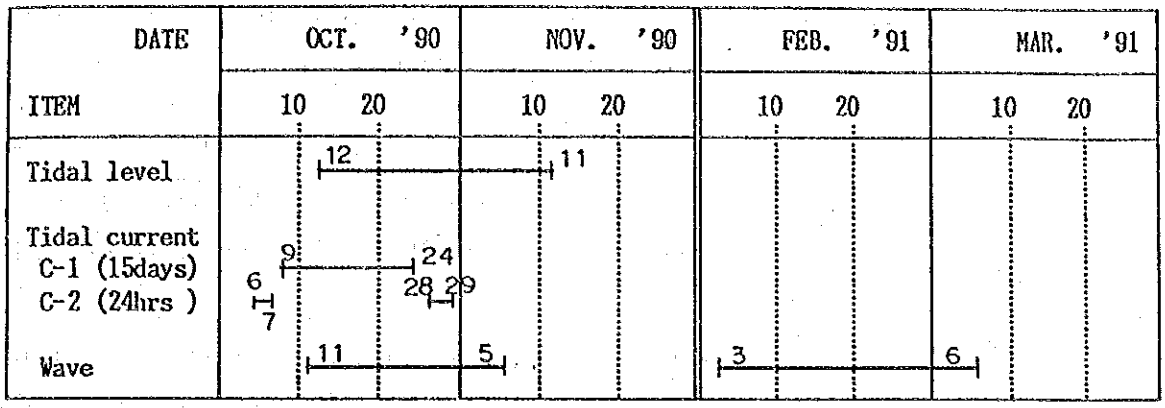


Figure-1.3.2.2 Oceanographical Survey Schedule

1) Tidal level

The tidal level at Tanjang Manis given in Tide Tables is as follows;

Highest Astronomical Tide : 5.8 m
Mean Higher High Water : 4.9 m
Mean Sea Level : 3.4 m
Mean Lower Low Water : 1.1 m
Lowest Astronomical Tide : 0.0 m

Heights are expressed relative to Chart Datum.

An additional site survey was carried out by the team to obtain tidal characteristics and tidal levels.

Table listed below shows the comparison of tidal levels with other ports.

Table-1.3.2.1 Comparison of tidal levels

unit ; metre

Port	Lowest Astronomical Tide	Mean Lower Low Water	Mean Higher Low Water	Mean Sea Level	Mean Lower High Water	Mean Higher High Water	Highest Astronomical Tide
Sibu	0.5	1.4	2.0	2.4	2.9	3.3	3.9
Sarikei	0.0	0.9	2.1	2.9	4.2	4.5	5.5
Tanjung Manis	0.0	1.1	2.2	3.4	4.5	4.9	5.8
Kuala Paloh	0.2	1.0	2.1	2.7	3.6	3.8	4.3

source ; Tide Table, 1990

Further information such as tidal current harmonic analysis is described in Volume 1 Chapter 1. Natural conditions.

2) Tidal Current

In order to obtain tidal current characteristics in the Tanjung Manis area, observation were made at two locations as shown in **Figure-1.3.2.1.**

Current velocity and direction were measured by self-recording type current meter for 15 days at C-1 point, and for 24 hours in spring and neap tide at C-2 point.

Measuring depth was 2m below water surface.

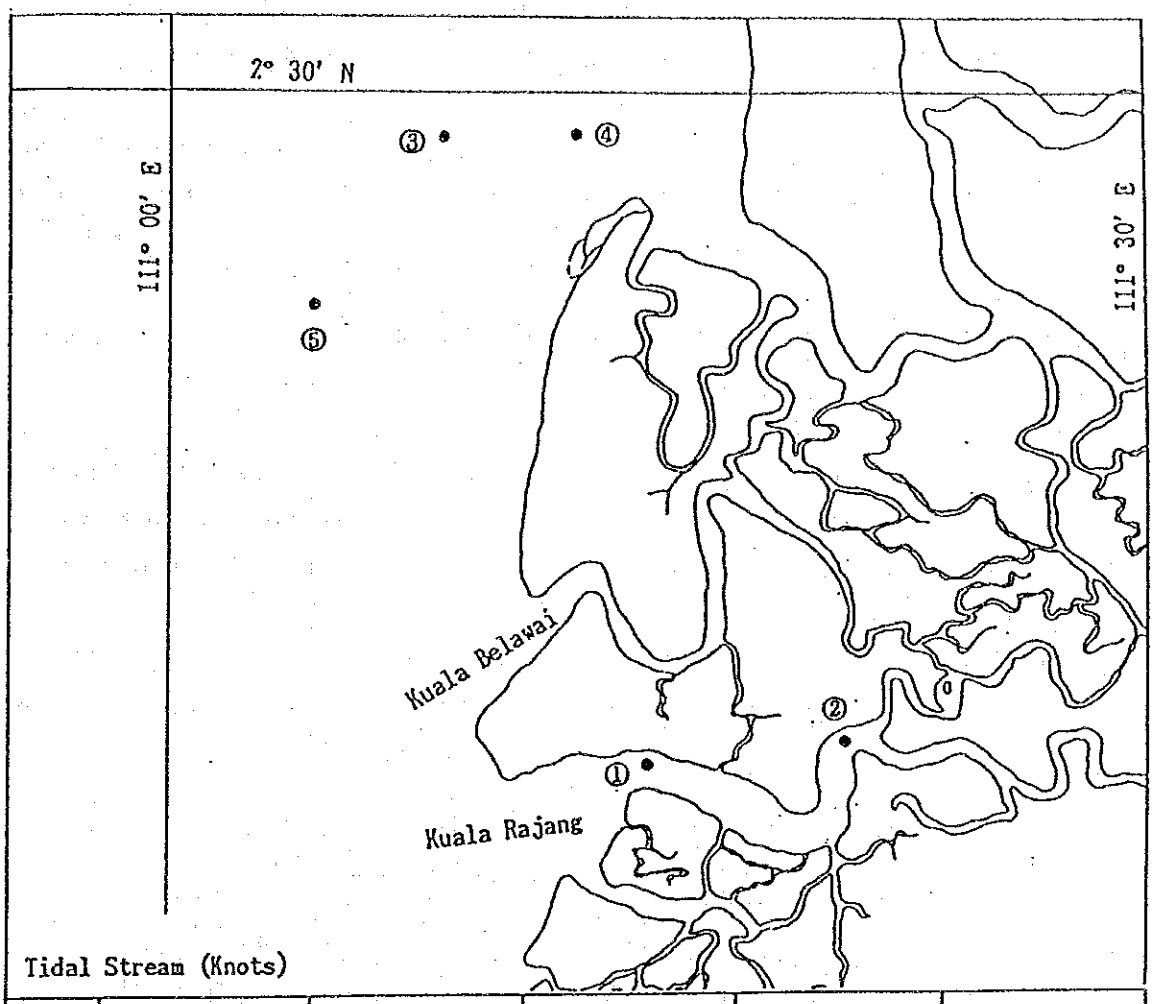
Generally, the direction of tidal current is parallel to the river channel, upwards in flood tide and downwards in ebb tide. The maximum current velocity during the observation period was 1.42m/sec (2.8 knots) as shown in **Table-1.3.2.2.**

Table-1.3.2.2 Daily Maximum Current Velocity

Date	Local time	Direction (Degree)	Velocity (m/sec)	Location	Tide (m)
06/Oct./90	23:40	129	1.34	C - 2	1.4
07/Oct./90	12:40	307	1.42	C - 2	0.6
09/Oct./90	21:00	221	1.23	C - 1	5.1
10/Oct./90	21:40	213	1.11	C - 1	4.9
11/Oct./90	22:20	211	0.90	C - 1	4.6
12/Oct./90	23:40	212	0.83	C - 1	4.4
13/Oct./90	00:00	209	0.79	C - 1	4.5
14/Oct./90	01:00	211	0.94	C - 1	4.6
15/Oct./90	02:20	210	1.11	C - 1	4.7
16/Oct./90	02:20	212	1.22	C - 1	4.7
17/Oct./90	03:00	223	1.24	C - 1	4.7
18/Oct./90	16:00	221	1.41	C - 1	4.9
19/Oct./90	04:00	221	1.35	C - 1	4.7
20/Oct./90	12:40	217	1.42 (Max)	C - 1	1.2
21/Oct./90	03:20	213	1.11	C - 1	3.6
22/Oct./90	09:40	030	1.11	C - 1	2.6
23/Oct./90	21:00	041	1.23	C - 1	4.8
24/Oct./90	07:00	219	1.03	C - 1	4.3
28/Oct./90	12:00	109	1.09	C - 2	3.4
29/Oct./90	10:20	301	0.94	C - 2	3.4

[Note] 1) Location:See Figure-2.4.1.1 2) Tide:above C.D.

Figure below shows current data for the surrounding area of Kuala Rajang.



Tidal Stream (Knots)

		① 2° 08' 9N 111° 14' 6E		② 2° 09' 6N 111° 21' 0E		③ 2° 29' 0N 111° 08' 4E		④ 2° 28' 2N 111° 12' 8E		⑤ 2° 23' 3N 111° 09' 2E	
		Dir.	Sp. Np.	Dir.	Sp. Np.	Dir.	Sp. Np.	Dir.	Sp. Np.	Dir.	Sp. Np.
Before H.W	-6	276	0.5 0.2	060	0.2 0.1	036	1.4 0.8	032	0.7 0.4	005	0.4 0.2
	-5	276	2.3 1.0	243	0.4 0.2	025	1.7 1.0	328	1.3 0.8	003	0.6 0.2
	-4	273	2.7 1.1	242	1.3 0.5	007	1.7 1.0	314	1.9 1.1	345	0.8 0.3
	-3	272	2.6 1.1	248	1.3 0.6	334	1.1 0.7	301	2.3 1.4	337	0.8 0.3
	-2	270	2.2 0.9	251	1.2 0.5	300	0.8 0.5	300	1.7 1.0	318	0.4 0.2
	-1	265	1.0 0.4	254	1.1 0.5	243	0.7 0.4	291	0.7 0.4	288	0.2 0.1
H.W	0	120	0.4 0.2	278	0.3 0.1	200	1.1 0.7	155	0.5 0.3	197	0.4 0.2
After H.W	+1	103	1.9 0.8	077	0.6 0.3	185	1.3 0.8	139	1.2 0.7	166	0.9 0.4
	+2	095	2.9 1.2	075	1.2 0.5	179	1.2 0.7	133	1.8 1.1	161	1.0 0.4
	+3	087	2.6 1.1	075	1.3 0.6	170	0.9 0.6	129	1.8 1.1	152	0.7 0.3
	+4	083	2.1 0.9	066	1.2 0.5	150	0.5 0.3	126	1.4 0.9	143	0.3 0.1
	+5	080	1.4 0.6	061	0.9 0.4	130	0.4 0.2	121	0.7 0.4	013	0.1 0.0
	+6	—	slack	061	0.4 0.2	045	1.0 0.6	050	0.5 0.3	005	0.3 0.1

source ; Marine Chart

Figure-1.3.2.3 Current Data

3) Wave

A pressure type wave recorder was installed at the estuary of Rajang River where the water depth is about 10m.

The observation had been carried out each month from the middle of October 1990 and from the beginning of February 1991.

Height and period of waves were recorded by the wave recorder every three hours and the direction of waves were recorded by visual observation twice a day.

The wave conditions obtained from the field survey are summarized as follows;

i) Wave height and period

The sea is generally very calm, and wave heights less than 5cm were recorded 72% of the time in the first observation and 65% in the second one. The maximum wave height during the observation period was 74cm.

Wave periods of 3-7 seconds predominated.

Table-1.3.2.3 shows the relation of the wave height and the wave period.

Table-1.3.2.3 Frequency Distribution of Wave

H_s / T_z(sec.)	Less than 5 cm	5 ~ 9 cm	10 ~ 19 cm	20 ~ 29 cm	30 ~ 39 cm	Total (%)
——	72.06 64.90 (68.48)					72.06 64.90 (68.48)
3.00 ~ 3.99		1.47 0.41 (0.94)	2.94 0.82 (1.88)	0.49 —— (0.24)	—— —— (——)	4.90 1.23 (3.06)
4.00 ~ 4.99		7.84 4.90 (6.37)	9.32 3.27 (6.30)	3.92 —— (1.96)	0.49 —— (0.24)	21.57 8.17 (14.87)
5.00 ~ 5.99		1.47 3.67 (2.57)	—— 2.04 (1.02)	—— —— (——)	—— —— (——)	1.47 5.71 (3.59)
6.00 ~ 6.99		—— 3.67 (1.84)	—— 7.76 (3.88)	—— —— (——)	—— —— (——)	—— 11.43 (5.72)
7.00 ~ 8.99		—— —— (——)	—— 8.56 (4.28)	—— —— (——)	—— —— (——)	—— 8.56 (4.28)
Total (%)	72.06 64.90 (68.48)	10.78 12.65 (11.72)	12.26 22.45 (17.36)	4.41 —— (2.20)	0.49 —— (0.24)	100.00 100.00 (100.00)

* Remarks ; Upper ; 11-OCT-90~05-NOV-90
Middle; 03-FEB-91~06-MAR-91
Lower ; Average

ii) Wave direction

The predominant wave direction was observed to come as from the west (270°-280°) in the first and the second observation period.

Figure-1.3.2.4 shows the distribution of wave direction.

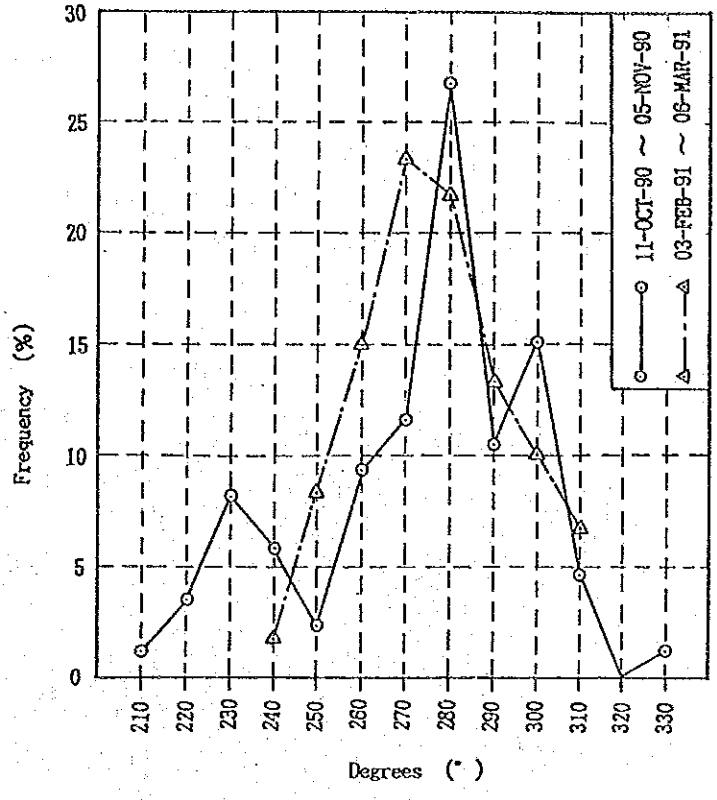


Figure-1.3.2.4 Wave Direction

(4) Water Quality

1) The results of the water quality survey conducted by the Department of Environment

The DOE has conducted a water quality survey across the whole of Malaysia. (River Water Quality, Coastal Water Quality, Ground Water Quality)

According to the guidelines, the Rajang River belongs to the Third class.

The water quality of the Rajang River is measured at points indicated on the map shown below, and the results of the survey (1989 and 1990) are listed in **Table-1.3.2.4.**

Figure-1.3.2.5 Location of Water Examination by D.O.E

Table-1.3.2.4 The result of water quality survey by DOE

Ammoniacal-N	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2115603	0.2	0.02	0.06	0.36	0.02	0.36	0.02	0.13	N.D	0.2	0.02	-	0.02	0.2	0	0.05
2116602	0.02	0.12	0.02	0.02	0.24	0.24	0.02	0.08	0.02	0.04	0.02	-	0.02	0.04	0.02	0.03
2218615	0.02	0.02	0.02	0.1	0.02	0.1	0.02	0.04	-	-	-	-	-	-	-	-
2218601	-	1	-	0.04	0.04	0.04	0.04	0.04	0.04	0.12	0.06	0.08	0.14	0.14	0.04	0.09
2318614	-	1	-	-	-	-	-	-	0.02	0.02	0.06	0.02	0.04	0.06	0.02	0.03

BOD	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2115603	2.3	8.1	0.9	0.6	0.7	8.1	0.6	2.52	1.6	0.9	0.5	1.1	0.3	1.6	0.3	1.6
2116602	0.5	0.8	0.2	0.5	0.3	0.8	0.2	0.46	0.4	2.4	0.1		0.1	2.4	0.1	0.75
2218615	1.4	0.6	0.2		3.3	3.3	0.2	1.38								
2218601	1.3	1.2	0.1	2.4	0.8	2.4	0.1	1.16	0.6	1.6	0.3	0.7	0.9	1.6	0.3	0.82
2318614									0.7	0.3	0.9	1	0.2	1	0.2	0.62

COD	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2115603	10.9	9.3	15	12	25.9	25.9	9.3									
2116602	15.8	16.7	10.7	6.6	14.5	16.7	6.6	12.86								
2218615	15.9	8.8	17.6	7.7	8.9	17.6	7.7	11.78								
2218601	7.9	8.8	1.9	28.3	6.6	28.3	1.9	10.7	7.6	12.9	8.3	6.2	11.2	12.9	6.2	9.24
2318614									3.8	6.5	9.2	5.3	10.2	10.2	3.8	7

DO	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2215603									4.6	4.5	5	4.7	4	4.7	4	4.5
2216602									4	6	5.3	4	4.3	6	4	4.72
2218615																
2218601									5.6	5.2	5.8	4.2	5.1	5.8	4.2	5.18
2318614									5.6	5.4	4.2	4.1	5.2	5.6	4.2	4.92

PH	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2215603									6.82	6.9	7	6.74	7.6	7.6	6.74	6.95
2216602									4.9	6.12	6.1	7.1	7	7.1	4.9	6.24
2218615																
2218601									5.8	6.3	6.28	6.97	6	6.97	5.8	6.27
2318614									5.4	5.78	5.8	6.71	6.4	6.71	5.4	6.02

SS	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2215603	26	181	40	32	12	181	12	58.2	148	242	2	146	149	242	2	137.4
2216602	122	363	597	60	80	597	60	244.4	85	369	157		223	369	85	208.5
2218615	220	145	90	192	115	220	90									
2218501	119	148	239	137	100	239	100	148.6	258	399	128	72	402	402	72	251.8
2318614									91	237	148	72	507	507	72	211

Temperature	1989								1990							
Station No.	January	April	July	October	December	Max	Min	Ave	January	April	July	October	December	Max	Min	Ave
2215603									28	27	30	30	29	30	27	28.8
2216602									27	27	28	27	28	28	27	27.4
2218615																
2218601									27	26	28	29	26	29	26	27.2
2318614									27	26	28	31	26	31	26	27.6

Salinity 0.5m

2) The result of the survey by the JICA team

The water quality examination of the river in 1990 was conducted by the team at nine points, with two samples taken at each point.

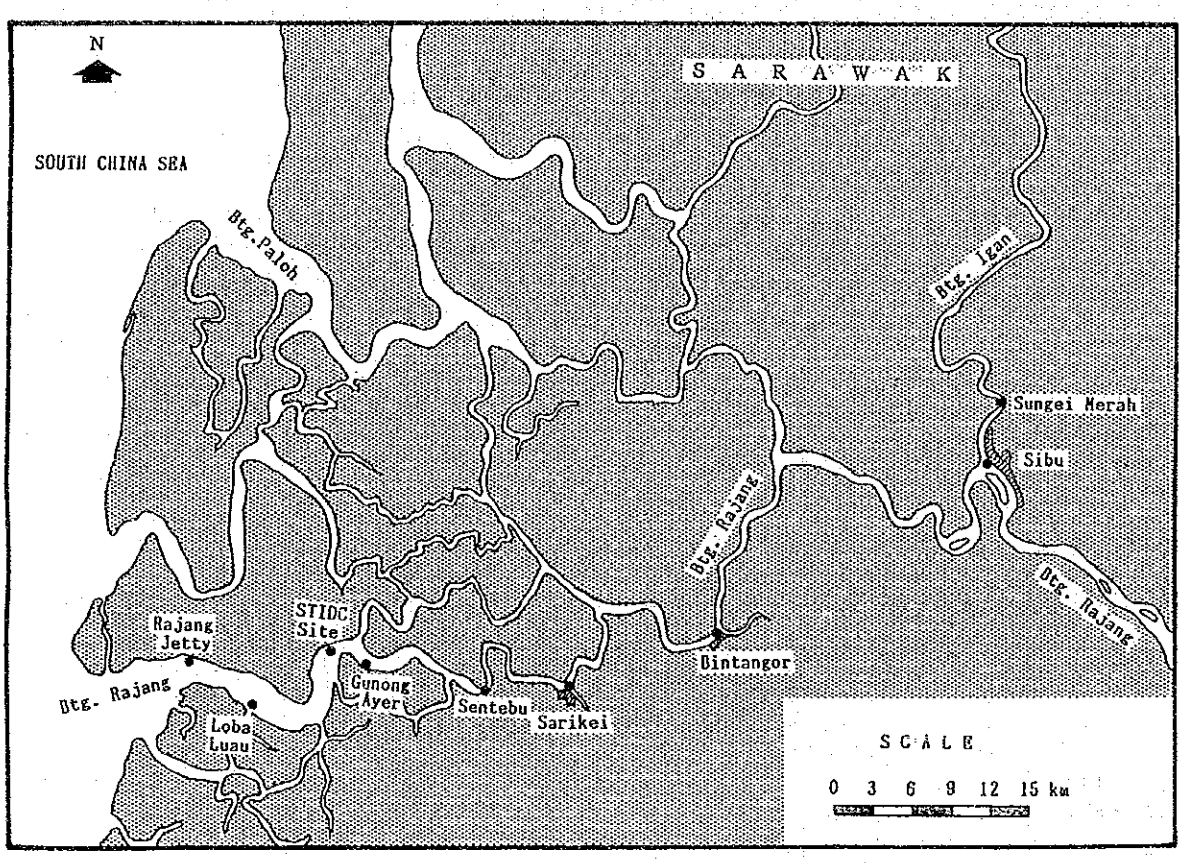


Figure-1.3.2.6 Location of Water Examination by JICA team

The results of the water examination are as follows.

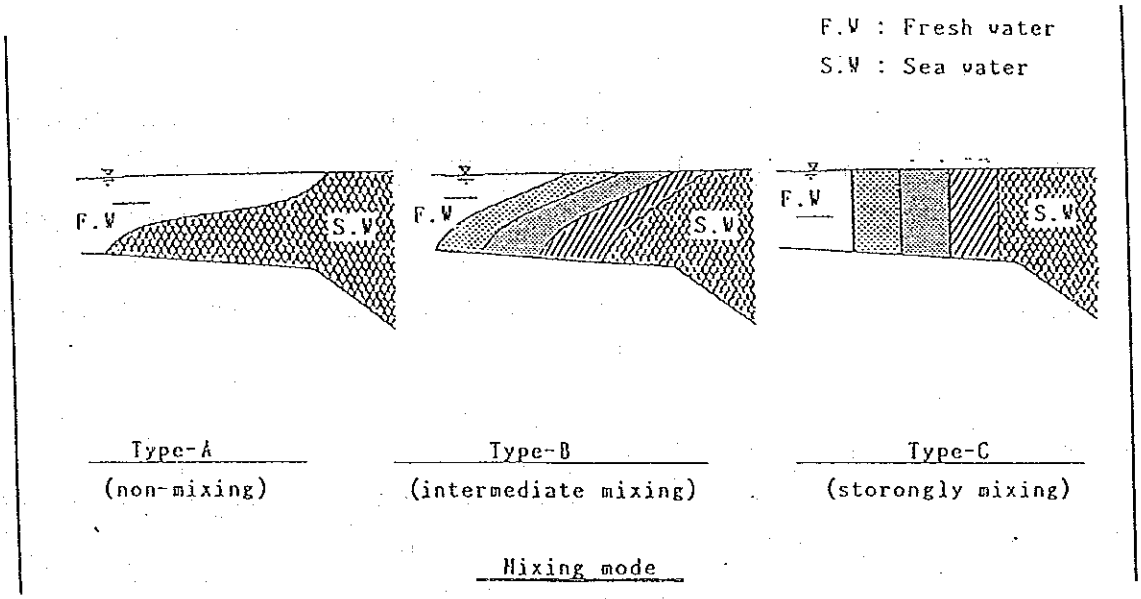
i) Water temperature

The water temperature in the surrounding areas of Tg. Manis is higher than that of Sibu and Bintangor, which is 28.0-30.5C° and 24.5-29.0C° respectively.

ii) Salinity

The water is mixed with sea water, and the salinity content increases in the deeper water downstream. Salinity content in the surroundings of Tg. Manis is approximately 30%, which is slightly lower in comparison with the ocean (average salinity content of the ocean is 33% - 37%).

The mixing mode of fresh water and seawater at the mouth of tidal river is divided into three types.



Type-A and B are called salt water wedges, which are considered to be a cause of sedimentation. From the results of the examination, the mixing mode of this area belongs to Type-B and sedimentation is supposedly occurring. But sedimentation is distributed far and wide, because the position of the salt-water wedge is unstable, changing with depending on the tide.

iii) PH (Exponent of Hydrogen Ion Concentration)

PH is between 6.5 and 8.0 except at Bintangor, which was examined on 29/9/90 and found to be at 6.3. Alkalinity increases downstream of the Rajang River.

iv) DO (Dissolved Oxygen)

The DO of the river water has a wide range between 3.5 and 7mg/1 and no relation to its location. It is common knowledge that a bad smell will occur under DO<2mg/1 condition.

v) SS (Suspended Solid)

The SS of the river water is influenced by conditions such as rainfall in the upstream region and the tide level of the estuary. Between Sibu and Sarikei, the river water is turbid and brownish with suspended solid at all times. On the other hand, in the surroundings of Tg. Manis, the river water is clear and colorless with a negligible amount of sediment.

vi) BOD (Biochemical Oxgen Demand)

BOD test was conducted at the laboratory for five days at 20°C. All the results show that BOD values are not high.

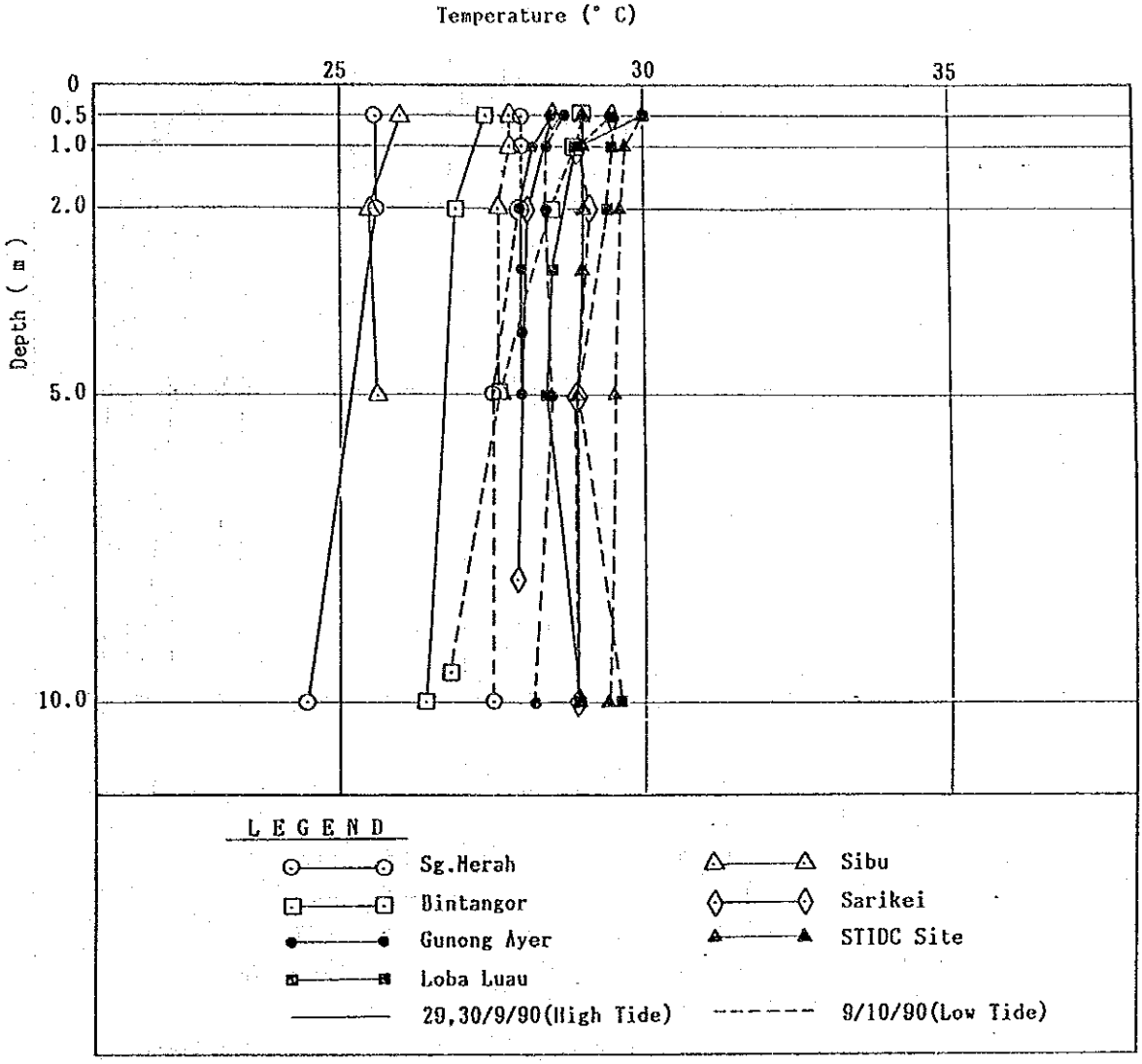


Figure-1.3.2.7 Water Temperature

Table-1.3.2.5 Water Temperature

Temperature

Location	Date	0.5m	1.0m	2.0m	3.0m	4.0m	5.0m	8.0m	9.5m	10m	20m	30m	Average
Sibu	29/9/90	26.0		25.5			25.6						25.7
	9/10/90	27.8	27.8	27.6			27.6						27.7
	Ave												26.7
S. Merah	29/9/90	25.6		25.6						24.5			25.2
	9/10/90	28.0	28.0	28.0			27.5			27.5			27.8
	Ave												26.5
Bintangor	29/9/90	27.4		26.9						26.4			26.9
	9/10/90	29.0	28.9	28.5			27.6		26.8				28.2
	Ave												28.0
Sarikei	29/9/90	28.5		28.1				27.9					28.2
	9/10/90	29.5	28.9	29.1			28.9			28.9			29.1
	Ave												28.8
Off S. Sentebu	30/9/90	28.5											28.5
	9/10/90	29.7											29.7
	Ave												29.1
Off Gunong Ayer	30/9/90	28.5	28.2	28.0	28.0	28.0	28.0						28.1
	9/10/90	28.7	28.4	28.4			28.5			28.2			28.4
	Ave												28.3
Off STIDC site	30/9/90	29.0	29.0	29.0	29.0		28.9			28.9			29.0
	9/10/90	30.0	29.7	29.6			29.5			29.4			29.6
	Ave												29.3
Off Loba Luau	30/9/90	30.0	28.9	28.5			28.4			28.9			28.5
	9/10/90	29.5	29.5	29.4			28.9			29.6			29.4
	Ave												29.2
Rajang Jetty	30/9/90	29.9	29.2	28.9			28.7			28.5	28.5	29.2	29.0
	9/10/90	30.5	30.2	30.1			29.9			29.7			30.1
	Ave												29.6
Off Sarikei	30/9/90	26.0											26.0

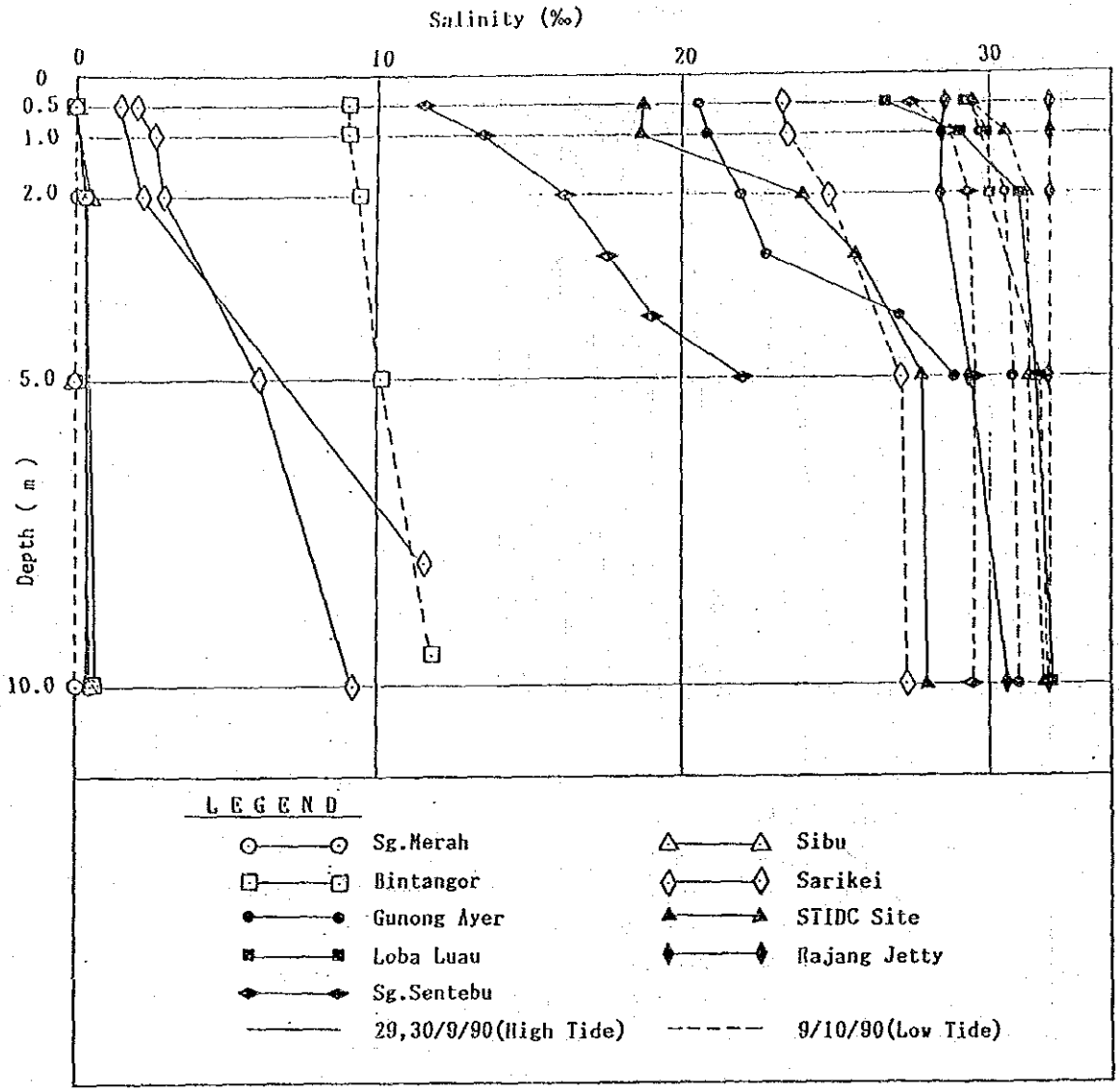


Figure-1.3.2.8 Salinity

Table-1.3.2.6 Salinity

Salinity

Location	Date	0.5m	1.0m	2.0m	3.0m	4.0m	5.0m	8.0m	9.5m	10m	20m	30m	Average
Sibu	29/9/90	0.0		0.4			0.6						0.27
	9/10/90	0.0	0.0	0.0			0.0						0.00
	Ave												0.13
S. Merah	29/9/90	0.0		0.3						0.5			0.27
	9/10/90	0.0	0.0	0.0			0.0			0.0			0.00
	Ave												0.13
Bintangor	29/9/90	0.0		0.3						0.6			0.30
	9/10/90	9.0	9.0	9.4			10.1		11.8				9.86
	Ave												4.68
Sarikei	29/9/90	1.4		2.2				11.5					5.03
	9/10/90	23.2	23.4	24.7			27.1			27.3			25.10
	Ave												12.88
Off S. Sentebu	30/9/90	11.5	13.5	16.2	17.6	19.0	22.0						16.63
	9/10/90	27.4	28.7	29.3			29.5			29.5			28.88
	Ave												22.79
Off Gunong Ayer	30/9/90	20.5	20.8	21.9	22.7	27.0	28.9						28.36
	9/10/90	29.4	29.7	30.5			30.8			31.0			30.28
	Ave												26.56
Off STIDC site	30/9/90	18.7	18.6	23.9	25.6		27.8			28.0			23.77
	9/10/90	29.4	30.5	31.2			31.3			31.8			30.84
	Ave												27.12
Off Loba Luau	30/9/90	26.5	29.0	31.0			31.6			32.1			30.04
	9/10/90	29.2	29.9	30.0			31.7			31.7			30.54
	Ave												30.20
Rajang Jetty	30/9/90	28.5	28.4	28.4			29.3			30.6	31.2	32.0	29.77
	9/10/90	32.0	32.0	32.0			32.0			32.0			32.00
	Ave												30.52
Off Sarikei	30/9/90	2.0	2.6	2.9	3.6	5.5	6.1			9.2	11.0		5.36

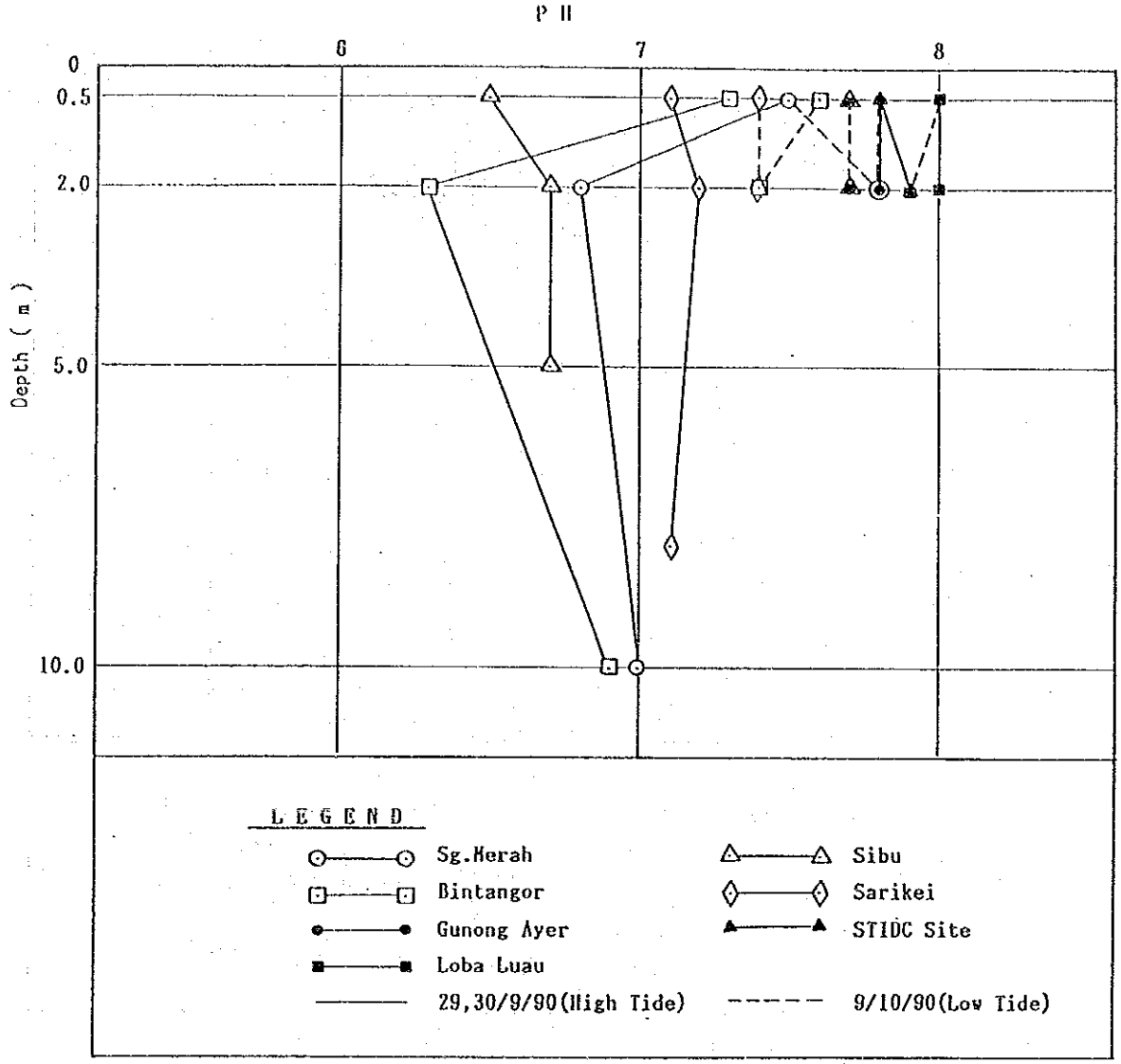


Figure-1.3.2.9 P H

Table-1.3.2.7 P H

PH

Location	Date	0.5m	1.0m	2.0m	3.0m	4.0m	5.0m	8.0m	9.5m	10m	20m	30m	Average
Sibu	29/9/90	6.5		6.7			6.7						6.63
	9/10/90	7.7		7.7									7.70
	Ave												6.65
S. Merah	29/9/90	7.5		6.8						7.0			7.10
	9/10/90	7.5		7.8									7.65
	Ave												7.40
Bintangor	29/9/90	7.3		6.3						6.9			6.83
	9/10/90	7.6		7.4									7.50
	Ave												7.15
Sarikei	29/9/90	7.1		7.2				4.0					6.10
	9/10/90	7.4		7.4									7.40
	Ave												7.28
Off S. Sentebu	30/9/90												-
	9/10/90												-
	Ave												-
Off Gunong Ayer	30/9/90	7.8		7.8									7.80
	9/10/90	7.7		7.7									7.70
	Ave												7.75
Off STIDC site	30/9/90	7.8		7.9									7.85
	9/10/90	7.8		7.8									7.80
	Ave												7.83
Off Loba Luau	30/9/90	8.0		8.0									8.00
	9/10/90	8.0		7.9									7.95
	Ave												7.98
Rajang Jetty	30/9/90												-
	9/10/90												-
	Ave												-
Off Sarikei	30/9/90												-

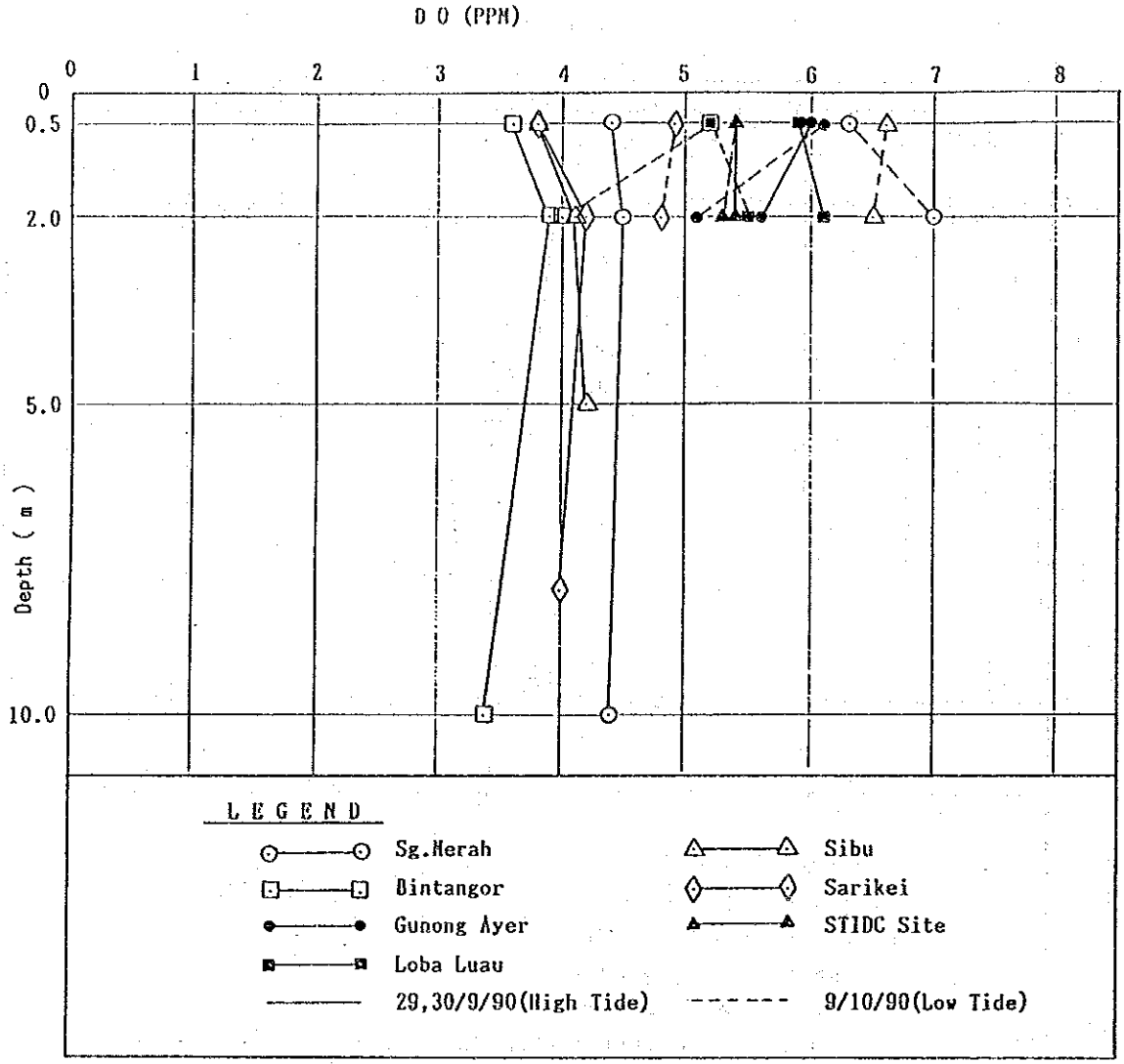


Figure-1.3.2.10 D O

Table-1.3.2.8 D O

Do

Location	Date	0.5m	1.0m	2.0m	3.0m	4.0m	5.0m	8.0m	9.5m	10m	20m	30m	Average
Sibu	29/9/90	3.8		4.1			4.2						4.03
	9/10/90	6.6		6.5									6.55
	Ave												5.25
S. Merah	29/9/90	4.4		4.5						4.4			4.43
	9/10/90	6.3		7.0									6.65
	Ave												5.55
Bintangor	29/9/90	3.6		3.9						3.4			3.63
	9/10/90	5.2		4.0									4.60
	Ave												4.18
Sarikei	29/9/90	3.8		4.2				4.0					4.00
	9/10/90	4.9		4.8									4.85
	Ave												4.43
Off S. Sentebu	30/9/90												-
	9/10/90												-
	Ave												-
Off Gunong Ayer	30/9/90	6.0		5.6									5.80
	9/10/90	6.1		5.1									5.60
	Ave												5.70
Off STIDC site	30/9/90	5.4		5.4									5.40
	9/10/90	5.4		5.3									5.35
	Ave												5.38
Off Loba Luau	30/9/90	5.9		6.1									6.00
	9/10/90	5.2		5.5									5.35
	Ave												5.68
Rajang Jetty	30/9/90												-
	9/10/90												-
	Ave												-
Off Sarikei	30/9/90												-

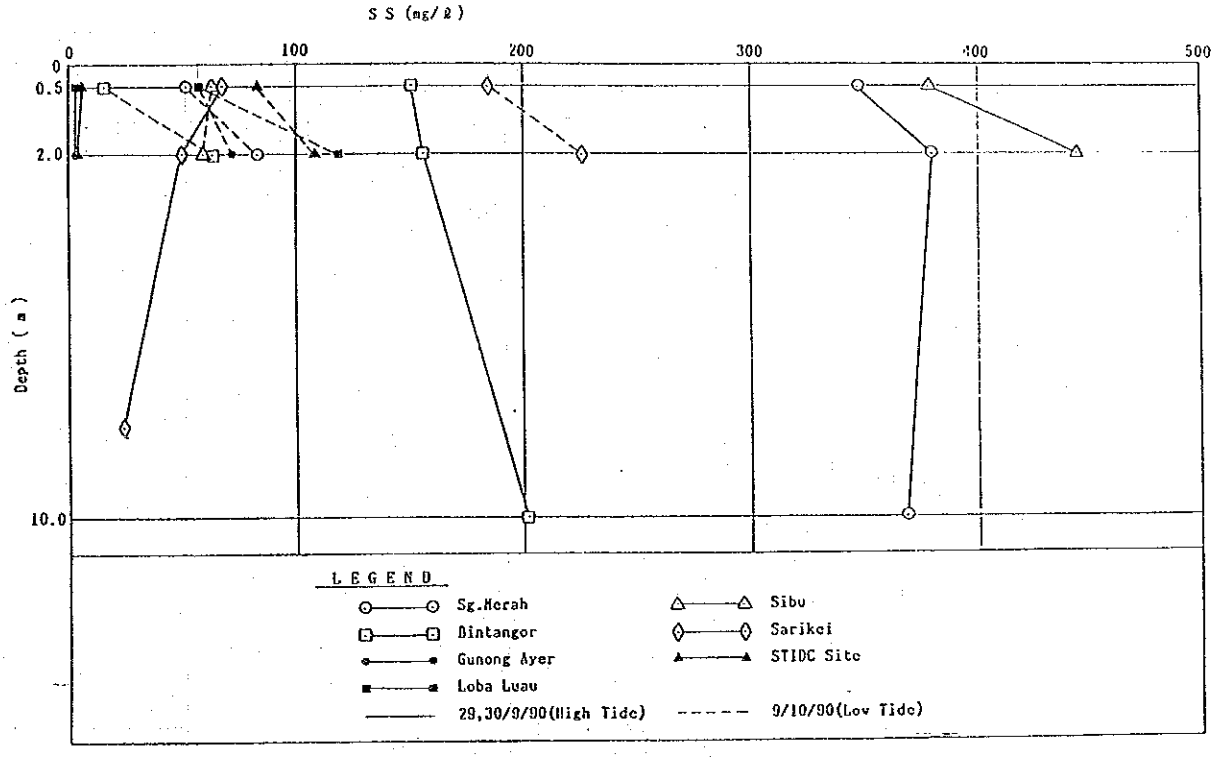


Figure-1.3.2.11 S S

Table-1.3.2.9 S S

SS

Location	Date	0.5m	1.0m	2.0m	3.0m	4.0m	5.0m	8.0m	9.5m	10m	20m	30m	Average
Sibu	29/9/90	368		444									406.0
	9/10/90	63		59									61.0
	Ave												233.5
S. Merah	29/9/90	348		380						368			365.3
	9/10/90	52		83									67.5
	Ave												215.8
Bintangor	29/9/90	150		156						202			169.3
	9/10/90	16		63									39.5
	Ave												96.3
Sarikei	29/9/90	68		50				24					47.3
	9/10/90	184		226									205.0
	Ave												132.0
Off S. Sentebu	30/9/90												-
	9/10/90												-
	Ave												-
Off Gunong Ayer	30/9/90			3.3									3.3
	9/10/90	58		72									65.0
	Ave												37.7
Off STIDC site	30/9/90	5.6		3.6									4.6
	9/10/90	83		108									95.5
	Ave												50.1
Off Loba Luau	30/9/90	3.0		3.2									3.1
	9/10/90	58		118									88.0
	Ave												45.6
Rajang Jetty	30/9/90												-
	9/10/90												-
	Ave												-
Off Sarikei	30/9/90												-

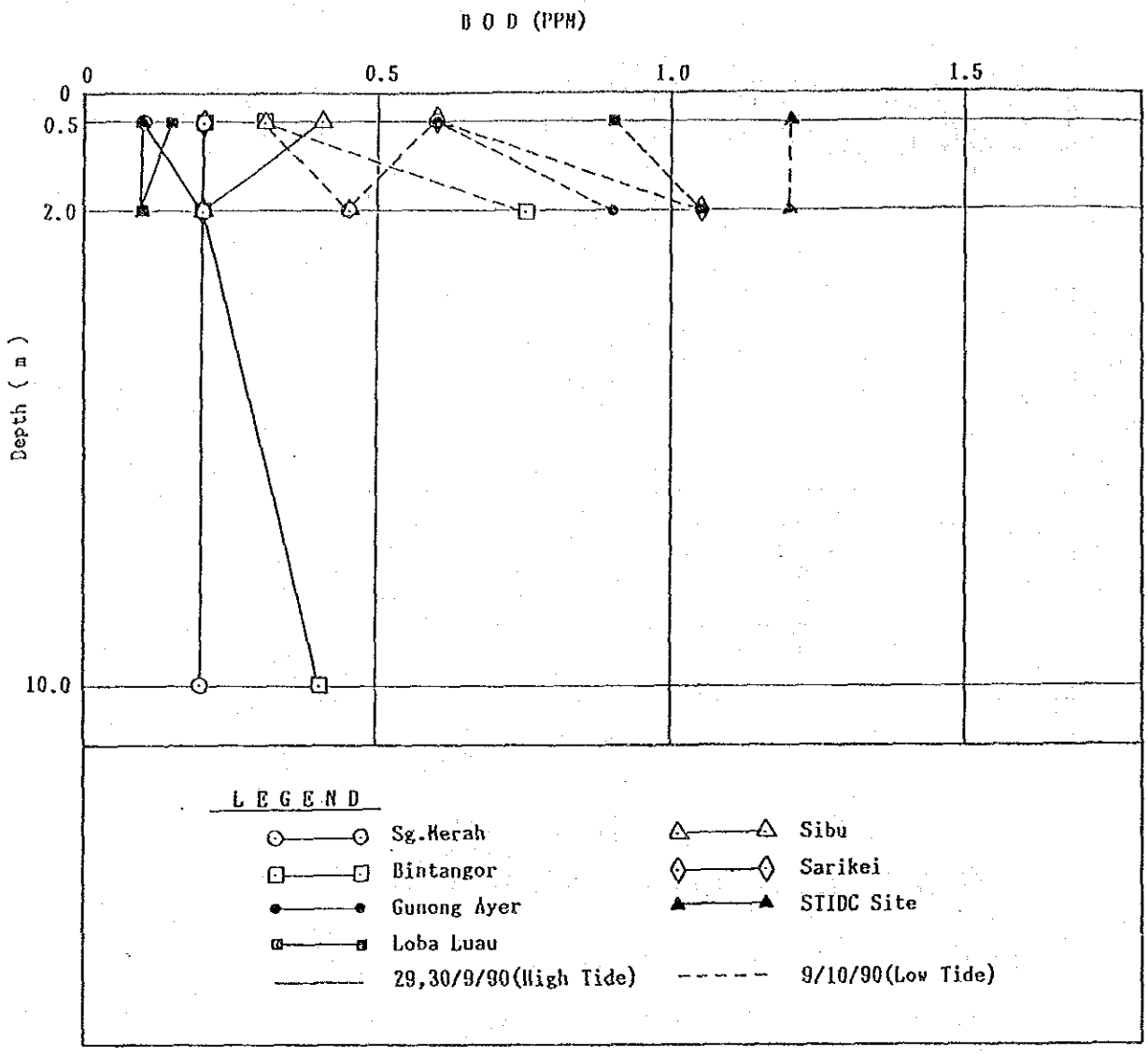


Figure-1.3.2.12 B O D

Table-1.3.2.10 B O D

BOD

Location	Date	0.5m	1.0m	2.0m	3.0m	4.0m	5.0m	8.0m	9.5m	10m	20m	30m	Average
Sibu	29/9/90	0.40		0.20									0.30
	9/10/90	0.30		0.45									0.38
	Ave												0.34
S. Merah	29/9/90	0.10		0.20						0.20			0.17
	9/10/90	0.60		0.45									0.53
	Ave												0.34
Bintangor	29/9/90	0.20		0.20						0.40			0.27
	9/10/90	0.30		0.75									0.53
	Ave												0.36
Sarikei	29/9/90	0.20		0.20									0.20
	9/10/90	0.60		1.05									0.83
	Ave												0.51
Off S. Sentebu	30/9/90												-
	9/10/90												-
	Ave												-
Off Gunong Ayer	30/9/90	0.15											0.15
	9/10/90	0.60		0.90									0.75
	Ave												0.38
Off STIDC site	30/9/90	0.10		0.10									0.10
	9/10/90	1.20		1.20									1.20
	Ave												0.65
Off Loba Luau	30/9/90	0.15		0.10									0.13
	9/10/90	0.90		1.05									0.98
	Ave												0.55
Rajang Jetty	30/9/90												-
	9/10/90												-
	Ave												-
Off Sarikei	30/9/90												-

(3) Evaluation

The water quality standard in Malaysia is shown in the following table.

Table-1.3.2.11 WATER QUALITY STANDRD (proposed)

PARAMETERS	(units)	CLASSES					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/L	0.1	0.3	0.3	0.9	2.7	>2.7
BOD	mg/L	1	3	3	6	12	>12
COD	mg/L	10	25	25	50	100	>100
DO	mg/L	7	5-7	5-7	3-5	<3	<1
PH		6.5-8.5	6-9	6-9	5-9	5-9	-
Colour	TCU	15	150	150	-	-	-
Elect. Cond.*	umhos/cm	1000	1000	-	-	6000	-
Floatables		N	N	N	-	-	-
Odour		N	N	N	-	-	-
Salinity*	0/00	0.5	1	-	-	2	-
Taste		N	N	N	-	-	-
Total Diss. Solid*	mg/L	500	1000	-	-	4000	-
Total Susp. Solids	mg/L	25	50	50	150	300	>300
Temperature	°C	-	Normal ±2	-	Normal ±2	-	-
Turbidity	NTU	5	50	50	-	-	-
F. Colif.**	counts/ 100mL	10	100	400	5000 (20000)a	5000 (20000)a	
Tot. Colif.	counts/ 100mL	100	5000	5000	50000	50000	>50000

N = No visible floatable materials/debris,
or No objectionable odour,
or No objectionable taste,

* = Related parameters, only one recommended for use

** = Geometric mean

a = Maximum not to be exceeded

The system of use classification proposed is defined as follows:

CLASS USES

I Conservation of natural environment
Water supply I - practically no treatment necessary (except by disinfection or boiling only) Fishery I - very sensitive aquatic species

IIA Water supply II - conventional treatment required Fishery II - sensitive aquatic species

IIB Recreational use with body contact

III Water supply III - extensive treatment required Fishery III - common, of economic value, and Livestock drinking

IV Irrigation

a. Ammoniacal Nitrogen

The Ammoniacal Nitrogen (NH3-N) is sufficiently lower than the standard. (<0.9mg/1)

Concerning Ammoniacal Nitrogen in all rivers in Sarawak, it is on an annually declining trend. (Please see **Table-1.3.2.4**)

b. BOD

The BOD of the Rajang River nearly satisfied the standard. (65 samples of 66 samples were below the limit.)

c. COD

As for the COD of the Rajang River, the Standard was met satisfactorily. The tendency of COD is the same as BOD.

d. DO (Dissolved Oxygen)

According to the results survey by DOE and the team, DO is in the range of 3.4-7.0 mg/l satisfying the Standard (3-5 mg/l).

e. PH

With regard to PH of the Rajang River, it almost satisfied the standard in the upper area from Sarikei, and other satisfactory samples were recorded in the lower area of Sarikei.

(5) Drainage Pattern

With regard to the drainage pattern in the project area, the secondary drainage part of the land is obvious in the form of short creeks and short channels.

In the overall drainage system, these water outlets/inlets are found to be of less importance for drainage in view of the existence of the Rajang River itself.

As for the location of short creeks and short channels please refer to **Fig-1.3.1.31** and **Fig-1.3.1.32.**

At site B, there are some small creeks such as S.Sekumang, S.Barong and S.Nyitong.

Regarding site C, three creeks, S.Tapongan, S.Tajau and S.kubou, and two small channels, called Loba Luau and Loba Kubau, exist in the area.

(6) Water Balance

The area consists of natural forests, and there is no equipment for pumping up the water in massive amounts.

7) Flooding

According to the "National Water Resources Study" of the Malaysian Government and JICA, some flooding occurred in the past, causing disasters in the Rajang area.

Since then, there has never been an improvement in the river bank; for example, there has not been a large scale revetment of more than 10km continuously, so the basic characteristic of the river has not changed until now.

The table below shows the river characteristics of Rajang River.

Table-1.3.2.12 Characteristic of the Rajang River

Item	Description	Reference
State	Sarawak	
Name of River	Rajang	
Basin No.	241	
Catchment Area (km^2)	51,053	
Annual Basin Rainfall (mm)	3,990 (1963-80)	
Annual Mean Run-off (m^3/s)	2,004 (Bilong)	
River Morphology	heavy meandering exists in the lower reach.	
	Banks are eroded by flood, tidal fluctuation and inland navigation boats. Rivers trifurcated at downstream of Sibu play as floodways.	SJ 2
Estuary	No problems reported.	SJ 1
Sediment	Sand and gravel are extracted for construction purposes.	
	No silting-up problems reported so far.	SJ1
Salt Water Intrusion	Salt water extends to R. Patch, 238km from the estuary.	SJ 2
Flood	Severe flood at Sibu 1 1/2' depth, duration 31 days. Flood along riverine villages and log- lying plain near the Coast and also roads.	SJ15
Other Items	Pelages and Balu hydropower schemes are proposed at the middle reach.	
	No flood control storage is allotted.	SJ 17

Source; 1: DID State Office
2: Observations on field visit and on 1/63,360 maps
3: Other informations from References

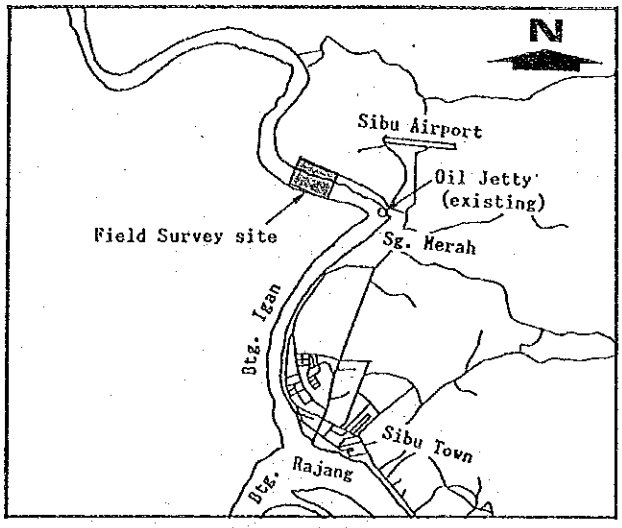
(8) Existing Use

The Rajang River is used for passage by ships such as general cargo vessels, container ships, tug boats, express boats and so on. Additionally, some port facilities of the Rajang Port Authority and some timber operations are located along the river.

In fact, both sides of the river are used for log ponds in a section of the river valley from Tg. Manis to a point 20km upstream.

For more details on the port facilities, the traffic volume of vessels and the log ponds, please refer to **Volume II.**

Picture-1.3.2.1 Rajang River in front of Project site



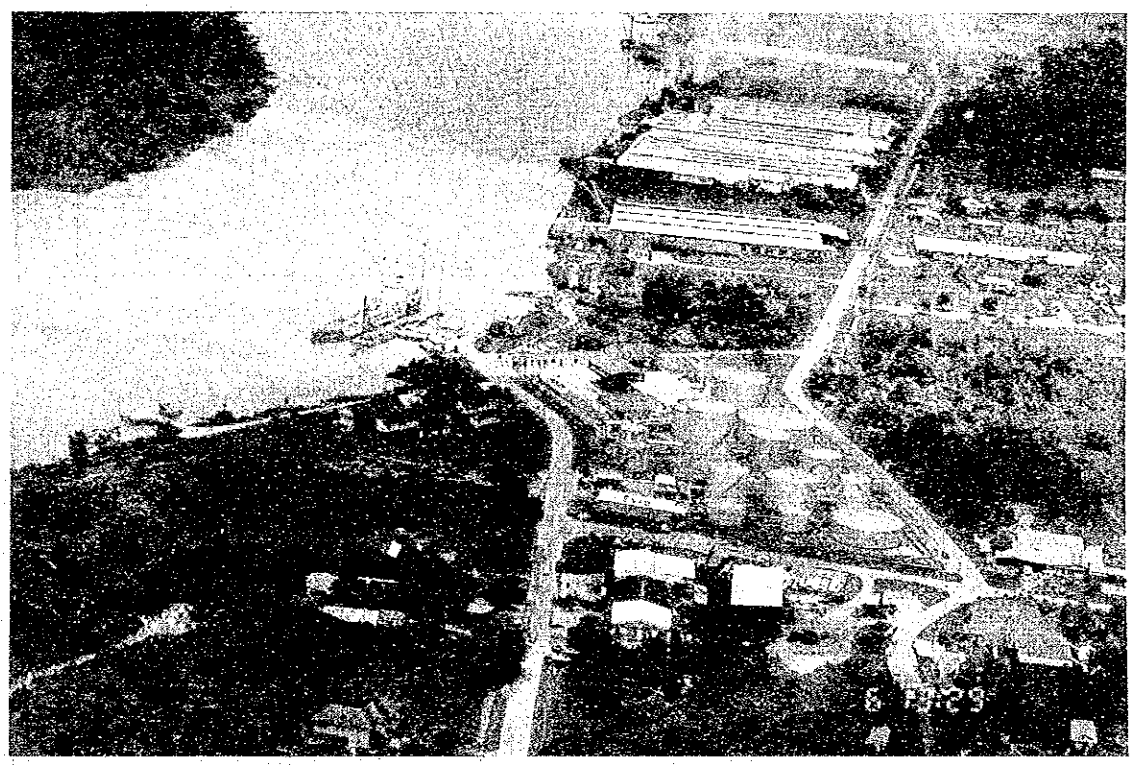


Figure-1.3.2.13 Sungai Merah

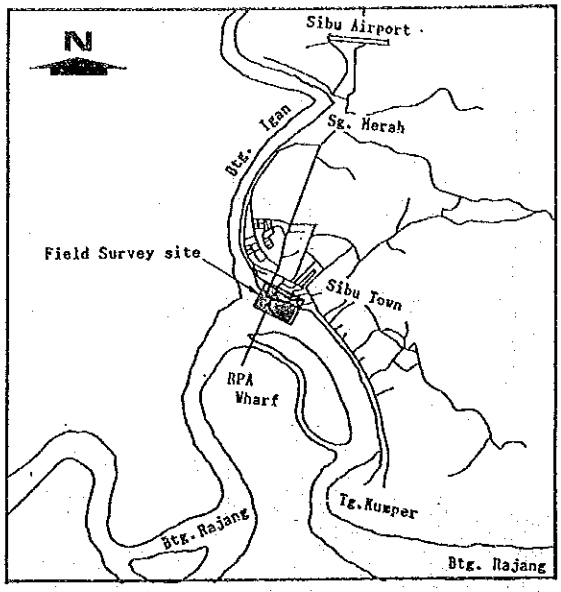
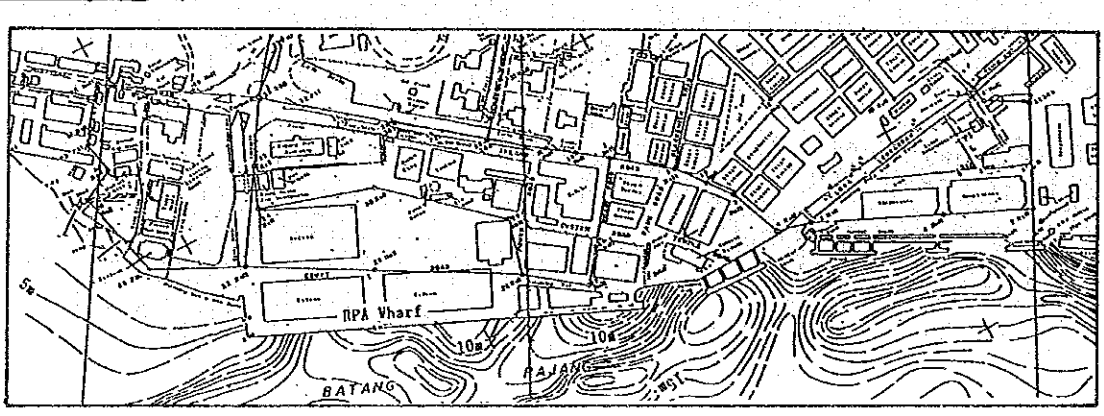
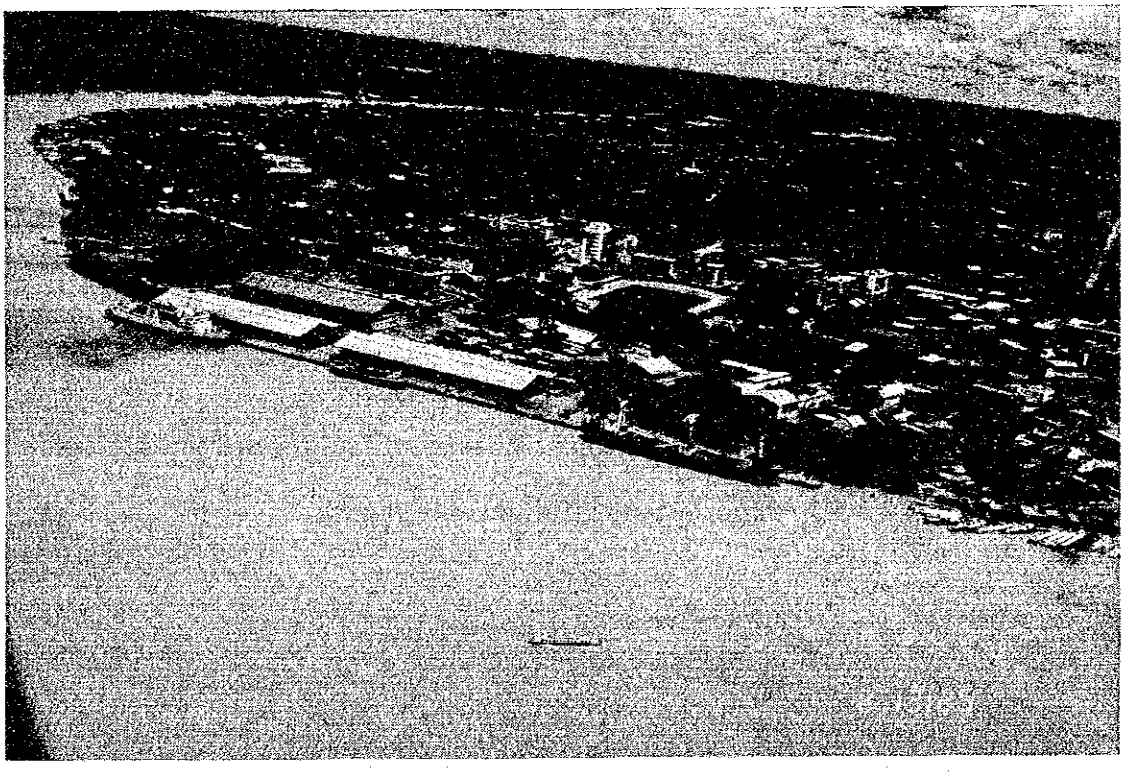


Figure-1.3.2.14
Location of RPA wharves at Sibu





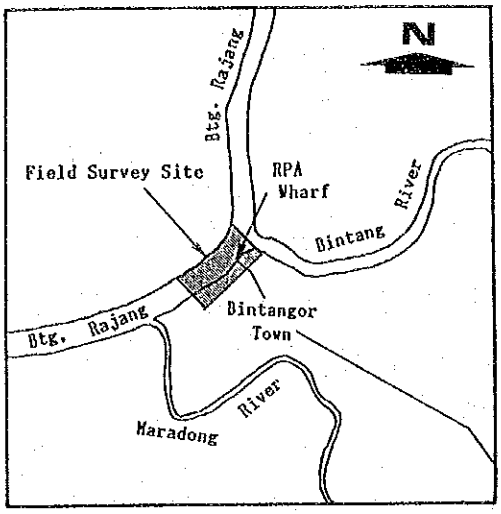
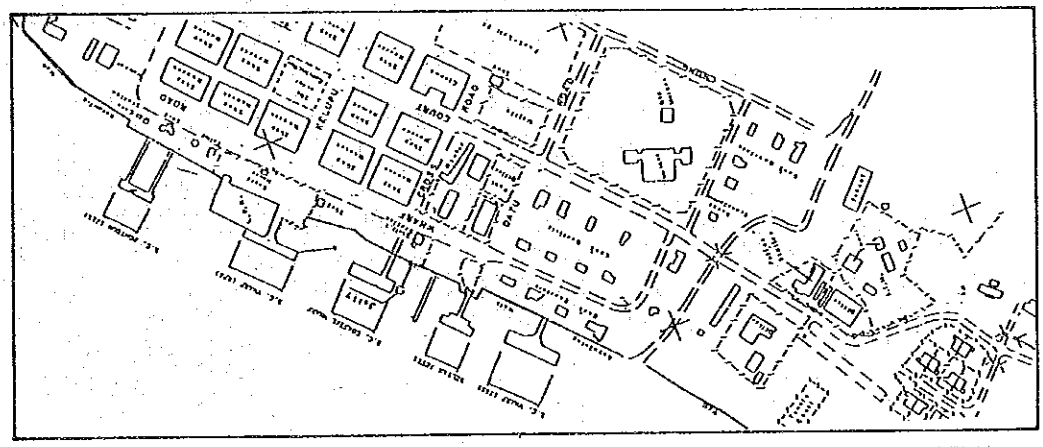


Figure-1.3.2.15
Location of wharves at Bintangor



Picture-1.3.2.4 Bintangor Port

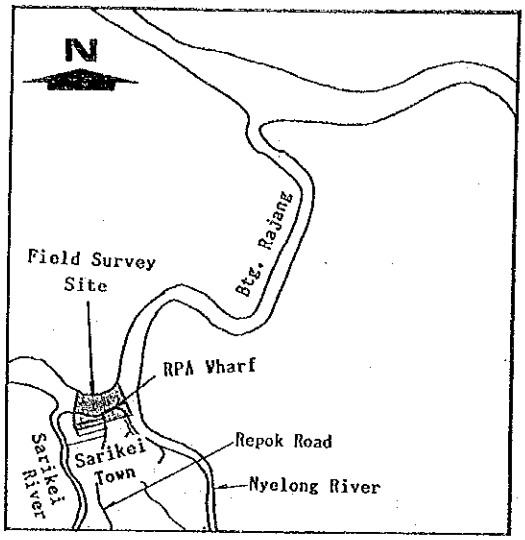
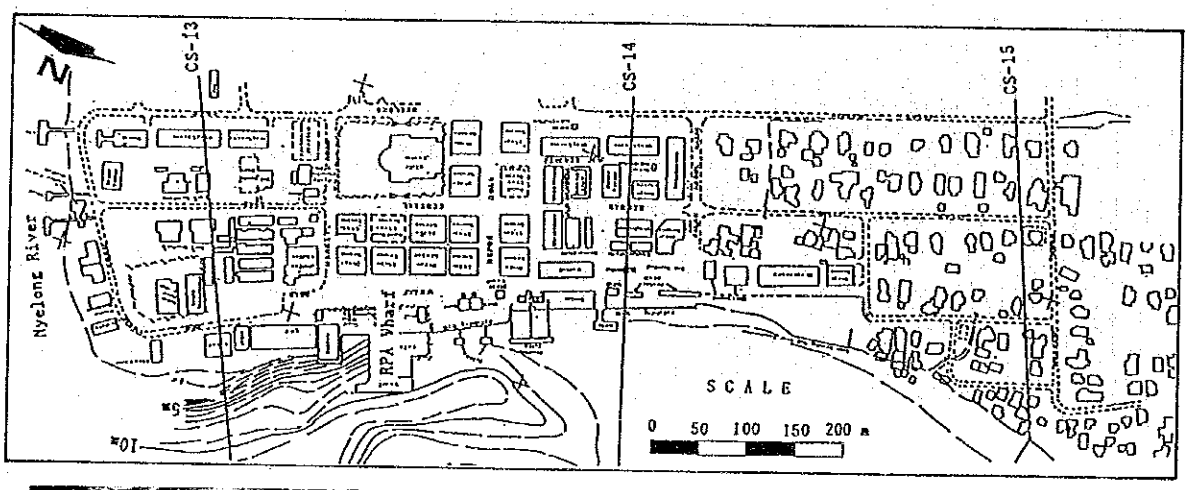
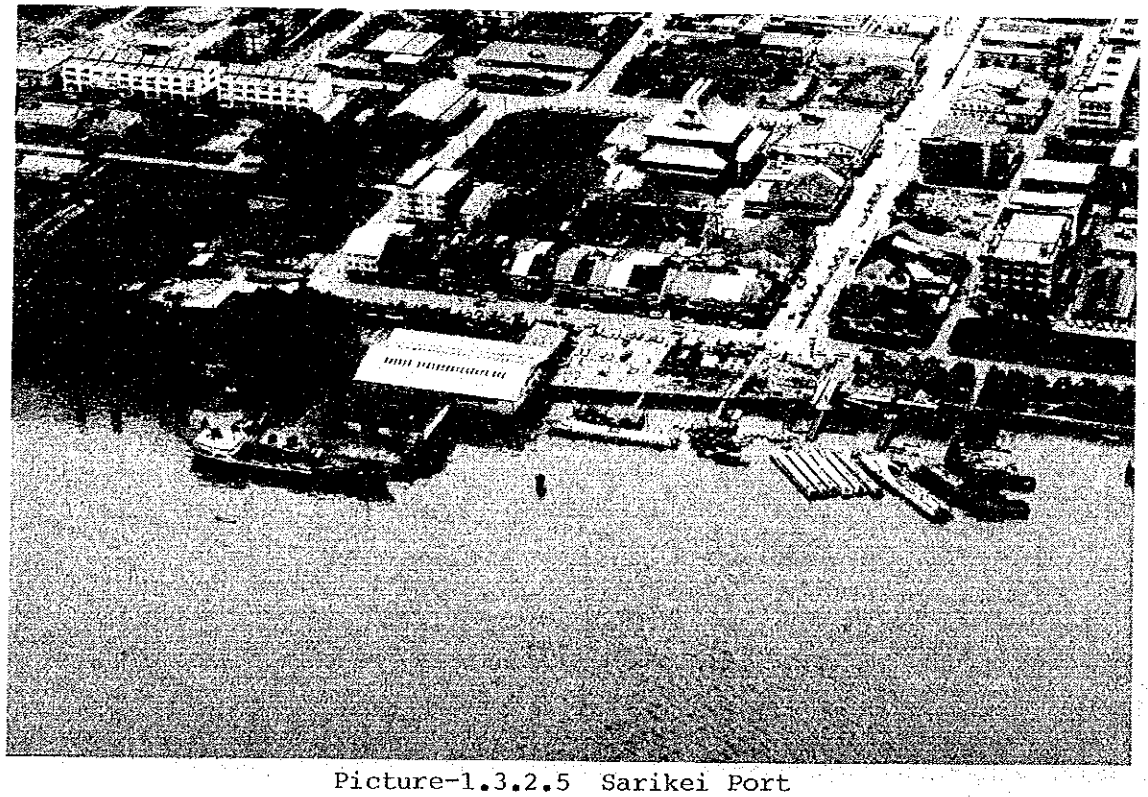


Figure-1.3.2.16
Location of Sarikei Port





Picture-1.3.2.5 Sarikei Port