control of safe navigation, specifically of small boats and barges.

Every possible measure should be taken to prevent collisions of ships with the submerged wall and, during the construction period, to ensure the safe and smooth passage of vessels through the channel.

6. Application of the Study Results

It is recommended that good use be made of the results of this Study, such as newly found phenomena and knowledge, the methods of analysis developed and effective measures applicable to the planning, execution, study and research concerning other ports suffering from similar problems of siltation and dredging.

7. Utilization of Survey Equipment

The survey equipment procured in this Study should also be utilized for surveys in Indonesia as much as possible.

8. Replenishment of Port Statistics

The port statistics should be replenished and upgraded in terms of, for example, unit of cargo volume, classification of containers, treatment of passing ships, record of marine casualty, etc., and be reflected in formulating port development policy.

SUMMARY

PART I INTRODUCTION

Chapter 1 Background of the Study

The Port of Banjarmasin, located approximately 26km upstream from the mouth of the Barito River, has a significant siltation problem in its 14km long access channel. The annual volume dredged is 2 to 3 million m^3. In spite of these efforts, the planned channel depth has not been maintained, which has had negative economic effects on the port.

Considering this situation, the Indonesian Government asked for the Japanese Government's technical cooperation in ameliorating the problem in 1985.

Chapter 2 Objectives of the Study

The objectives of the study are:

- To develop measures to reduce the siltation volume in the access channel of the Port of Banjarmasin,
- To develop effective measures for maintenance dredging, and
- To formulate a comprehensive plan and a first stage plan to deal with the siltation in the access channel.

Chapter 3 Methodology and Organization

The major study activities and items are analyses of present conditions; field surveys; planning of alternatives for siltation reduction and dredging efficiency improvement; discussions on siltation reduction effect by hydraulic model tests and numerical simulations; and formulation of the Comprehensive and First-stage Plans.

The Study Team consisted of 13 specialists from the Overseas Coastal Area Development Institute of Japan (OCDI) and Nippon Tetrapod Co., Ltd. (NTC).

Chapter 4 Schedule of the Study

The study was carried out from March 1988 to March 1991. During the period the Study Team visited Indonesia eight times and held seminars/training six times.

PART II ANALYSIS OF PRESENT CONDITIONS OF THE PORT, ACCESS CHANNEL AND DREDGING

Chapter 1 Present Conditions Related to Port and Access Channel

(1) Socio-economic Conditions

The hinterland of Banjarmasin Port covers the western part of the Province of South Kalimantan and the eastern part of the Province of Central Kalimantan. The population in the area is 2,762 thousand persons. Banjarmasin City has the largest population with 432,657 (Population figures are from 1985). Major industries in the area are agriculture, forestry and fishery.

(2) Present Organization

Ports and navigational channels in Indonesia are under the jurisdiction of the Ministry of Communications (MOC), in which the Directorate General of Sea Communication (DGSC) is in charge of matters concerning port facilities, equipment, port services, pilotage, dredging and others. Under MOC, the District Offices of Communications (KANWIL) are located at each province and Harbour Administration Offices (ADPEL) are attached to major ports, including Banjarmasin. The management of Banjarmasin Port is undertaken by Perumpel III, Banjarmasin Branch Office.

(3) Present and Past Condition of the Port and the Channel

In Banjarmasin Port, there are two port areas: one in Trisakti Wharf (length 320m, depth about 9m) and the other in Martapura Wharf (length 288m, depth about 5m). A development project is being carried out at Trisakti to expand wharfs (+120m, 9m, and +350m, 5m) funded by ADB and other institutions from 1987 and is expected to be completed in 1991.

The access channel off the river mouth has a length of 14km at present. The channel was dredged to a depth of -6m and a bottom width of 100m in 1975 and 1976. Since then it has been maintained by dredging every year to less than a depth of 5m and a width of 60m on average due to heavy siltation and the limited volume of dredging.

Chapter 2 Natural Conditions

(1) Objective

In order to obtain a basic understanding of the mechanism of siltation, a comprehensive field survey was carried out for one (1) year from September 1988 to September 1989, in the coast and the harbour area of Banjarmasin Port. The data derived from the survey were effectively utilized for the hydraulic model test and the numerical simulation to make the siltation situation clear and to evaluate various countermeasures against siltation.

(2) Survey Implementation

The survey was executed by a local Indonesian consulting company under the supervision of the Study Team, using various pieces of state-of-the-art survey equipment, which were granted to the Indonesian Government by the JICA after the survey, together with several pieces of equipment of the consulting company. With regard to data processing, the final processing of the data was done by the Study Team, including analyses of the data.

(3) Survey Items and its Contents

1) Control Point Survey and Position-fixing of Survey Boat

Many control points were established on land around the survey area to measure the position of survey boat at the beginning stage. The position-fixing of the survey boat was carried out by a microwave positioning system, in principle.

2) General Survey

General surveys were carried out three (3) times in the survey period: September-October 1988 (dry season), January-February 1989 (rainy season) and April-May 1989 (intermediate season), and the period of each survey was about one (1) month. The survey included a) tidal currents offshore, b) bottom currents on the delta of the Barito River, c) surface flow pattern from the mouth of the Barito River, d) the relation between current velocity and turbidity on the delta and e) the relation between bottom material, salinity and suspended material on the delta.

3) Monthly Survey

Monthly surveys were carried out about once a month; totally twelve (12) times, in the survey period. The survey included a) saline wedge pattern in the Barito River and the access channel, b) discharge volume and quantity of transported material of the Barito River, c) bottom materials in the Barito River and the access channel and d) siltation volume in the access channel by means of echo sounding.

4) Year-long Survey

Year-long survey was carried out continuously for one (1) year, using self-recording equipment. The survey included a) tides at the pilot station and off the end of the access channel, b) winds at the pilot station and c) waves off the end of the access channel.

5) Echo Sounding (Wide Area)

Echo sounding was carried out two (2) times: December 1988 to June 1989 and June to September 1989, in the area offshore from the Barito River; 40km (E-W) X 30km (N-S).

6) Soil Boring

Soil boring was carried out at three (3) locations around the access channel up to 20m in depth below the seabed.

7) Seabed Level Calibration

Seabed level calibration was carried out three (3) times: in May, June and August 1989, in/around the access channel by means of different sensors, i.e., lead line, current meter, echo sounder and core sampler, etc.

8) Bottom Sampling

400 liters of bottom materials were taken from the seabed of the access channel for special soil tests in Japan on the characteristics of sedimentation and flotation.

9) Collection and Analysis of Existing Data

Data related to natural conditions were collected; for example, sounding charts, wind/rainfall and Landsat data, and were analyzed.

(4) Survey Results

The results on this field survey were compiled in the Progress Report (1) to the Progress Report (3) and the Interim Report (1). Additionally, the detailed results were compiled in the reports of Natural Conditions Survey in Banjarmasin Port, which were published in March 1990. The essence of the results is summarized hereinafter in Chapter 2 of PART II of this Report. Some of the major achievements of the survey are herein introduced as follows:

1) The current conditions around/off the estuary were revealed. Especially, the surface flow pattern was quite interesting, as shown in Fig. II-1.

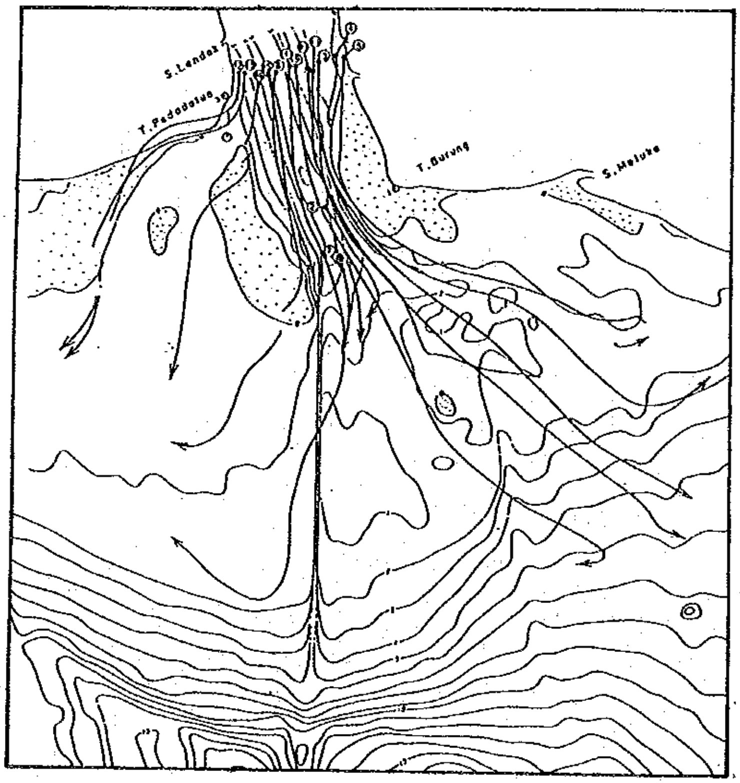


Fig. II-1 Flow Pattern of Surface Current
(Ebb Tide)

2) The bottom materials distributed in the Barito River and around/off the estuary were revealed.

3) The outlines of locations of the saline wedge formation were recognized by season, etc.

4) The annual changes of unit discharge volume and transported suspended material quantity were clarified, as shown in Fig. II-2, compared with the monthly rainfall.

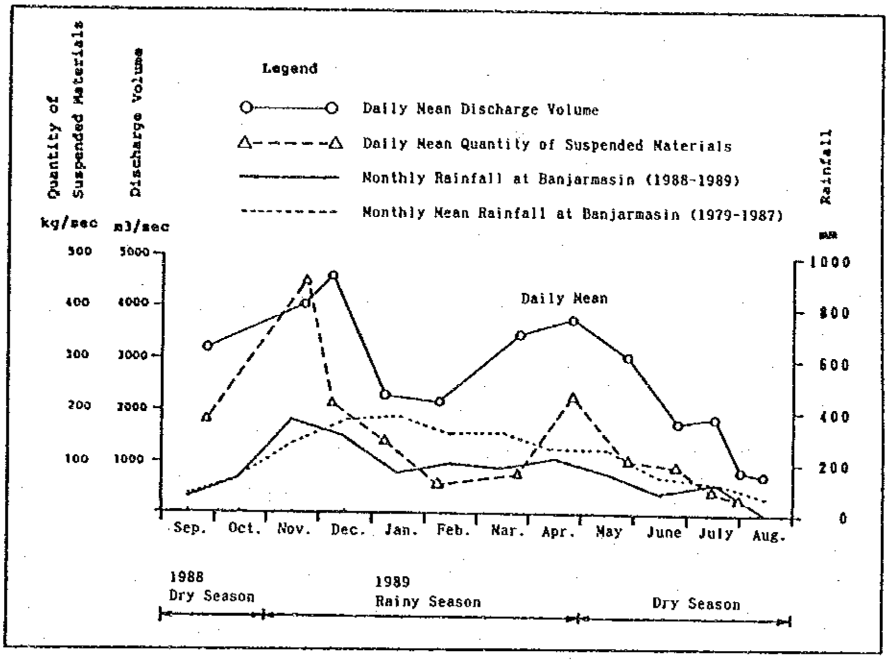


Fig. II- 2 Annual Change of Discharge Volume, Quantity of Suspended Material and Rainfall

5) The annual change of siltation volume in the access channel was revealed, but most of the change was affected by the dredging work.

6) During the intermission in the dredging work, that is, February to May 1989, the development of fluid mud between the reflected planes of frequency 210 kHz and 33 kHz was recognized and traced.

7) The constants of tidal components were calculated, based on the year-long data on tides at the pilot station and off the end of the access channel. Both tides were of a diurnal type.

8) Tendencies of year-long winds at the pilot station and waves off the end of the access channel were understood.

9) The broad submarine topography around/off the estuary was clarified.

10) The soil borings revealed a sequence of soil accumulated up to about 20m below the seabed around the access channel; soft silt/clay to silty clay with a trace of sand overlaid with loose fine sand.

11) Landsat data revealed a tendency of progress of the coastline, a flow-out pattern of river water and a distribution of relative turbid water.

Chapter 3 The Present Condition of Siltation in the Access Channel

(1) Long-term and Wide-ranging Changes in the Sea Bottom

The seabed contours of the Java Sea show that the Barito and Kapuas rivers were confluent at a point 100km offshore of the present river mouth during the glacial lowering of sea levels. The present fan-shaped bar can be understood to have been formed on this old seabed topography. Old charts prove that the coastline immediately west of mouth of the Barito River has advanced at an annual rate of more than 100 meters.

One of the most characteristic and important features of the bottom contours is the shallow banks formed to the west of the inlet of the channel between Spots Nos. 10,500 and 13,000. The upper bank extends into the channel and constitutes a submerged dam at around Spot No.12,300 behind which a fluid mud layer of about 2 meters in thickness covers the rest of the channel. An example of the longitudinal profile along the channel center line is shown in Fig. II-3.

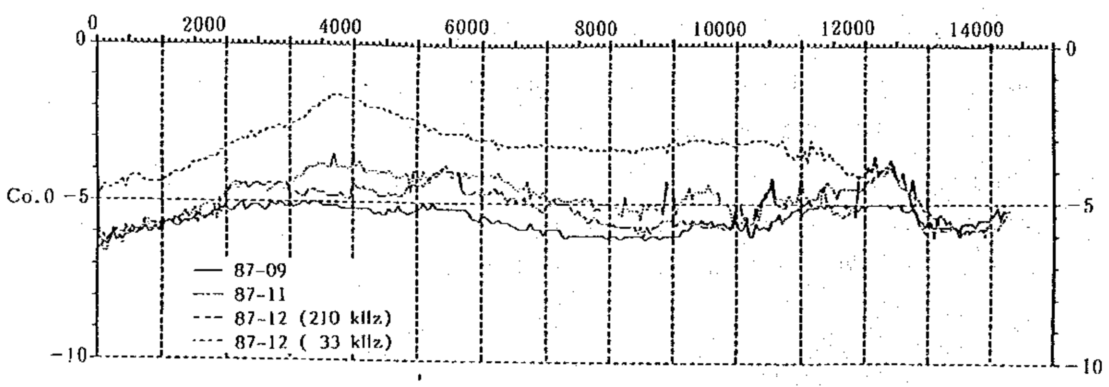


Fig. II- 3 Progress of Siltation along the Channel Center

(2) Siltation Volume of the Access Channel

Siltation volume during the capital dredging in 1975 and 1976 was estimated to be 3.5 million m^3 and in 1988 was revised to 5.26 million m^3 by Pacific Consultants International. The siltation rate measured from the past sounding records with 210 kHz echo sounders shows considerable variation monthly and annually, e.g., 240 to 860 thousand m^3 per month during March to June and more than 2 million m^3 per month during November to December.

(3) Characteristics of Siltation in the Access Channel

As far as siltation volume per unit length of the channel concerns, the most severe siltation occurs between Spots Nos. 4,000 and 9,000 and secondly Spots Nos. 9,250 and 12,500.

The vertical profile of fluid mud accumulating in the channel was revealed by the study team in 1990. After termination of dredging, the submerged dam is normally formed first and then the fluid mud layer developes at a speed of 2 to 3 cm/day.

Chapter 4 The Present Condition of Navigation Channel Dredging

(1) Related Organizations Involved in Maintenance Dredging

Maintenance dredging of the navigation channel is under the control of the Ministry of Communications(MOC), and many other organizations are also involved with the planning and execution of the dredging such as the Directorate General of Sea Communication (DGSC), the Regional Offices of MOC (KANWIL DEPHUB), the Perum Pengerukan (Perumpen) and the Perum Pelabuhan (Perumpel).

(2) Management and Operation of Maintenance Dredging

The main present allocation of functions of the five organizations concerning management and operation of maintenance dredging is summarized as follows:

Table II- 1 Present Allocation of Function for Management and Operation of Maintenance Dredging

Function \ Organization	MOC	DGSC	KANWIL	Perum Pengerukan	Perum Pelabuhan
Research on water depth requirements for all ports and entrance channels		✓	✓	✓	✓
Preparation of dredging programs for ports and channels		✓	✓		✓
Approval of dredging programs	✓	✓			✓
Calculation of dredging volume		✓	✓	✓	✓
Execution of dredging				✓	
Monitoring of dredging performance		✓	✓	✓	✓
Post dredging, water depth, and siltation surveys		✓	✓	✓	✓
Appointment of private companies for execution work				✓	
Coordination of dredging activities		✓	✓	✓	✓
Preparation of crew standards and equipment standards	✓	✓		✓	
Approval of new investment plans for equipment and installation	✓	✓			
Equipment preparation		✓		✓	
Budget preparation	✓	✓	✓	✓	✓
Budget approval	✓	✓		✓	✓
Budget control		✓		✓	✓
Administration of overall dredging activities		✓		✓	✓

(3) Dredging Equipment

The present dredging fleet of Perumpen consist of 13 trailing suction hopper dredgers, 3 cutter suction dredgers, 3 bucket dredgers and 8 grab dredgers. The total estimated capacity of the 27 dredgers is approximately forty million cubic meters per year.

Supporting equipment includes tugboats, hopper barges, water barges, fuel barges, crew barges, anchor boats, flat top barges, survey boats, communication boats, pontoons and discharging lines.

(4) Dredging Activities

Based on dredging requirements sent from several offices such as

Perumpel I to IV, KANWIL, etc., to the DGSC, the DGSC prepares dredging plans which are to be approved by BAPPENAS.

Dredging for navigation channels is the responsibility of the government (DGSC), and Perumpel is responsible for dredging in basins. Trailing suction hopper dredgers have played a major role, dredging nearly 90% of the total dredged volume in recent years.

Similar to other construction works, dredging operations are controlled in terms of quality, progress, safety and cost.

(5) Maintenance and Repairs

Most of the repairs and maintenance are being executed at Perumpen's own facilities at Tanjung Priok, Jakarta and Tanjung Perak, Surabaya. The repairs and maintenance of the underwater parts of working vessels beyond Perumpen's dock capacity are carried out at several shipyards owned by the state.

Chapter 5 Present Activities and Utilization of the Port

(1) Traffic of Vessels

There are seven types of vessel calling at Banjarmasin Port, i.e., oceangoing vessels (Samudera, O.G.), interisland vessels (Nusantara, I.I.), local vessels (Lokal, Loc.), sailing vessels (Rakyat, PL/PLM), specialized vessels (Khusus Industry, S.I.), tankers (Tank.) and pioneer vessels (Perintis).

Shipping service routes include domestic routes to/from Surabaya, Tg. Priok, Balikpapan, Semarang, etc. and foreign routes to/from Singapore, Hong Kong, etc.

Past records of the number of ship calls show that the number increased 5.1% p.a. for the past five years, but the ship size did not change in the same period, as shown in Tables II-2(1) and (2).

(2) Cargoes and Passengers

Cargo volume increased drastically at a rate of 11.3% p.a. during the said period, as shown in Table II-2(3). The major cargoes were plywood for export, asphalt for import, sawn timber for outgoing and fertilizer for incoming.

Containerization started in 1987 and the throughput grew rapidly and reached 4,180 TEU in 1989. Interisland passenger traffic also grew from around 60,000 psn in 1984 to 150,000 psn in 1989.

(3) Condition of Berthing

Ships that entered the channel were those up to 6,000 GRT due to the limited depth of the channel. Larger ships are urged to stay in offshore basins.

(4) Present Navigational Safety Conditions

Conditions of the present navigational safety are not satisfactory. The number of accidents in the channel was not small, i.e., 21 for the past four and a half years, including wreckages, collisions, strandings, etc. The present arrangement and maintenance of navigational aids are also not adequate.

Table II- 2 Past Records of Shipping by Ship Type

(1) Number of Calls

Ship Type	1983	1984	1985	1986	1987	1988	1989
Oceangoing	206	216	340	435	424	423	617
Interisland	169	290	275	298	218	212	191
Local	993	1,044	787	950	1,081	1,096	973
Sailing	2,763	2,501	2,417	2,256	1,827	1,643	1,666
Special	595	591	2,131	2,774	3,713	4,411	2,565
Tanker	227	223	210	217	217	255	241
Total	4,953	4,865	6,160	6,930	7,480	8,040	6,253

(2) Average Ship Size (GRT/Ship)

Ship Type	1983	1984	1985	1986	1987	1988	1989
Oceangoing	6,500	8,300	5,900	8,100	7,900	7,500	5,500
Interisland	1,750	1,100	700	1,400	1,200	1,000	940
Local	140	140	110	170	150	160	190
Sailing	100	100	90	130	100	100	120
Special	600	550	230	340	330	330	610
Tanker	1,000	1,100	1,000	1,000	1,000	1,000	1,300

(3) Total In and Out Cargo Volume

(x 1,000 ton/m^3)

Ship Type	1983	1984	1985	1986	1987	1988	1989
Oceangoing	764	727	-	1,042	1,153	1,156	1,142
Interisland	143	174	-	137	207	241	321
Local	132	181	-	243	252	256	504
Sailing	570	646	-	746	558	577	797
Special	278	53	-	487	473	445	208
Tanker	308	290	(303)	243	261	280	276
Total	1,993	2,074	(2,340)	2,894	2,902	2,954	3,548

Chapter 6 Dredging Operation at the Access Channel of Banjarmasin Port

(1) Related Oganizations

The maintenance dredging at the access channel of Banjarmasin is executed by the DIP, and work performed by the related organizations is shown as follows:

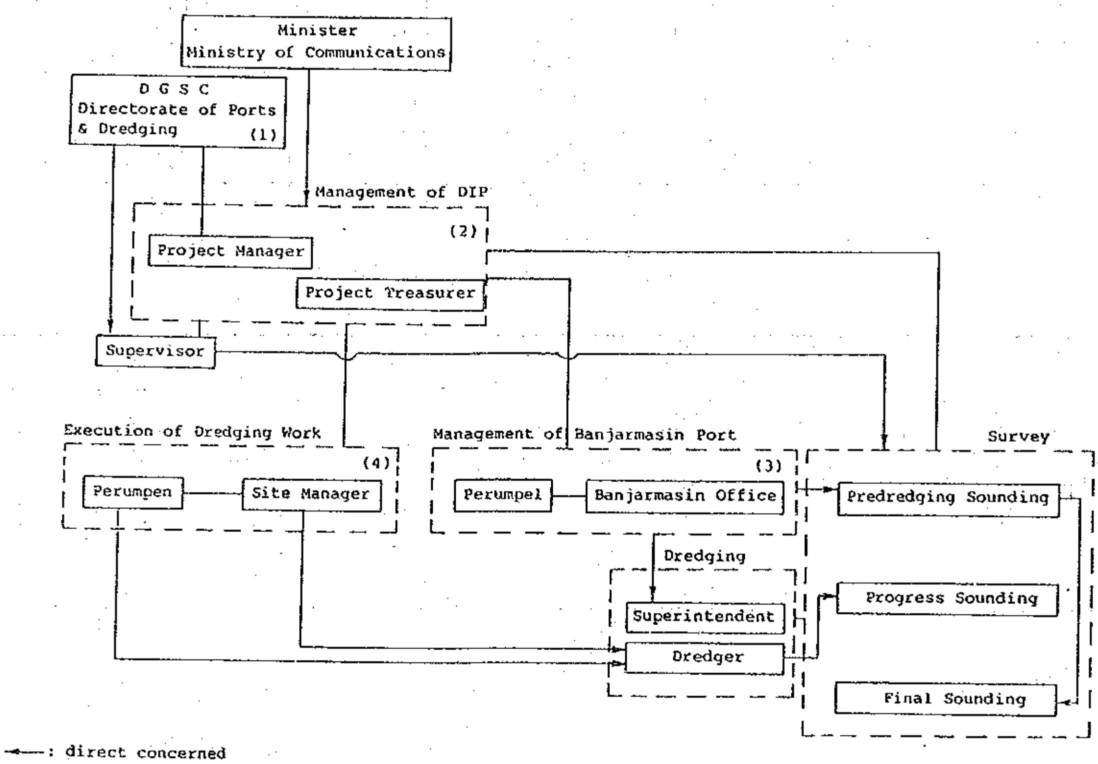


Fig. II- 4 Related Organizations of the Maintenance Dredging at Banjarmasin

(2) Management and Operation

1) Instructions for Execution of Dredging Work

The related organizations have executed the maintenance dredging according to the New Instruction of the DGSC of Development and Controlling of Dredging Work of Navigation Channels and Basins (No. PP. 74/1/6-90 10 April 1990).

2) Dredging Contract

The implementation of maintenance dredging has been carried out by

Perumpen exclusively without tendering a contract. However, the tender of contract for dredging including private companies financed by DIP or Perumpel will start in April 1991 according to Ministry of Communications Decree No.KM.20A 1989.

3) Dredging Budget

The maintenance dredging for the access channel of Banjarmasin is ranked as a top priority project. However, in recent years, maintenance dredging at Banjarmasin has been executed using funds from Perumpel and from foreign countries.

(3) Dredging Equipment

Nine trailing suction hopper dredgers, comprising four separate types of dredger as defined by capacity, have been utilized in the maintenance dredging in the access channel of Banjarmasin Port.

(4) Record of Dredging Activities

Capital dredging in this channel was carried out by a Japanese cutter suction dredger from September 1975 through to September 1976. The actual dredged volume reached twice the estimated volume of 6.3 million cubic meters due to siltation during operations. The annual dredging volume in recent years ranged between around 2.0 million cubic meters and 3.6 million cubic meters.

The semi-capital dredging under the ADB loan was carried out from June 1988 to February 1989. It can be said that hopper dredging was most frequent at the west side of the channel and agitation dredging was executed at the center of the channel most frequently. It seems that the present capacity of Perumpen's trailing suction hopper dredgers is around 70% of the standard estimated capacity in case of maintenance dredging in this channel.

According to the past daily report of dredgers operated in the channel, the main reasons for non-operation are:

- frequent cleaning of sea chest
- not sailing due to low tide
- waiting for the sailing of other vessels

(5) Dredging Execution

The depth of the channel before maintenance dredging usually ranges from 2 m to 4 m below LWS. Therefore, agitation dredging is necessary to secure the navigation of the dredger itself. Following this agitation dredging, normal dredging operations take place. That is, the dredged material is poured into the hopper and the dredger sails to the dumping area and dumps it at a fixed dumping area located around 4.5 km southward from the entrance of the channel.

(6) Maintenance and Repairs

There is no repair facility for dredgers around Banjarmasin and dredgers must sail to Surabaya, the nearest place to Banjarmasin where Perumpen has its own repair facility and where there are also big shipyards, when repairs are necessary.

PART III STUDY ON THE ACCESS CHANNEL PLAN AND MAINTENANCE DREDGING DEVELOPMENT MEASURES

Chapter 1 Channel Planning

(1) Socio-eocnomic Framework

The population of the hinterland, i.e., 2,762 thousand in 1985, is projected to increase up to 3,500 thousand in 1995 and 3,800 thousand in 2000.

The growth rate of the GRDP in the hinterland is forecast to be 3.9-4.9% p.a., 4.1-5.5% p.a. and 4.9-5.7% p.a. in 1985-1990, 1990-1995 and 1995-2000, respectively.

(2) Future Cargo Forecast

Based on the above projections of population and GRDP, past trends and correlations between cargo volume and economic indices, commodity-wise cargo forecasts are made and the results are shown in Table III-1. It is expected that the total cargo volume will be 1.9 times and 2.5 times the 1989 volume in 1995 and 2000, respectively.

(3) Future Vessel Traffic Forecast

The forecast of the number of ships is made by type of ship, and the result is shown in Table III-2. The number is expected to be 1.5 times and 1.7 times the 1989 number in 1995 and 2000, respectively.

(4) Requirements for Channel Dimensions

The requirements for the channel are discussed from the planning viewpoint, and can be summarized as follows:

Number of lanes:	one
Night navigation:	to be allowed
Design ship:	6,500 GRT (10,000 DWT) class cargo vessels
Channel dimensions:	depth DL-6m, bottom width 100m, and side slope 1/8 - 1/10

Table III-1 Summary of the Projection of Future Cargo

Unit: thousands of tons/m^3

Item	Past		Records			Forecast	
	1985	1986	1987	1988	1989	1995	2000
I. Foreign							
1)Exports	737.3	771.4	966.8	1,009.2	1,402.6	2,523	3,146
2)Imports	33.4	50.7	39.3	31.0	39.5	67	92
Sub-Total	770.7	822.1	1,006.1	1,040.2	1,442.1	2,590	3,238
II.Domestic							
1)Outgoing	487.5	591.8	444.0	516.3	652.1	1,047	1,253
2)Incoming	1,082.1	1,480.5	1,452.2	1,397.2	1,453.8	3,147	4,370
Sub-Total	1,569.6	2,072.3	1,896.2	1,913.5	2,105.9	4,194	5,623
Total	2,340.3	2,894.4	2,902.3	2,953.8	3,548.0	6,784	8,861

Table III- 2 Forecast of the Number of Ship Calls

Year	Type of Ship	Volume Number (Th. ton) (Th. psn)	Average Volume (Ton/ship) (psn/ship)	Number of ships	
				Annual	Daily
1995	Oceangoing	2,780	3,740	743	2.04
	Interisland	706	2,600	271	0.74
	Local	598	600	997	2.73
	Sailing	794	500	1,588	4.35
	Special	1,598	280	5,707	15.64
	Tanker	309	1,300	238	0.65
	(Sub-Total)	(6,784)	(-)	(9,544)	(26.15)
	Passenger	198	2,500	79	0.22
	Total	-	-	9,623	26.36
2000	Oceangoing	3,547	4,500	788	2.16
	Interisland	934	3,000	311	0.85
	Local	779	640	1,217	3.33
	Sailing	933	510	1,829	5.01
	Special	2,327	380	6,124	16.78
	Tanker	340	1,600	213	0.58
	(Sub-Total)	(8,861)	(-)	(10,482)	(28.72)
	Passenger	233	2,500	93	0.26
	Total	-	-	10,575	28.97

Chapter 2 Alternative Siltation Reduction Plans

(1) Siltation Phenomena and their Causes.

Siltation phenomena and their causes are re-discussed based on the surveys and analyses, and summarized as follows:

a. Sedimentation due to saline wedges on the bank,

b. Shallow spit on the west bank and formation of a submerged dam in the channel at around Spot No. 12,300,

c. Erosion of the sea bed by current at areas upstream of Spot No. 11,000,

d. Siltation at the central portion of the channel due to the action of waves and currents,

e. Scouring and slumping by waves offshore of Spot No. 4,000 and

f. Gentle siltation in the area offshore from Spot No. 2,000.

(2) Alternative Plans for Siltation Reduction

The following alternative plans are selected for the discussions on the effects of siltation reduction:

1) Present conditions (Depth DL-6m, width 60m; No facility)

2) No facility plans

a. Principal plan (Depth DL-6m, width 100m)

b. Enlargement plan (Depth DL-8m, width 120m)

c. Trap plan (Depth DL-6m, width 120m and depth DL-5.5m, width 70m)

3) Training wall plan (Depth DL-6m, width 100m; Spot No. 9,900-13,000)

4) Long jetty plan (Depth DL-6m, width 100m; Length 6km)

5) Submerged wall plans

a. Short submerged wall plan (Spot No. 3,000 - 9,000)

b. Extended submerged wall plan (Spot No. 2,000 - 10,500)

c. Long submerged wall plan (Spot No.2,000 - 13,000)

d. Non-continuous submerged wall plan
(Spot No. 3,000 - 7,000 and 10,000 - 13,000)

e. Stage plans (Spot No. 3,000 - 7,000, and Spot No. 3,000 - 7,000 plus No. 10,000 - 13,000)

6) Comprehensive protection plan (Depth DL-6m, width 100m)

a. Training wall and submerged wall plan

b. Long jetty and submerged wall plan

7) Relocation plan (Depth DL-6m, width 100m; New N-S Alignment)

Chapter 3 Improvement of Navigational Safety and Countermeasures for Navigational Aids

(1) Improvement of Navigational Safety

Navigational problems in the existing channel can be classified as follows:

a. Mixed traffic of ocean-going vessels and small vessels,

b. Poor maneuverability of tugs and barges,

c. Rather strong cross current,

d. Insufficient width and depth of the channel, and

e. Others

For the improvement of navigational safety, the following measures are required:

a. Regular maintenance survey and dredging,

b. Navigational control,

c. Optimum arrangement and maintenance of navigational aids,

d. Communication system, and

e. Other back-up systems.

Other possible measures include a shore-based radar control system, port traffic signals, monitoring and advising by patrol boats, telecommunication systems, and special rules for towing vessels and fishing boats.

(2) Improvement of Navigational Aids

Navigational aids to be considered include:

a. Pair buoy system,

b. Synchronized lighting system,

c. Automatic lamp changer,

d. Solar battery system,

e. Leading lights,

f. Radar reflector, and

g. Radar transponder.

Chapter 4 Effective Management and Operation for Dredging

(1) Organization

The related organizations of the mainternance dredging have changed their functions and structure. KANWIL DEPHUB has become a unit of MOC and is subordinated and accountable to the Ministry. In a rationalization effort, the number of directorates at Perumpel and Perumpen has been reduced from four to three.

Considering the budgetary restraints, the related organizations should strongly express the necessity for proper maintenance dredging to the Central Government in order to ensure the safe navigation of channels from the viewpoint of the national economy.

(2) Maintenance and Supply of Equipment

Regular maintenance docking of some trailing suction hopper dredgers has not been carried out. The schedule of maintenance docking should be kept according to the regulations and the maintenance planning. Regular inspection and floating repairs have been decided upon by Perumpen and should be carried out regularly.

Procurement at Perumpen has been executed via the head office and thus requires much time. It is necessary to speed up procurement process and to introduce a computer system for maintenance and repairs, including the management of spare parts.

(3) Personnel and Training

Most of the personnel are concentrated at the head office and Tanjung Priok because only six years have passed since Perumpen was established in 1984.

A training program of Perumpen is being carried out using foreign funds. It is necessary to proceed with such large-scale training.

This is necessary not only for the personnel of Perumpen but also for the personnel of related organizations.

(4) Dredging Budget and Unit Price

There was a large difference in the dredging budget and volume between the planning and execution in PELITA IV.

It is necessary to secure the funds for execution of maintenance dredging in PELITA V for the safe navigation of channels.

The unit price of dredging is determined between the MOC and the DGSC according to the basic estimation of Perumpen, which is reviewed every years. There are many factors that influence the estimation of dredging cost which vary based on the conditions at each site. The dredging cost should be estimated considering the estimated output and the calculated working time of the dredger at each dredging site.

Chapter 5 Effective Technology for Dredging

In this chapter, effective technology is studied considering both a long time span aiming around the year 2000 and the present circumstances.

(1) Planning

1) Long-term Viewpoint

The most important factor for maintaining navigation channels is to know the nautical depth. In order to know the accurate depth of the sea bottom, sounding by dual frequencies such as 210 kHz and 33 kHz is always necessary and a cross check should be made by lead.

Dredging requirements are the first and the most fundamental data for planning. In order to make proper planning, the dredging requirements by area and by soil conditions are necessary.

2) Under the Present Circumstances

As the first step for effective planning, the accumulation of past dredging records and analyses of these data are necessary.

(2) Execution and Control of Dredging

1) Long-term Viewpoint

Trailing suction hopper dredgers are the most suitable, judging from various conditions of the channel. The draghead is the most crucial part for dredging efficiency and sometimes small attachments such as knives improve the output. A future draghead could be expanded outward near the sea bottom and the total width will be two or three times the present one. The dredging efficiency inevitably decreases towards the latter stages of the work. One method is to use a leveling blade to prevent the dropping of dredging efficiency to a minimum level.

Judging from the analyses of the dredging record of the initial stage of the semi-capital dredging, agitation dredging seems to be effective.

The present positioning system of a dredger indicates the position of the dredger and does not show the dredging location. Using the draghead position indicator is one of the best methods to determine the exact dredging location.

Throughout the world, control of the progress and quality of dredging execution is mainly carried out by echo soundings, so the rationalization of echo sounding is necessary.

2) Under the Present Circumstances

The spade for a draghead developed in Japan might be effective in the channel. The experimental dredging with the leveling blade in Japan showed good results.

In order to fully utilize the dredging capacity, the optimal operation meeting the different stages will be necessary.

It can be said that agitation dredging is effective at least at the area near the center line of the channel over a short period.

Preparing a turning basin in the middle of this narrow channel is the best way to reduce cycle time and non-productive time. The ratio of saved sailing distance to total sailing distance is calculated at around 14%.

If dredgers dump the dredged material at the east of the channel near the river mouth, the dumped material might be carried away by the southward stream during the ebb tides.

As the channel is located at the river mouth and has a length of 14 km, two tide poles should be set along the channel.

(3) Maintenance and Repairs

1) Long-term Viewpoint

A home docking system has been discussed in recent years by the ministries of Communication and Industry. Maintenance and inspection standards for dredgers made in Japan will contribute to the maintenance and repairs by Perumpen. It is recommended that Perumpen should aim at preventive maintenance.

2) Under the Present Circumstances

As the first step, all records of maintenance and repairs of each dredger are arranged and should be written in history sheets. It is correct that the dredging crew have been carrying out inspections and maintenance and repairs following maker's instruction manuals.

PART IV EFFECTS OF SILTATION COUNTERMEASURES IN THE ACCESS CHANNEL

Chapter 1 Hydraulic Model Tests

Three dimensional hydraulic model testing was conducted to examine the present siltation situation and estimate the effectiveness of countermeasure structures to reduce the deposit volume in the channel. The tests were carried out utilizing saltwater in the sea area and freshwater discharge from the river. The model layout is shown in Fig. IV-1.

The outline and findings of the tests are summarized as follows.

(1) Reproduction Tests of the Present Conditions

Test conditions were decided based on detailed examination regarding the field survey data. Test conditions were fundamentally based on the third general survey conducted in April 1989 because the present siltation situation was clarified during the field observation during the intermission in dredging work from March to May 1989.

The present hydraulic conditions such as the tide, tidal currents, surface currents and saline wedges were well reproduced in the model.

Upstream average currents toward the river mouth were observed within the channel especially in the lower layer both in the field and model. Strong upstream average currents were present in the area near the river mouth.

The main surface currents due to river discharge flowed toward the center of the east bank and a part of the main stream cross the channel toward the west in the offshore area.

Saline wedges reached the upstream beyond Banjarmasin Port in the dry season and stayed around the river mouth in the rainy season.

In the early stage of the sedimentation during the intermission in the dredging work from March to May 1989, a noticeable deposition forming a dam was observed in the part near the river mouth. Once this dam had formed, rapid deposition occurred in the part immediately downstream of the dam. In the offshore area, a high deposition rate was observed in the part ranging from 4km to 7km from the offshore outlet of the channel. The tracer tracking tests confirmed these aspects of the deposition except for the actual dam formation as shown in Fig. IV-2.

(2) Tests for Improvement Plans

Various improvement plans such as submerged walls, a training wall, an expanded channel width and new alignments were tested by means of tracer tracking tests.

Surface flow patterns did not change for the principal plan (widened channel) and submerged wall plans when compared with the present situation. The jetty and training wall plans showed changes in the current pattern in the vicinity of the structures.

The upstream average currents were strengthened in the channel by the improvement plans.

In the present channel, high tracer concentration was observed in the tests near Spot No. 6,500 as indicated in the field survey. Improvement plans relieved such high concentration accumulated in the channel.

Submerged wall and new alignment plans effectively reduced the tracer concentration accumulated in the channel.

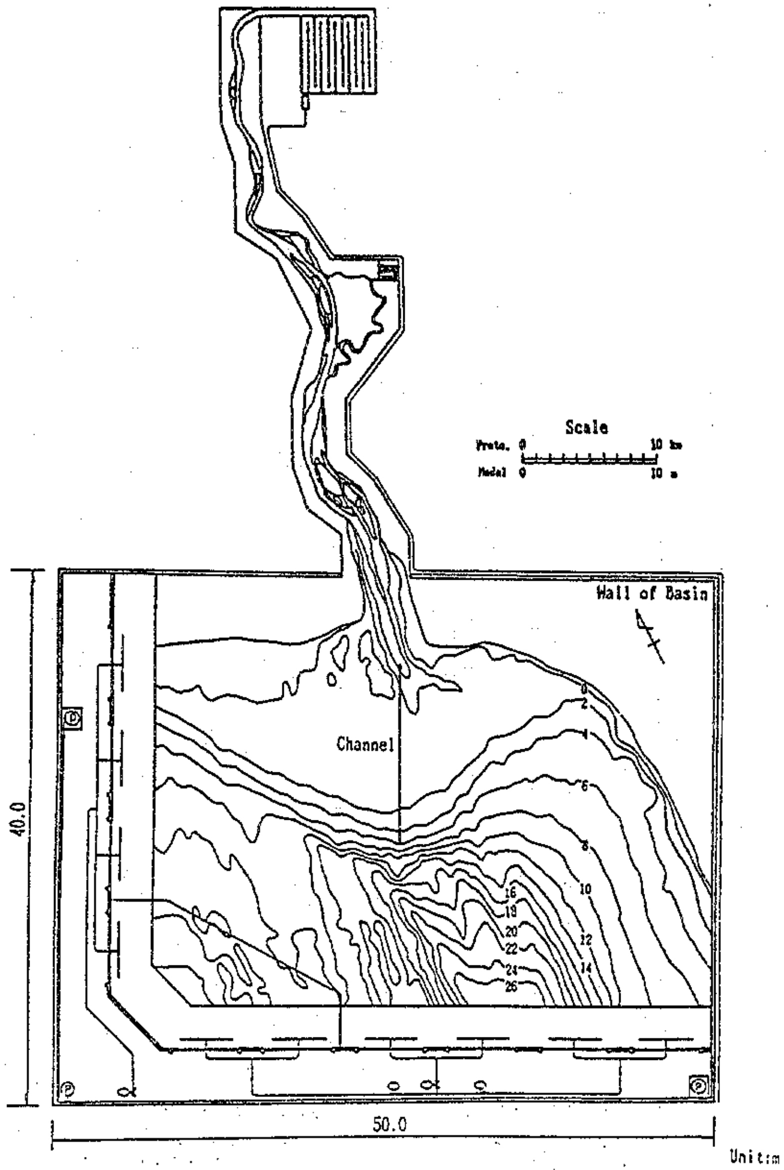


Fig. IV- 1 Layout of the Model

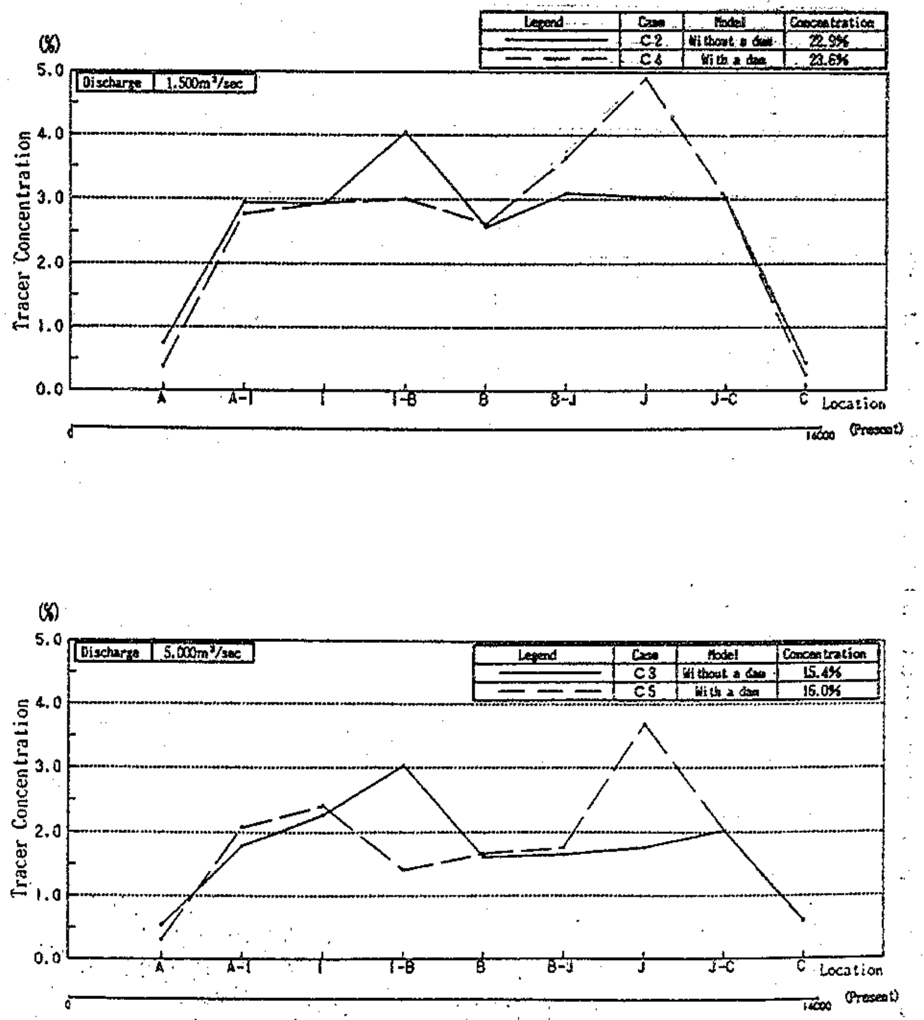


Fig. IV- 2 Concentration of Tracer in the Channel

Chapter 2 Laboratory Tests and Numerical Simulations

(1) Laboratory Tests of Bed Soil

Three kinds of tests are carried out to analyze the physical characteristics and behavior of in-situ mud in the Banjarmasin Channel:

a. Fluidity,

b. Erosion and deposition and

c. Settling and consolidation.

Various physical parameters such as the erosion rate and settling velocity are determined and applied to numerical simulations.

(2) Numerical Simulations

The numerical simulation employs a multi-layer three-dimensional level model taking account of erosion, diffusion, convection, transport and deposition of sediment due to currents and waves. The mesh map is shown in Fig. IV-3.

Calculations are performed for the following cases:

a. Present conditions,

b. Principal plan,

c. Submerged walls,

(Width, depth, height and arrangement are varied),

d. Training wall and submerged walls,

e. Trap,

f. Expansion plan, and

g. New N-S alignment.

for the rainy and dry seasons.

1) Comparison between Simulated and Actual Siltation

First, comparisons were made between the results of simulated and actual siltation in the present channel. They coincide quite well, as shown in Fig. IV-4.

2) Assessment of Siltation for Alternative Plans

Next, assessment of siltation volume was carried out for the above alternative plans. A result of comparison between the long submerged wall and principal plans is shown in Fig. IV-5.

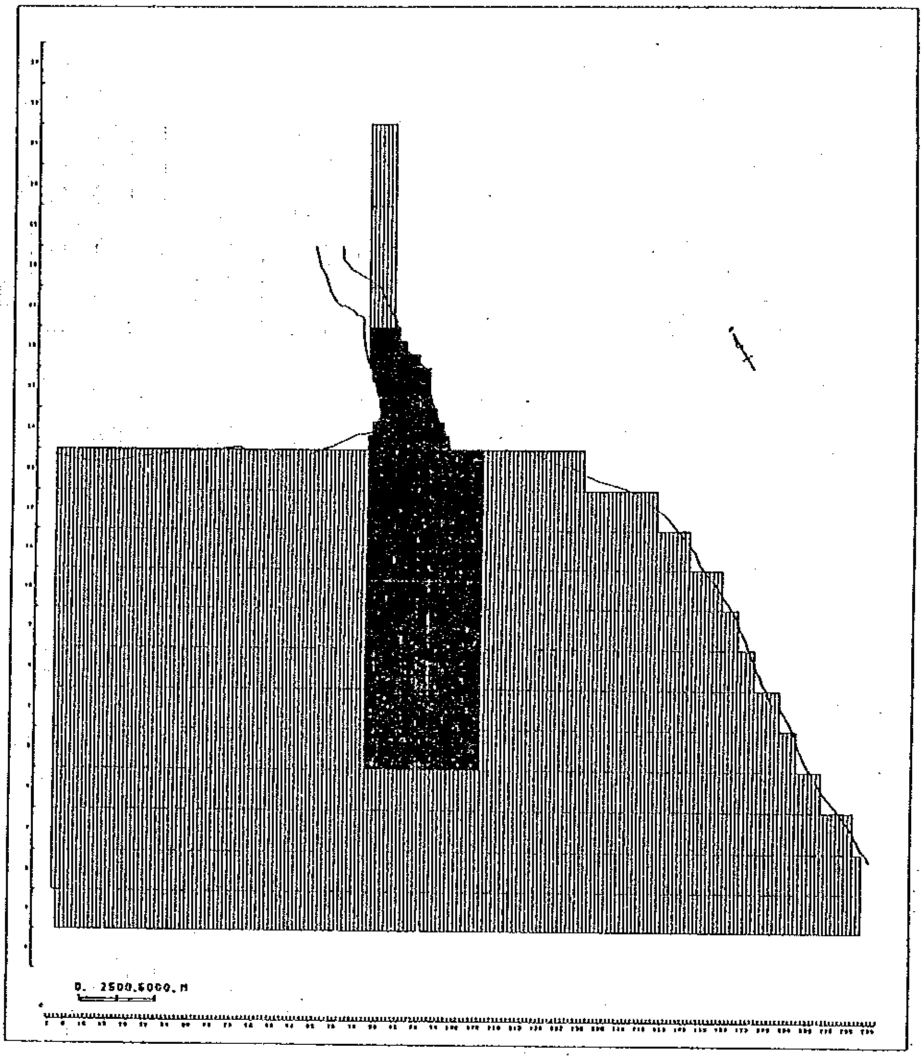


Fig. IV- 3 Mesh Map around the River Mouth

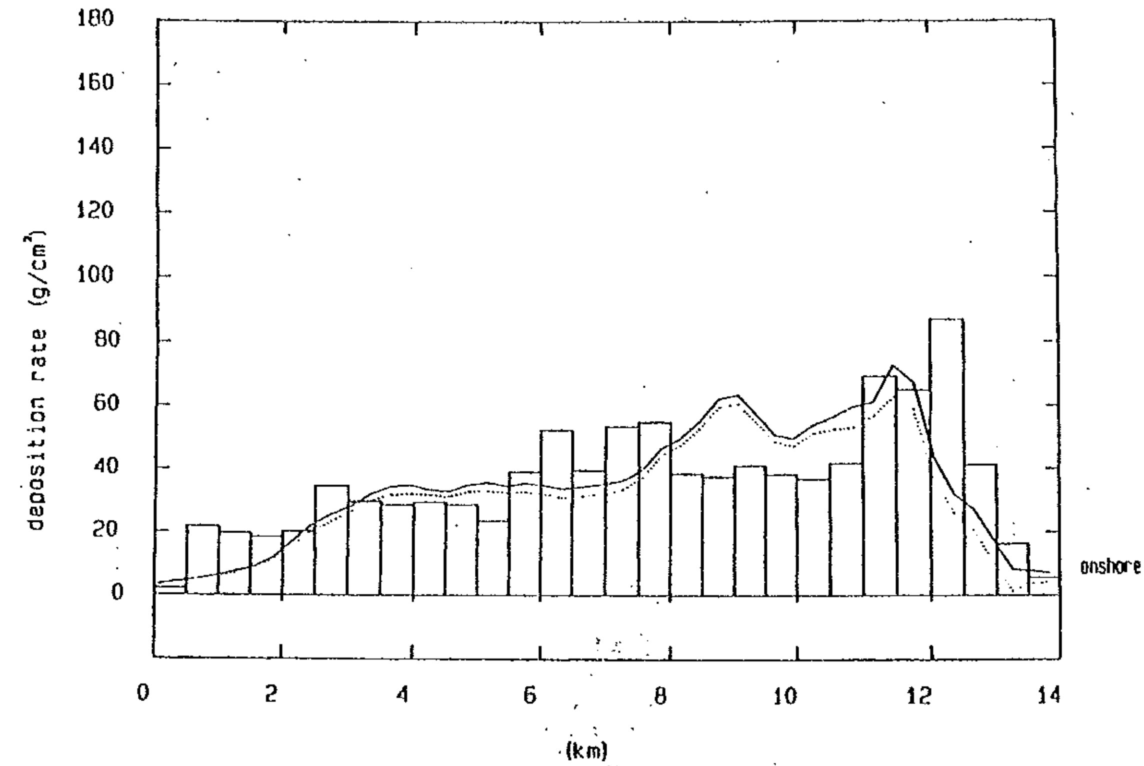


Fig. IV- 4 Actual and Simulated Siltation
(Discharge 3,500m^3/sec Case I-1)

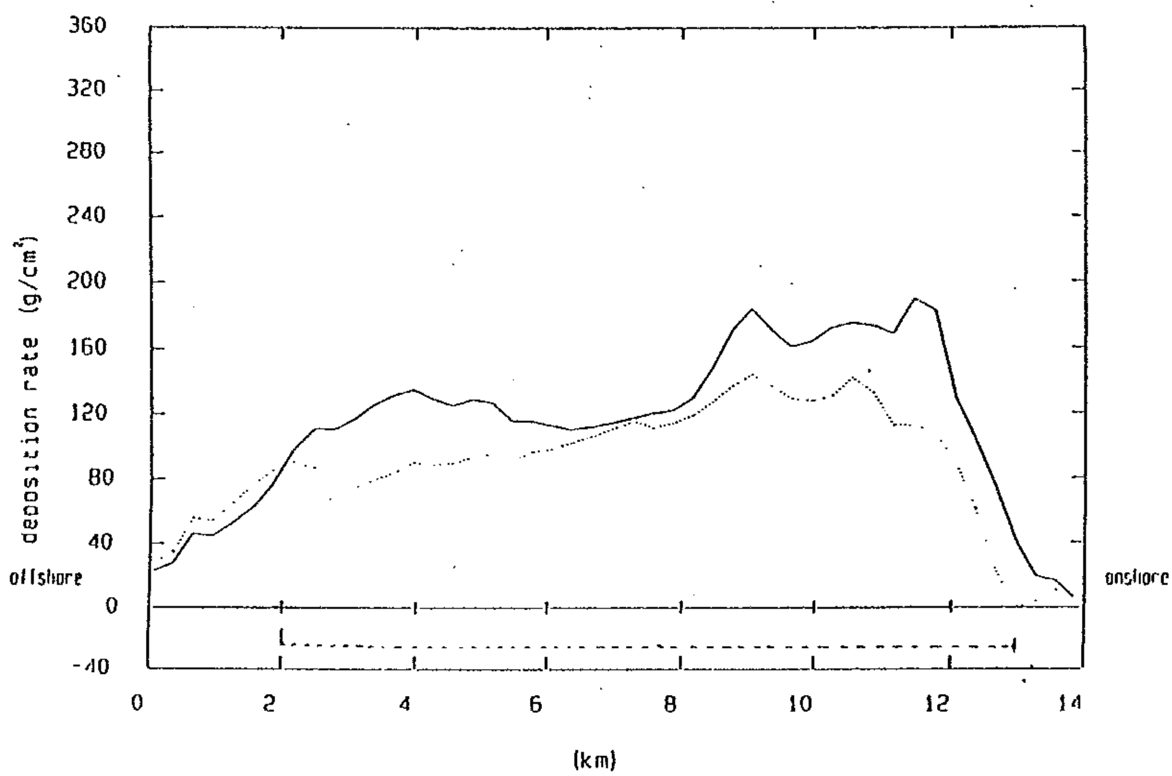


Fig. IV- 5 Effect of Submerged Walls (dotted line) and Principal Plan (solid line)
(Discharge: 5,000m^3/sec, Distance between Walls: 270m)

Chapter 3 Effects of Siltation Countermeasures

(1) Summary of the Results of Hydraulic and Numerical Tests

The results of siltation forecast by hydraulic model tests and numerical simulations are summarized in Tables IV-1 and 2, respectively.

(2) Effects of Widening and Deepening Channel

Siltation volumes for various channel sizes are estimated by extrapolating the results of the above simulations of the present channel and expanded channel, assuming that the siltation volume is exponentially proportional to depth and bottom width. The results are 4.0 million m^3 for depth -4m and bottom width 60m, 4.2 million m^3 for -6m and 60m (Present Condition), 5.1 million m^3 for -6m and 100m (Principal Plan), 5.9 million m^3 for -8m and 120m (Expansion Plan).

(3) Effects of Submerged Walls

The effect of submerged walls in terms of halting siltation is proportional to the wall-coverage ratio. It is, however, quite different in hydraulic and numerical tests: the former, which represents density-flow type phenomena had a much greater effect than the latter, which takes account of suspension-and-settling type phenomena. A way of combining the phenomena was developed, introducing a contribution of fluid mud derived by some assumptions and results of hydraulic tests, site survey and theoretical calculations. The revised volumes obtained are 2.3, 2.8, 2.9 and 3.5 million m^3/year for long submerged walls with wall distances (Channel width) of 180m (60m), 210m (100m), 270m (100m) and non-continuous case with 270m (100m), respectively. It is noted that, in case there is no submerged wall, the siltation volume becomes same as that of numerical simulation.

(4) Effects of Other Countermeasures for Siltation Reduction

The effect of a training wall is similar to the case of the submerged wall plan.

The effect of a long jetty is assessed by means of the so-called one-line theory. It is forecast that the eastward longshore transport will be cut considerably and the progress of the shoreline will be such that it will take about 40 years to reach the tip of the jetty. The effect of channel realignment in a north-south direction coincides with an effect of shortening the channel length.

(5) Variation of Siltation

The siltation volumes assessed above are the average volumes of annual siltation divided into the rainy and dry seasons. The annual variation of siltation is roughly estimated based on the result of numerical simulations and site surveys and could reach 45% or more.

Table IV- 1 Results of Siltation Forecast by Hydraulic Model Tests

(1) Ratio of Tracer Density for the Present Conditions

Case No.	River Discharge	Present Cond. ($3,500m^3/sec$)	Rainy Season ($5,000m^3/sec$)	Dry Season ($1,500m^3/sec$)	Remarks
C-1	$3,500m^3$	-	1.00 (2.66)*	1.00 (2.27)*	Without a dam
C-2	1,500				
C-3	5,000				
C-4	$1,500m^3$	-	1.06	1.03	Without a dam
C-5	5,000				
C-6	3,500				

*) Compared with the principal plan (D1)

(2) ratio of tracer Density Density for Improvement Plans

Case No.	Classification	River Discharge (m^3/sec)	Channel Depth and Width	Layout	Crown Height	Present Cond. ($3,500m^3/s$)	Rainy Season ($5,000m^3/s$)	Dry Season ($1,500m^3/s$)
D1-1	Principal Plan	1500	-6m, 100m	-	-	-	1.00	1.00
D1-2		5000						
D1-3		3500						
D2-1	Long Jetty	1500	-6m, 100m	6km	MWL	-	0.52	0.90
D2-2		5000						
D3-1	Submerged wall (3)	1500	-6m, 100m	SP. 2,000 -10,500	1m ab. sea bed	-	0.38	0.65
D3-2		5000						
D4-1	Submerged wall (1)	1500	-6m, 100m	SP. 3,000 -9,000	1m ab. sea bed	-	0.44	0.88
D4-2		5000						
D5-1	Submerged wall (2)	1500	-6m, 100m	SP. 3,000 -9,000	2m ab. sea bed	-	-	-
D5-2		5000						
D6-1	Jetty + Subm. Wall	1500	-6m, 100m	6km above(3)	MWL 1m	-	0.11	0.72
D6-2		5000						
D7-1	Training Wall	1500	-6m, 100m	SP. 9,900 -13,000	HWL 1m	-	0.76	0.94
D7-2		5000						
D8-1	Trap	1500	-6m, 170m	SP. 4,000 -13,500	-	-	0.30	0.80
D8-2		5000						
D9-1	New N-S Alignment (29°)	1500	-6m, 100m	-	-	-	0.21	0.59
D9-2		5000						
D9-3		3500						
D10-1	New N-S Alignment (48°)	1500	-6m, 100m	-	-	-	0.58	0.87
D10-2		5000						
E1-1	Non-Continuous Subm. Wall	1500	-6m, 100m	SP. 3,000 -7,000 SP.10,000 -13,500	1.5m ab. sea bed	-	0.38	0.73
E1-2		5000						
E1-3		3500						
E2-1	Subm. Wall During Construction(1)	1500	-6m, 100m	SP. 3,000 -7,000 SP.10,000 -13,500	1.5m ab. sea bed	-	0.50	0.73
E2-2		5000						
E3-1	Subm. Wall During Construction(2)	1500	-6m, 100m	SP. 3,000 -7,000	1.5m ab. sea bed	-	0.61	0.97
E3-2		5000						

Table IV- 2 Results of Siltation Forecast by Numerical Simulations

(Unit: million m^3)

Case No.	Classification	River Discharge (m^3/sec)	Channel Depth and Width	Layout	Crown Height	Present Condition	Rainy Season	Dry Season	Annual Total
I-1 I-2 I-3	Present Condition	3,500 5,000 1,500	-6m 60m	- - -	- - -	0.8<1.00>	2.7<1.00>	1.5<1.00>	4.2<1.00>
II-1 II-2	Principal Plan	5,000 1,500	-6m 100m	- -	- -	-	3.3<1.22> (1.00)	1.8<1.21> (1.00)	5.1<1.21> (1.00)
III	Submerged Wall (1)	5,000	-6m 100m	Sp. 3,000 -9,000	1m ab. sea bed	-	2.9(0.89)	-	-
IV	Submerged Wall (2)	5,000	-6m 100m	Sp. 2,000 -10,500	1m ab. sea bed	-	2.9(0.88)	-	-
V	Submerged Wall (3)	5,000	-6m 100m	Sp. 2,000 -13,000	1m ab. sea bed	-	2.7(0.82)		
VI-1 VI-2	Submerged Wall (4)	5,000 1,500	-6m 100m	Sp. 2,000 -13,000	1.5m ab. sea bed	-	2.5(0.77) 2.4**(0.75)	1.4**(0.75)	3.8**(0.75)
VII	Training Wall +Subm. Wall	5,000	-6m 100m	Sp. 2,000 -13,000	HWL+ 1m ab.s.b.	-	2.4(0.74)		
VIII	Trap	5,000	-6m 180m	Sp. 4,000 -13,500	-	-	3.0(0.92)		
IX	Expansion Plan	5,000	-8m 120m	- -	- -	-	3.8(1.15)		
X-1 X-2	New N-S Alignment	5,000 1,500	-6m 100m	- -	- -	-	2.8(0.85) <1.03>	1.6(0.87) <1.06>	4.4(0.86) <1.04>
XI-1 XI-2 XI-3	Present Con. + submerged Wall (4)	3,500 5,000 1,500	-6m 100m	Sp. 2,000 -13,000	1.5m ab. sea bed	*0.6<0.74>	1.9*<0.71>	1.1*<0.73>	3.0*<0.71>
XII-1 XII-2	Non-continuous Subm. Wall (4)	5,000 1,500	-6m 100m	Sp. 2,000 -6,000 Sp.10,000 -13,000	1.5m ab sea bed	-	2.7(0.81)	1.6(0.85)	4.2(0.83)

Notes *) Distance between walls: 180m
**) Distance between walls: 210m, the others are 270m,

PART V EVALUATION OF ALTERNATIVE PLANS

Chapter 1 Siltation Reduction Plans

(1) Viewpoint of Channel Planning

1) Planning Bases

There are three considerations involved in channel planning when evaluating siltation reduction plans: whether they satisfy traffic demands and planning criteria, allow future expansion and secure navigational safety. Plans to be disregarded are those for a channel depth of less than -6m and for a channel width less than 100m. The submerged wall plan with a narrow distance between the walls distance has disadvantages in terms of future expansion and navigational safety.

2) Navigational Safety

Requirements and allocation of navigational aids are discussed for the present channel, with and without submerged walls, and new N-S alignments, including improvement of leading lights, a fairway buoy, channel buoys and marking lights for submerged walls.

3) Environmental Impact

Serious problems are not anticipated for any of the alternatives from the environmental point of view.

(2) Prevention of Siltation

Judged only from the viewpoint of prevention and reduction of siltation, relatively advantageous countermeasures are the various Submerged Wall Plans and the New N-S Alignment Plan. The Non-continuous Submerged Wall Plan is considered to be a part of the Continuous Submerged Wall Plan. The Long Jetty Plan and Expansion Plan are considered most suitable and possible after the year 2000. The difference of the effects of submerged wall distances between 210m and 270m is not substantial and 240m can be another alternative. Other technical consideratons include improvement of dredging efficiency in relation to siltation reduction facilities and technical problems and reliability. The possible alternatives for further discussion are summarized and re-numbered in Table V-1.

Table V-1 Candidate Alternatives and Estimated Siltation Volume

(Million m^3/year and ratio in ( ))

Case No.	Classification	Distance Between Walls	Annual Siltation Volume
II.	Principal Plan	-	5.1 (1.0)
III-2	Submerged Walls	210m ~225m	2.8 (0.55)
-3	Submerged Walls	240m	2.9 (0.55)
IV.	New N-S Alignment	-	4.4 (0.86)

The Principal Plan is not technically difficult, but has very large siltation volume. The Submerged Wall Plans give the highest siltation reduction effect. Possibility of accumulation and/or erosion of the seabed beside the wall should be considered in the detailed design. The New N-S Alignment has medium siltation volume. It is necessary, however, to consider additional volume because of anticipated large scale erosion of the surrounding seabed.

(3) Dredging Viewpoint

Concerning the four alternatives selected as countermeasures, evaluations are made from the point of view of dredging.

1) Principal Plan (Case No.II)

Widening of the channel is required and a cutter suction dredger will be necessary. This type of dredger will hinder the navigation of other vessels during dredging.

2) Submerged Walls (Case No.III)

Concerning the plan for submerged walls between 210 m and 225 m apart (Case No.III-2), the estimated annual siltation volume is estimated at the lowest of all the cases. If side-casting dredging which dumps soils beyond submerged walls can be carried out, the efficiency of side-casting dredging will greatly increase and the total dredging efficiency will also remarkably increase. The features of this plan also apply to the plan of submerged walls 240 m apart (Case No.III-3).

3) New Alignment (Case No.IV)

Capital dredging will be carried out by a big cutter suction dredger. The alignment of the channel is similar to the direction of the predominant current, so agitation dredging will not be efficient.

(4) Rough Cost Estimates

The initial costs for the candidate alternatives of siltation reduction plans, including capital dredging, siltation reduction facility and navigational aids, are shown in Table V-2.

Table V-2 Costs of Siltation Reduction Plans

Case No.	Classification	Channel Depth and Width	Layout	Crown Height, Width	Annual Siltation Volume (mill.m^3)	Total Dredging (A) (000US$) (mill.Rp)	Total Facility (B) (000US$) (mill.Rp)	Navi. Aid (C) (000US$) (mill.Rp)	Grand Total (A)+(B)+(C) (000US$) (mill.Rp)
II	Principal Plan (PP)	-6m 100m	Present Alignment	No Facilities	5.1	9,820 18,157	-	1,126 2,081	10,945 20,238
III -2	Submerged Wall (C2)	-6m 100m	Sp. 2,000 -13,000	1.5m 210m	2.8	8,128 15,028	30,334 56,087	981 1,815	39,443 72,930
III -3	Submerged Wall (C3)	-6m 100m	Sp. 2,000 -13,000	1.5m 240m	2.9	8,177 15,120	30,334 56,087	981 1,815	39,493 73,022
IV	New N-S Alignment (NA)	-6m 100m	N-S Direction	No Facilities	4.4	29,366 54,297	-	1,078 1,992	30,443 56,290

Chapter 2 Dredging Efficiency Improvement Plans

(1) Dredging Methods

1) Appropriate Method

Judging from the present conditions of the channel such as soil, climate, meteorology, sailing vessels, fuel oil supply, fresh water supply, profile, dumping area, etc., trailing suction hopper dredgers are most suitable for maintenance dredging of the channel.

2) Making the Turning Basin

Trailing suction hopper dredgers with 2,900 m^3 and 4,000 m^3 hopper capacity will reduce its sailing distance by 14.2%, so dredging efficiency will increase by 16.5% in the case of making a turning basin.

3) Attachments to Dragheads

The mean concentration ratio of IRIAN JAYA during the semi-capital dredging is around 47%. Other dredgers will increase their concentration ratio to the level of 47% by attaching spades to the dragheads.

4) Tugboat Equipped with a Blade

Using a tugboat equipped with a blade might be necessary to support maintenance dredging by a trailing suction hopper dredger. It is difficult to estimate the dredging improvement efficiency quantitatively. However, it is expected that dredging efficiency will increase by around 5% by using a tugboat with a blade.

5) Draghead Position Indicator System

Dredging efficiency will be increased by installing a draghead position indicator system, and thus the number of bathymetric surveys required will decrease.

6) Agitation Dredging and Side-casting

It is not clear whether the agitation dredging method is effective or not, because the behavior of material dumped following agitation dredging is unknown. However, it can be said that agitation dredging is effective at least over a short period, because a trailing suction hopper dredger can operate safely after agitation dredging.

In the case where a dredger can side-cast the dredged material beyond submerged walls, it is expected that re-siltation of the dumped material will be greatly reduced due to submerged walls. However, there will be some problems regarding this method.

7) Others

The annual siltation volume in this channel is large, so it is necessary that one dredger is always dredging throughout the year. It is preferable to dredge the entire length of the channel totally step by step.

If it is found that dumping near the river mouth in the east is effective by trials, it might be effective to dump there during ebb tides especially when the dredging area is near the river mouth.

(2) Dredging Equipment

The spade can be easily attached to the present dragheads. The tugboat equipped with a blade will be necessary to contribute to better operation by a trailing suction hopper dredger. The draghead position indicator system will be installed in a trailing suction hopper dredger.

(3) Dredging Control and Survey

1) Dredging Control

There are four elements in the control of the dredging works: quality, progress, safety and cost. Some instruments such as flow, concentration and draft meter are useful. A personal computer will be very useful in controlling the daily dredging operation.

2) Survey

It is necessary to set two tide poles along the channel near Spots Nos. 5,000 and 10,000 for bathymetric survey. One new platform will be constructed in the east part of the river mouth so that the accurate positions of a survey boat and a dredger can be known. One survey boat that can sail quickly and steadily will be required, and complete survey instruments will be installed in the survey boat.

(4) Rough Cost Estimates

The costs of making the turning basin for each siltation reduction plan are shown in Table V-3.

Table V-3 Costs of Making Turning Basin

Case No.	Classification	Channel Depth and Width	Layout	Crown Height, Width	Annual Siltation Volume (mill. m^3)	Turning Basin Additional Volume ($000m^3$)	Unit Cost (US$) ($/m^3$)	Total (000US$) (mill.Rp)
II	Principal Plan (PP)	-6m 100m	Present Alignment	No Facilities	5.1	40	1.73	69.2 127.9
III-2	Submerged Wall (C2)	-6m 100m	Sp. 2,000 -13,000	1.5m 210m	2.8	40	1.73	69.2 127.9
III-3	Submerged Wall (C3)	-6m 100m	Sp. 2,000 -13,000	1.5m 240m	2.9	40	1.73	69.2 127.9
IV	New N-S Alignment (NA)	-6m 100m	N-S Direction	No Facilities	4.4	50	2.57	128.7 237.9

The costs of the dredging equipment and other machinery are shown in Table V-4.

Table V-4 Costs of Dredging Equipment and Machinery

Unit: thousands of US$

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL
Dredging Equipment				
Tug Boat with a Blade & Survey Equipment				742.6
Tug Boat with a Blade (700PS)	Nos.	1	713.8	713.8
Echo Sounder (210KHZ/33KHZ)	Nos.	1	28.8	28.8
Survey Boat				656.8
Survey Boat (FRP, 20 knots Max.)	Nos.	1	480.4	480.4
Positioning System	Nos.	1	137.3	137.3
Echo Sounder (210KHZ/33KHZ)	Nos.	1	28.8	28.8
Data Processing System	L.S.	1	10.3	10.3
Spade for Draghead	Nos.	8	1.72	13.7
Draghead Position Indicator	L.S.	1	274.5	274.5
Survey Platform	Nos.	1	6.9	6.9
Personal Computer	Nos.	1	3.4	3.4
Tide Pole	Nos.	2	0.34	0.7
Hopper Dredger Remodeling	Nos.	1	14,687.2	14,687.2
Total without Hopper Dredger Remodeling				1,698.6 (mill. Rp.) 3,140.8
Total with Hopper Dredger Remodeling				16,385.8 (mill. Rp.)30,297.4

Chapter 3 Rough Economic Comparison

The purpose of the economic comparison in this chapter is to roughly evaluate the alternatives and to help determine the comprehensive plan from the economic point of view. It is to be noted that hereinafter the IRR's are calculated without economic pricing.

(1)Channel Plans

The cases analyzed here are as follows:

Table V-5 Cases for Comparison of Channel Size

Case	Depth	Width	Annual Maintenance Dredging Volume	Remarks
"Without" Case	-4m	60m	4.0 Million m^3	Actual Condition
Case A	-6m	100m	5.1 Million m^3	Principal Plan
Case B	-8m	120m	5.9 Million m^3	Expansion Plan

1) Benefits

The difference between the waiting time and its cost of the ships in the "With" and "Without" cases is considered as a benefit of enlarging the channel.

2) Evaluation

The internal rate of return (IRR) of the cases are shown in Table V-6.

Table V-6 Internal Rate of Return of Each Channel Size

Case	IRR
Case A (Depth -6m, Width 100m)	33.2%
Case B (Depth -8m, Width 120m)	13.3%

Judging from the above figures, Case A is the best alternative for the channel planning.

(2) Siltation Reduction Plans

The cases analyzed here, are shown in Table V-1.

1) "Without" Case

Case II is assumed as the "Without" case in this comparison.

2) Benefits

The savings on the maintenance dredging cost is assumed as the benefit of the siltation reduction plans.

3) Evaluation

The internal rate of return of the cases are shown in Table V-7.

Table V-7 Internal Rate of Return of Each Siltation Reduction Plan

Case	Case III-2	Case III-3	Case IV
IRR	8.5%	8.1%	3.4%

The submerged wall plans (Case III-2 and III-3) have substantial values of IRR.

(3) Dredging Efficiency Improvement Plans

It is assumed that the increase of the dredging efficiency will save the dredging cost proportionally. This is the benefit of the dredging efficiency improvement plans.

1) Effects of Dredging Efficiency Improvement Plans

The effects of each dredging efficiency improvement plans in case of Principal Plan are shown in Table V-8.

Table V-8 Effects of Dredging Efficiency Improvement Plans

(Unit: Thousands of US $)

Item	Making Turning Basin	Attachments to Dragheads	Tugboat Equipped with a Blade
Initial Cost	69	14	743
Increase in Dredging Efficiency	16.5%	13.8%	5%
Annual Benefit in Year 2000	624	534	210
Total Benefits -Total Costs Through Project Life	29,791	25,123	7,802

2) Side-casting

The effect of side-casting is estimated such that it will increase the efficiency of the maintenance dredging by 117% in Case III-3.

The internal rate of return of this investment becomes 3.4% based on the above assumptions.

3) Effects of Total Dredging Efficiency Improvement Plans

The effect of the total dredging efficiency improvement plans is estimated that it will save the dredging cost by 22% in Case II. The internal rate of return of the total dredging efficiency improvement plans becomes 42% based on the above assumptions. It is obvious that this investment is very good from the economic viewpoint.

Chapter 4 Selection of Alternative Plans

(1) Siltation Reduction Plan

The evaluations are based on the above discussions from planning, technical and economic viewpoints summarized in Table V-9. From the general point of view the Submerged Wall Plan (III-3) is considered the most promising candidate for the Comprehensive Plan, while the non-continuous submerged wall is set down as a stage plan of the continuous plan.

Table V- 9 Evaluation of Candidates for Siltation Reduction

Case No.	Classification/ Kind of Siltation Countermeasures	Bottom Width B (m)	Wall Distance W (m)	Planning			Technical			Economic
				Traffic Demands and Criteria	Navigation Safety	Future Expansion	Decrease of Siltation Volume	Improvement of Dredging Efficiency	Problems and Reliability	Cost Effectiveness
II	Principal Plan	100	-	+	+	+	-	-	+	
III-2	Submerged Walls	100	210 -225	+	-	-	+	+	0	+
3	ditto	100	240	+	0	+	+	0	0	+
IV	New N-S Alignment	100	-	+	+	+	-	-	-	-

Notes: + (very good), 0 (good), - (poor)

(2) Dredging Efficiency Improvement Plan

From the technical and economical viewpoints, the dredging efficiency improvement plan is:

a. Making a turning basin in the middle of the channel
b. Fixing spades to dragheads
c. Constructing a tugboat equipped with a blade and survey equipment
d. Installing a draghead position indicator in a dredger
e. Using devices such as flow, concentration and draft meters
f. Installing a personal computer on site
g. Carrying out sounding by dual frequencies such as 210 kHz and 33 kHz with cross-checking by lead
h. Setting two tide poles along the channel near Spots Nos. 5,000 and 10,000
i. Constructing a new platform for surveying in the east part of the river mouth
j. Constructing a fast survey boat equipped with complete survey instruments

PART VI THE COMPREHENSIVE PLAN

Chapter 1 Channel and Siltation Countermeasure Plans

(1) Target of the Comprehensive Plan

The target year of the Comprehensive Plan is 2000. Cargo throughput and ship traffic in 2000 are expected to be about 8.8 million tons/m^3 and 11,000 ships per year, respectively. The design ship passing the channel is 6,500 GRT (10,000 DWT) class cargo vessels.

(2) Channel and Siltation Countermeasure Plan

The channel alignment is the present one and its profile is 6m in depth, 100m in bottom width and 1/8 and 1/10 in side slope.

The channel is protected by 1.5m high long submerged walls from Spots Nos. 2,000 to 13,000 and 240m apart on the both shoulders.

(3) Navigational Safety Plan

Improved navigational aids are planned including two leading lights, one fairway buoy with racon, five channel buoys with radar reflectors and eight marking lights on the submerged walls. Other navigational safety measures are proposed along with procurement of a pilot boat.

The plan of the channel, submerged walls and navigational aids is shown in Fig. VI-1.

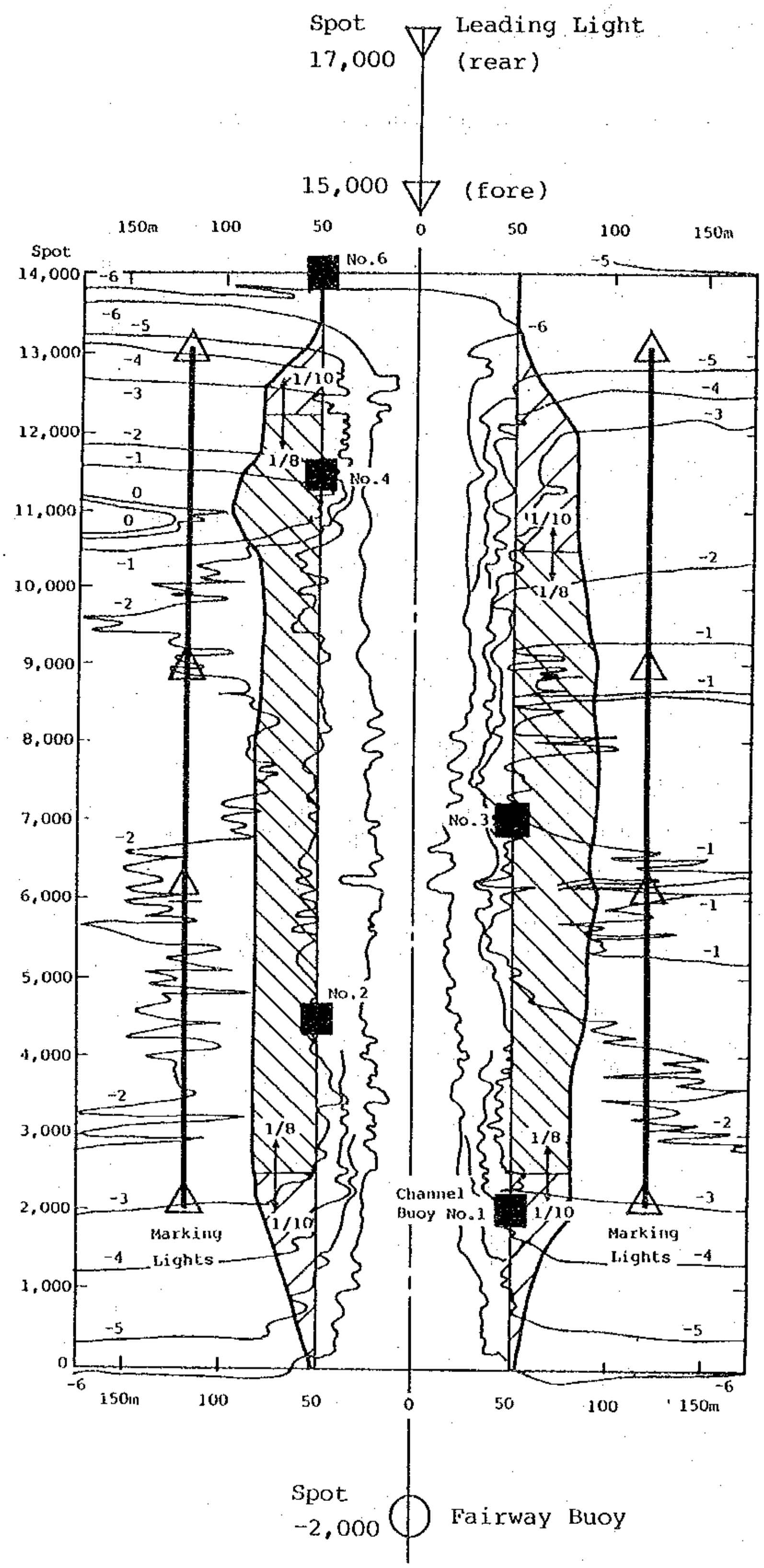


Fig. VI- 1 Arrangement of Submerged Walls and Navigational Aids (Comprehensive Plan)

Chapter 2 Dredging Plan

Firstly, widening and deepening the channel based on the design profile by trailing suction hopper dredgers and a cutter suction dredger of Perumpen is to be executed. Secondly, the channel should be maintained by trailing suction hopper dredgers of Perumpen to meet the design profile. Dredging efficiency improvement plans stated in Chapter 4 of PART V are to be carried out.

The estimated capacity after improvement by fixing spades to dragheads, making a turning basin and applying a tugboat equipped with a blade is calculated by multiplying the improvement efficiency by the capacity based on the records of the semi-capital dredging, etc. The estimated capacity after improvement of trailing suction hopper dredgers with a hopper capacity of 2,000 m^3 and 2,900 m^3 will be nearly the same as those with standard capacities. The estimated capacity after improvement of a trailing suction hopper dredger with a 4,000 m^3 will be around 85% of the standard capacity.

Chapter 3 Maintenance, Management and Operation Plans

(1) Maintenance and Management of Siltation Countermeasures

Regular surveys are required to check on conditions of the submerged walls and changes in the seabed in order to ensure continuing functioning.

(2) Maintenance and Reliability of Navigational Aids

Navigational aids should be selected, built, equipped and maintained such that they will be extremely reliable in ensuring continuity of services.

(3) Maintenance and Repair of Dredging Equipment

The crucial item is the supply of spare parts at present. It often happens that dredgers are idling just waiting for spare parts.

Preparation of history sheets of each dredger and supporting equipment showing the past maintenance and repairing records will be carried out. Various data will be collected to make maintenance and inspection standards for the Perumpen dredging fleet.

It is not clear whether a home docking system will be realized or not. If it is realized, Perumpen will follow this system. Perumpen plans to build its own shipyard in which it can maintain and repair all its own vessels in the future.

(4) Dredging Management and Operations

In order to effectuate the management and operation of maintenance dredging, the necessary improvements are suggested based on the following three points:

1) establishing a "core organization" within the MOC that will be responsible for maintenance dredging planning, administration and development,

2) establishing a monitoring system for maintenance and repair of dredgers including procurement of spare parts and materials, and

3) proceeding with large-scale training, not only for the personnel of Perumpen, but also for the personnel of related maintenance dredging organizations.

Chapter 4 Rough Cost Estimation

The project cost of the proposed Comprehensive Plan is shown in Table VI-1. The total project cost of the Comprehensive Plan is estimated at about 51 million US$ broken down into the foreign component of 37 million US$ (70% of the total) and the local component of 14 million US$ (30% of the total). About 60% of the total is for the submerged walls, 17% for the capital dredging, 3% for the dredging equipment and 2% for the navigational aids.

Table VI-1 Project Cost of the Comprehensive Plan

Unit: thousands of US$

ITEM	UNIT	QUANTITY	UNIT COST	FOREIGN	LOCAL	TOTAL	
[COMPREHENSIVE PLAN COST]							
Capital Dredging				0.0	8,552.0	8,552.0	16.7%
Dredging by Hopper	m^3	5,810,000	0.00081	0.0	4,713.4	4,713.4	
Dredging by Cutter	m^3	2,218,000	0.00173	0.0	3,838.6	3,838.6	
Submerged Walls	m	22,000	1.4	27,593.1	2,741.9	30,335.0	59.3%
Dredging Equipment				1,696.2	2.4	1,698.6	3.3%
Tug Boat(700PS)	Nos.	1	742.6	742.6	0.0	742.6	
Survey Boat	Nos.	1	656.8	656.8	0.0	656.8	
Spade for Draghead	Nos.	8	1.7	13.7	0.0	13.7	
Draghead Pos. Indicator	Nos.	1	274.5	274.5	0.0	274.5	
Survey Platform	Nos.	1	6.9	4.5	2.4	6.9	
Personal Computer	Nos.	1	3.4	3.4	0.0	3.4	
Tide Pole	Nos.	2	0.3	0.7	0.0	0.7	
Navigational Aids				982.8	152.7	1,135.5	2.2%
Leading Light Rear	Nos.	1	171.6	102.9	68.6	171.6	
Leadign Light Front	Nos.	1	178.4	109.8	68.6	178.4	
Fair-way Buoy	Nos.	1	86.5	82.4	4.1	86.5	
Channel Buoy	Nos.	5	24.5	116.7	5.8	122.5	
Sub. Wall Marking Light	Nos.	8	3.4	22.0	5.5	27.5	
Pilot Boat	Nos.	1	549.1	549.1	0.0	549.1	
Mob./Demob.	L.S.	1		686.3	53.2	739.5	1.4%
Engineering Services				1,725.0	928.8	2,653.8	5.2%
Detailed Desing	L.S.	1		690.0	371.5	1,061.5	
Superivision & Survey	L.S.	1		1,035.0	557.3	1,592.3	
Physical Contingency	L.S.	1		4,307.2	1,704.5	6,011.7	11.8%
Total				36,990.6 72.4%	14,135.5 27.6%	51,126.1 100.0%	100.0%

Chapter 5 Examination of Present Port Development Plan

(1) Demand and Facility Development

The result of this study is basically in accord with the present port development plan of Banjarmasin Port. The growth rate of cargoes at the Port in the past five years, however, has been higher than the projection made in the Review Master Plan in 1985.

It may be advisable to formulate a policy expediting the development of the facilities of the Port.

(2) Planning of Waiting Basin

According to the results of channel traffic simulations, it is necessesary to allocate two basins at the river mouth by the year 2000 for waiting ships.

PART VII THE FIRST-STAGE PLAN

Chapter 1 The Plan's Stages and the First-stage Plan

(1) Channel and Siltation Countermeasure Plan

Paying attention to careful implementation of the project, the first stage of the anti-siltation facility, i.e., the submerged walls, is set as non-continuous ones covering the most effective places from Spots Nos. 3,000 to 7,000, and 10,000 to 13,000. The target year of the First-stage Plan is 1995.

(2) Navigational Safety Measures

Navigational safety measures for the first stage include strengthening navigational control, purchase and installation of the navigational aids (the same number as stipulated in the Comprehensive Plan) and purchase of a pilot boat.

The plan of the channel's submerged walls and navigational aids is shown in Fig. VII-1.

(3) Dredging Plan

The dredging plan in the first stage is:

a. Widening and deepening the channel based on the design profile
b. Making a turning basin in the middle of the channel
c. Fixing spades to dragheads
d. Constructing a tugboat equipped with a blade and survey equipment
e. Installing a draghead position indicator in a dredger
f. Using devices such as flow, concentration and draft meters in a dredger
g. Installing a personal computer on site
h. Carrying out sounding by dual frequencies such as 210 kHz and 33 kHz with cross-checking by lead
i. Setting two tide poles along the channel near Spots Nos. 5,000 and 10,000
j. Constructing a new platform for surveying in the east part of the river mouth

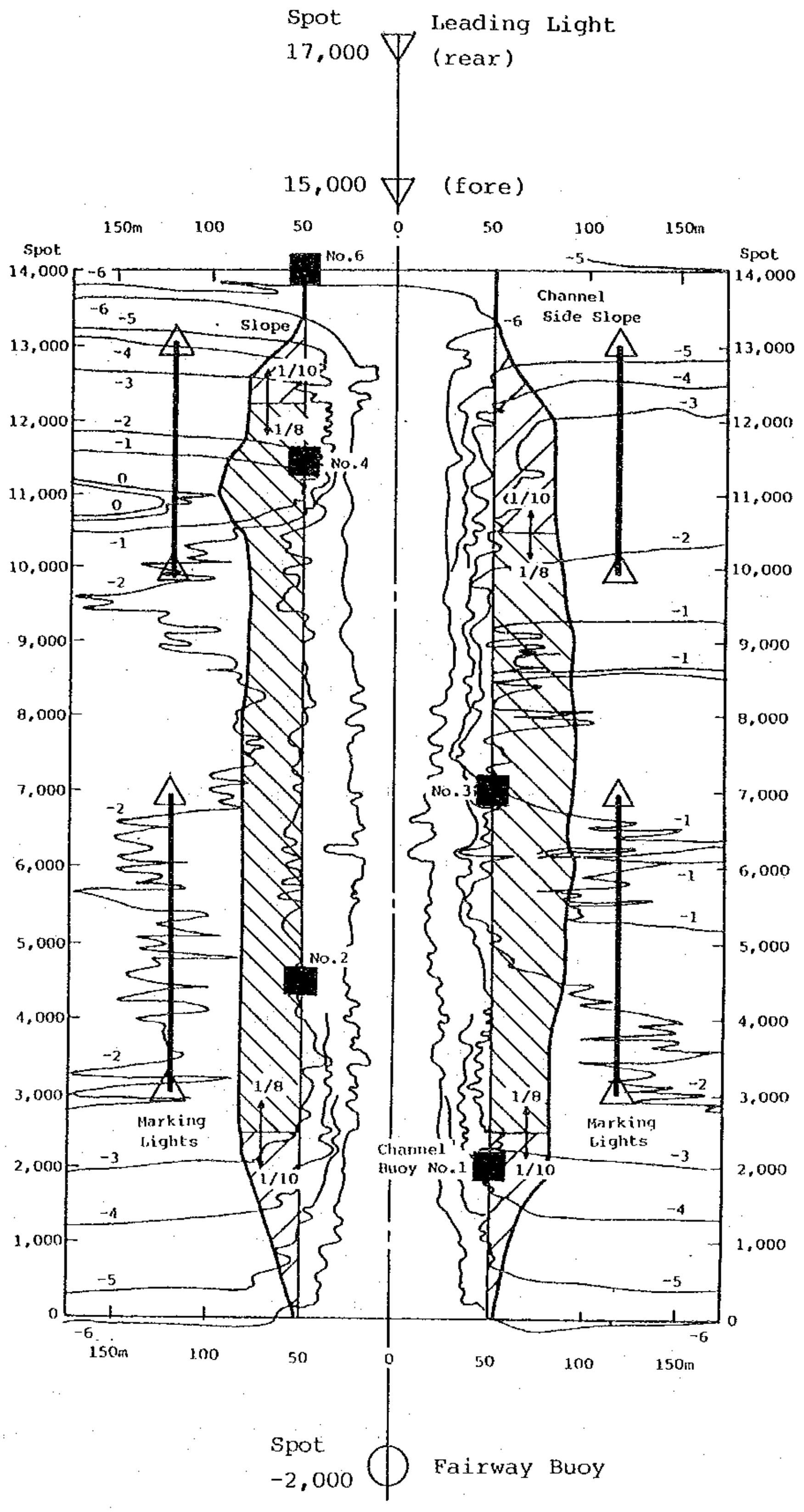


Fig. VII- 1 Arrangement of Submerged Walls and Navigational Aids
(First-stage Plan)

k. Constructing a fast survey boat equipped with complete survey instruments

l. Preparing necessary spare parts

m. Preparing history sheets of each dredger and supporting equipment showing the past maintenance and repair records

n. Preparing maintenance and inspection standards for the dredging fleet

o. Surveying the effects of the present agitation dredging

p. Carrying out trial dumping at the river mouth

q. Carrying out trial side-casting in which the dredged material will be dumped outside the submerged walls

(4) Engineering Services

Engineering services includes monitoring of submerged walls, follow-up surveys and administration of trial dredging operations in addition to the ordinary engineering services.

Chapter 2 Preliminary Design of Facilities and Equipment

(1) Channel

Channel arrangement and cross-sections are prepared including a turning basin with a diameter of 165m in the center of the channel.

(2) Siltation Reduction Facilities

1) Design Conditions

(a) Crown Height: 1.5m above sea bottom

(b) Tide

Indian Spring High Water:	DL +2.859m
Mean Sea Level:	DL +1.627m
Indian Spring Low Water:	DL +0.396m

(c) Soil Condition

The results of the soil survey are summarized below.

- The top layer was composed of dark gray silty sand with organic fragments to a thickness of about 3 to 4m.
- This top layer covers mostly soft silt and clay up to the end of bore holes of about 21m below the seabed.

- N-value:

Bore Hole No.1 located east of Spot No. about 4,000;

N-value varies from 2 (3m below seabed) to 4 (21m below seabed)

Bore Hole No.2 located west of Spot No. about 10,000;

N-value varies from 0 (3m below seabed) to 6 (21m below seabed)

- Unconfined Compression Strength (qu)

Bore Hole No.1;

qu varies from 0.217 kg/cm^2 (12m below seabed) to 0.502 kg/cm^2 (20m below seabed)

Bore Hole No.2;

qu varies from 0.325 kg/cm^2 (6m below seabed) to 0.515 kg/cm^2 (16m below seabed) and 0.3 kg/cm^2 (20m below seabed)

(d) Design Wave

The following condition was taken as the representative critical case at this stage of the feasibility study:

$H_{1/3}$ = 2.4m, Hmax = 3.8m, T = 6 sec, beta = 70°, at DL -2m

where beta is the angle between the direction of wave approach and the line normal to the submerged walls

2) Structure of Submerged Walls

The standard cross section of the proposed submerged wall, based on the comparison of the structural types, is shown in Fig. VII-2.

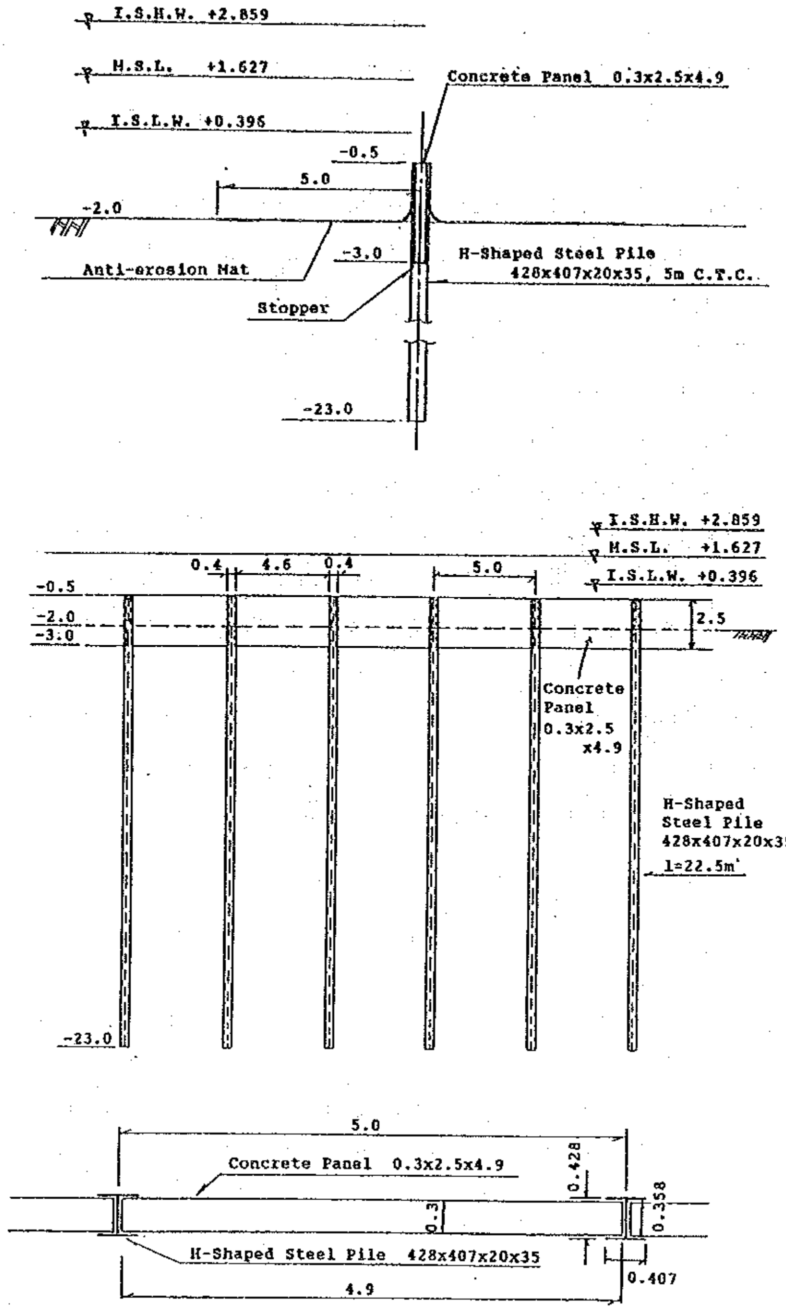


Fig. VII- 2 Structural Plan of Submerged Walls

(3) Navigational Aids

Design conditions, specifications and design of navigational aids and a pilot boat are prepared with drawings. The pilot boat has the following specifications:

Body

Material: FRP

Size: approx. Loa 17.5m x Bext 4.2m x D2.1m

Main Engine

Power: approx. 450PS x 2,000 rpm Diesel x 2 sets

Max.speed: more than 20kt

Capacity

Passengers: 8psn

Crew: 2psn

Equipment

Ladder: Rigging net

Radar, Search light, Radio (VHF, SSB and MW)

(4) Design of Dredging Equipment

1) Tugboat Equipped with a Blade

The specifications of a tugboat equipped with a blade are:

Length overall:	20.0 m
Breadth moulded:	6.8 m
Depth moulded:	2.8 m
Draught moulded:	2.0 m
Speed:	8.0 knots
Main engine:	350 PS x 2 sets

2) Survey Boat

The specifications of a fast survey boat made of FRP are:

Length overall:	17.0 m
Breadth moulded:	4.2 m
Depth moulded:	2.1 m
Draught moulded:	0.8 m
Speed:	20.0 knots (max)
Main engine:	360 PS x 2 sets

Chapter 3 Project Implementation Plan

The proposed implementation schedule of the First-stage Plan is shown in Fig. VII-3.

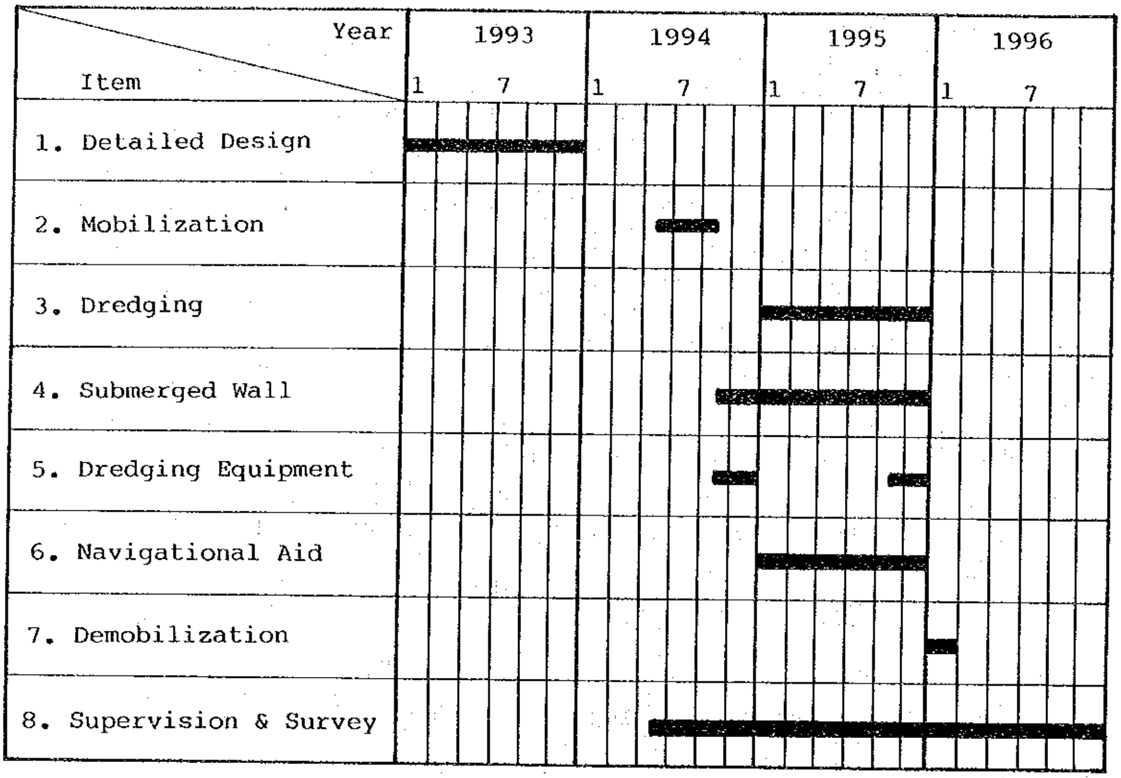


Fig. VII- 3 Project Schedule of the First-stage Plan

Chapter 4 Rough Cost Estimation

The project cost of the First-stage Plan is estimated as shown in Tables VII-1 and VII-2. The total project cost of the First-stage Plan amounts to about 38 million US$, equivalent to about 70 thousand million Rp broken down into 66% for the foreign portion and 34% for the local portion. About half of the total cost will be for the submerged walls, a quarter for the capital dredging, 5% for the dredging equipment and 3% for the navigational aids. About 80% of the investment cost is concentrated in 1995, 2% in 1993, 15% in 1994 and 1% in 1996.

Table VII-1 Project Cost of the First-stage Plan

Unit: thousands of US$

ITEM	UNIT	QUANTITY	UNIT COST	FOREIGN MATERIAL	FOREIGN LABOUR	FOREIGN TOTAL	LOCAL MATERIAL	LOCAL SKILLED LABOUR	LOCAL UNSKILLED LABOUR	LOCAL TOTAL	GRAND TOTAL	
Capital Dreadging				0.0	0.0	0.0	6,166.4	2,215.0	170.6	8,552.0	8,552.0	22.6%
Dredging by Hopper	m^3	5,810,000	0.00081	-	-	0.0	3,506.2	1,117.5	89.7	4,713.4	4,713.4	
Dredging by Cutter	m^3	2,218,000	0.00173	-	-	0.0	2,660.1	1,097.5	81.0	3,838.6	3,838.6	
Submerged Walls	m	14,000	1.4	15,242.7	2,316.5	17,559.2	1,005.4	606.9	132.5	1,744.9	19,304.1	51.1%
Dredging Equipment				1,696.2	0.0	1,696.2	0.7	1.4	0.3	2.4	1,698.6	4.5%
Tug Boat(700PS)	Nos.	1	742.6	742.6	-	742.6	-	-	-	0.0	742.6	
Survey Boat	Nos.	1	656.8	656.8	-	656.8	-	-	-	0.0	656.8	
Spade for Draghead	Nos.	8	1.7	13.7	-	13.7	-	-	-	0.0	13.7	
Draghead Pos.Indicator	Nos.	1	274.5	274.5	-	274.5	-	-	-	0.0	274.5	
Survey Platform	Nos.	1	6.9	4.5	-	4.5	0.7	1.4	0.3	2.4	6.9	
Personal Computer	Nos.	1	3.4	3.4	-	3.4	-	-	-	0.0	3.4	
Tide Pole	Nos.	2	0.3	0.7	-	0.7	-	-	-	0.0	0.7	
Navigational Aids				982.8	0.0	982.8	76.4	61.1	15.3	152.7	1,135.5	3.0%
Leading Light Rear	Nos.	1	171.6	102.9	-	102.9	34.3	27.5	6.9	68.6	171.6	
Leading Light Front	Nos.	1	178.4	109.8	-	109.8	34.3	27.5	6.9	68.6	178.4	
Fair-way Buoy	Nos.	1	86.5	82.4	-	82.4	2.1	1.6	0.4	4.1	86.5	
Channel Buoy	Nos.	5	24.5	116.7	-	116.7	2.9	2.3	0.6	5.8	122.5	
Sub.Wall Marking Light	Nos.	8	3.4	22.0	-	22.0	2.7	2.2	0.5	5.5	27.5	
Pilot Boat	Nos.	1	549.1	549.1	-	549.1	-	-	-	0.0	549.1	
Mob./Demob.	L.S.	1		343.2	0.0	343.2	36.7	15.4	1.1	53.2	396.3	1.0%
Engineering Services				454.6	1,060.8	1,515.5	204.0	571.2	40.8	816.0	2,331.5	6.2%
Detailed Design	L.S.	1		159.1	371.3	530.4	71.4	199.9	14.3	285.6	816.0	
Supervision & Survey	L.S.	1		295.5	689.5	985.1	132.6	371.3	26.5	530.4	1,515.5	
Physical contingency	L.S.	1		2,437.5	347.5	2,785.0	1,081.5	427.2	46.3	1,554.9	4,339.9	11.5%
Total				21,157.1 56.0%	3,724.8 9.9%	24,881.9 65.9%	8,570.9 22.7%	3,898.2 10.3%	406.9 1.1%	12,876.1 34.1%	37,757.9 100.0%	100.0%

Table VII-2 Annual Investment Cost of the First-stage Plan

Unit: thousands of US$

Item \ Year	1993	1994	1995	1996	Total
Capital Dredging	0.0	0.0	8,552.0	0.0	8,552.0
Dredging by Hopper	0.0	0.0	4,713.4	0.0	4,713.4
Dredging by Cutter	0.0	0.0	3,838.6	0.0	3,838.6
Submerged walls	0.0	3,860.8	15,443.3	0.0	19,304.1
Dredging Equipment	0.0	288.3	1,410.4	0.0	1,698.6
Tug Boat(700PS)	0.0	0.0	742.6	0.0	742.6
Survey Boat	0.0	0.0	656.8	0.0	656.8
Spade for Draghead	0.0	13.7	0.0	0.0	13.7
Draghead Pos. Indicator	0.0	274.5	0.0	0.0	274.5
Survey Platform	0.0	0.0	6.9	0.0	6.9
Personal Computer	0.0	0.0	3.4	0.0	3.4
Tide Pile	0.0	0.0	0.7	0.0	0.7
Navigational Aids	0.0	0.0	1,135.5	0.0	1,135.5
Leading Light Rear	0.0	0.0	171.6	0.0	171.6
Leading Light Front	0.0	0.0	178.4	0.0	178.4
Fair-way Buoy	0.0	0.0	86.5	0.0	86.5
Channel Buoy	0.0	0.0	122.5	0.0	122.5
Sub. Wall Marking Light	0.0	0.0	27.5	0.0	27.5
Pilot Boat	0.0	0.0	549.1	0.0	549.1
Mob./Demob.	0.0	264.2	0.0	132.1	396.3
Engineering Services	816.0	505.2	866.0	144.3	2,331.5
Detailed Design	816.0	0.0	0.0	0.0	816.0
Supervision & Survey	0.0	505.2	866.0	144.3	1,515.5
Physical Contingency	0.0	606.7	3,726.6	6.6	4,339.9
Total	816.0	5,525.2	31,133.7	283.0	37,757.9

Chapter 5 Economic Analysis

(1) Project Life

The project life is thirty-three years between 1993 and 2025.

(2) "Without" Case

The cost-benefit analysis is conducted on the difference between the "with" case and "without" case.

"With" case : Case II, With Non-continuous submerged walls

"Without" case : Case II, Without submerged walls

(3) Benefits

The amount of savings due to the smaller annual maintenance dredging volume stemming from the reduction of siltation and its costs in Economic Prices are identified as the annual benefits of the plan.

(4) Costs

The differences in the costs between the "With" and "Without" cases at Economic Prices are considered as the construction costs of the plan.

(5) Calculated Results of EIRR

Table VII-3 Results of EIRR Calculation

Case	EIRR
Base Case	13.2%
Increase of Construction Costs by 10%	11.9%
Decrease of Benefits by 10%	11.8%

(6) Conclusion

Judging from the above analysis the First-stage Plan can be regarded as feasible from the national economic point of view.

Chapter 6 Financial Analysis

(1) Method and Prerequisites

The method and the prerequisites such as the project life and "Without" case, are similar to that of the economic analysis mentioned in Chapter 5, except for economic pricing.

(2) Benefits

The savings on maintenance dredging cost is assumed as the benefit of the plan same as in the economic analysis. There is a difference in the price (unit cost) of the dredging. Considering the recent rate of increase of the price, we assume that it will rise 10% every three years from the nominal price at 1991.

(3) Costs

The difference in the costs between the "With" and "Without" cases should be considered as costs of the First-stage Plan.

(4) Calculated Results of FIRR

Table VII-4 Results of FIRR Calculation

Case	FIRR
Base Case	5.0%
Increase of Construction Costs by 10%	4.5%
Decrease of Benefits by 10%	4.4%

(5) Conclusion

Judging from the above analysis, this project is feasible, provided that the project is financed by low-interest funds such as government funds and foreign governmental loans.

Chapter 7 Management and Operation Plans

(1) Management of Siltation Reduction Facilities

It is recommended that surveys and analyses of the structure, topography and siltation be carried out throughout the project implementation period, and that appropriate countermeasure be taken if any problems arise.

(2) Management of Navigational Aids

Several navigational safety measures are proposed in terms of regular maintenance of navigational aids, accident prevention and handling accidents.

(3) Management of Dredging Equipment

It is assumed that a trailing suction hopper dredger will be used in the channel through the year, so the dredger should be always kept in good condition. Regular maintenance and repair and daily inspection are most important.

A complete array of survey equipment in a new survey boat should be protected from high levels of humidity.

(4) Dredging Management and Operations

Based on the analysis of the management and operations of maintenance dredging, the following points are recommended in order to make the maintenance dredging more effective for the First-stage Plan.

1) to support and upgrade communications between the relevant organizations,

2) to introduce a computer-based maintenance dredging management and operations system,

3) to strengthen the management and operation system at Perumpen, and

4) to continue training personnel.

Chapter 8 Notes on Implementation of the Projects

(1) Characteristics of this Study

The characteristics of this study are summarized to describe the nature of siltation and countermeasures against it in Banjarmasin Channel.

(2) Importance of the Project

The importance of this project is reviewed along with the achievements and applicability of this study to planning, execution, study and research works at other ports with similar problems on siltation and dredging.

(3) Technical Points of the Submerged Walls

Important technical points of the submerged wall construction are noted. Among others, the order and separation of the submerged wall construction are discussed and a possible step by step execution method is described allowing improvement or modification of the design and execution through monitoring surveys.

(4) Technical Notes on Dredging Operations

Anchoring for a cutter suction dredger and its pipeline should be well considered so as not to affect the navigation of other vessels.

It might become necessary to take into consideration moving the channel buoys outward to a minimum distance for a short period.

Concerning trial dumping at the river mouth in the east, siltation and flushing phenomena in the dumping area, and effects of submerged walls preventing re-siltation from the dumping area, especially near the river mouth, should be considered.

Concerning trial side-casting at the site, carrying out trials using a cutter suction dredger and trials before constructing the submerged walls as well as when the submerged walls have been partially constructed should be taken into consideration.

PART Ⅰ INTRODUCTION

Chapter 1 Background of the Study

1-1 Background

The Republic of Indonesia greatly depends on sea transportation and ports and harbours for cargo and passenger transportation because of the topographical, social and economic conditions of the Republic. In fact the share of sea transportation (ports and coastal shipping facilities) in the national transport sector budget increased from 10% in Repelita (National 5 Year Development Plan) I to 22% in Repelita IV.

Handling cargo volume at ports and harbours increased 6.3% per year during the 10 years between 1974 and 1984.

However, most of the ports and harbours are located at river mouths, inland rivers and shallow coastal areas, and therefore have access channels.

Due to geological and climatological conditions, most of the access channels have siltation problems. Dredging works are carried out by Perum Pengerukan (State Dredging Enterprise) using 27 dredgers consisting of 4 different types, but the planned depth of access channels at those ports and harbours has not always been maintained in many areas due to budgetary and technical constraints.

The Port of Banjarmasin, among others, has a significant siltation problem and the required maintenance dredging is estimated to total approximately 4.2 million cubic meters (m^3) per year. Banjarmasin port, one of the main ports in South Kalimantan, is located approximately 26 km upstream from the mouth of the Barito River, and the length of the access channel is 14 km. The capital dredging of this access channel was executed during 1975 and 1976 using a Japanese loan, and maintenance dredging has been carried out every year since then. The annual volume dredged is 2 to 3 million m^3. In spite of these efforts, the planned channel depth has not been maintained, and this has been affecting the functioning of the Port of Banjarmasin and has had negative economic effects. Establishing countermeasures to reduce the siltation volume together with an effective dredging system is thus very important and urgent.

Considering this situation, the Government of the Republic of Indonesia requested the Government of Japan to study the siltation mechanism of the access channel of Banjarmasin Port and to design measures to reduce the siltation volume, and to develop an effective dredging system to minimize the costs of the maintenance dredging.

1-2 Formation of the Study

The request of the study by the Government of the Republic of Indonesia to the Government of Japan is traced back to August, 1985, when the project proposal was submitted to the Embassy of Japan. Several discussions have been held between both governments since then. Due to its importance and urgency, the access channel of Banjarmasin was selected as the study site and it was decided in July 1986 that the study be undertaken by a technical cooperation program through the Japan Technical Cooperation Agency (JICA). And the Scope of Work of this study was agreed upon between the Directorate General of Sea Communications (DGSC) and JICA's Preliminary Study Team in November 1987.

Chapter 2 Objectives of the Study

The objectives of the study are:

- To develop measures to reduce the siltation volume in the Access Channel of the Port of Banjarmasin,
- To develop effective measures for maintenance dredging, and
- To formulate a comprehensive plan and a first stage plan to deal with the siltation in the Access Channel.

The Comprehensive Plan will cover the period up to the year 2000. The target year of the First Stage Plan was set to be 1995.

Chapter 3 Methodology and Organization

3-1 Methodology of the Study

As shown in Fig.I.3-1, the study comprises the following nine items:

1. Study of the present condition of
   - Ports/Harbours and channels,
   - Maintenance dredging system, and
   - Siltation;
2. Field surveys on natural conditions, including analysis of data;
3. Planning of access channels;
4. Development of effective measures for maintenance dredging;
5. Study of siltation phenomena and planning of alternatives for siltation reduction;
6. Hydraulic model tests;
7. Analysis of siltation mechanism by means of:
   - Laboratory tests, and
   - Numerical simulations;
8. Evaluation of alternatives for siltation reduction and formulation of the Comprehensive Plan; and
9. Formulation of the First-stage Plan.

This report is the final report, i.e., F/R in the Figure, and covers items 1 through 9.

3-2 The Study Team

The Study Team is organized with thirteen specialists from the associate of the Overseas Coastal Area Development Institute of Japan (OCDI) and Nippon Tetrapod Co., Ltd. (NTC). Their names, titles and responsibilities are as follows:

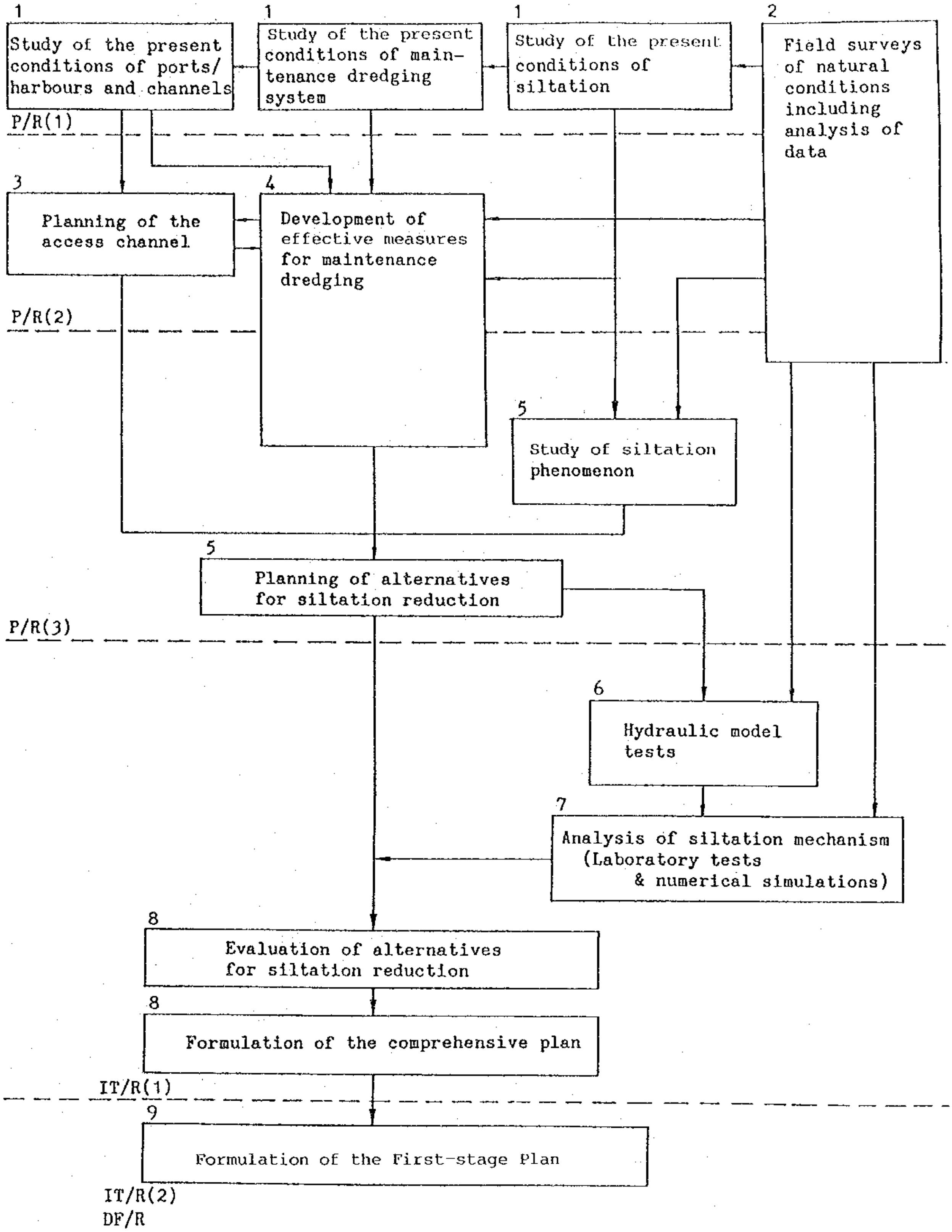


Fig. I.3-1 Master Flow Chart of the Study

TITLE	NAME	RESPONSIBILITY
Team Leader	Mr. Tamotsu OKABE	Overall Management
Deputy Team Leader	Mr. Kohei NAGAI	Port/Channel Planning and Siltation Countermeasures
Senior Port Engineer	Mr. Hiromasa OGINO	Port Demand Forecast
Senior Port Engineer	Mr. Ryuichi TOMIYAMA	Dredging Planning
Senior Navigation Expert	Capt. Koichi KUWAZAKI	Safe Navigation and Navigation Aids Planning
Senior Port Engineer	Mr. Masayuki FUJIKI	Dredging Management and Operation
Senior Oceanographic Geologist	Mr. Takeji OHTSUKA Mr. Hisayoshi SUZUKI	Natural condition, I
Senior Oceanographic Surveyor	Mr. Masashi ARISAWA	Natural condition, II
Senior Port Engineer	Mr. Kazumitsu KOBAYASHI	Hydraulic Model Test, I
Senior Port Engineer	Mr. Tsutomu ASAKAWA	Hydraulic Model Test, II
Senior Port Engineer	Mr. Minoru HANZAWA	Design and Cost Estimation
Economist	Mr. Tetsutaro TOMITA	Economic and Financial Analysis

The Hydraulic Laboratory of NTC carried out hydraulic model tests. The Port and Harbour Research Institute (PHRI) of the Japanese Ministry of Transport (MOT), consigned by the OCDI, undertook numerical simulations of siltation and laboratory tests of channel bed soil characteristics.

3-3 Counterparts

The organization for which the study team rendered its services is the Directorate General of Sea Communications (DGSC), Ministry of Communications (MOC) consisting of the following leading officials:

Mr. Junus Effendy Habibie:	Director General of Sea Communication.
Mr. Achmad:	Secretary to Directorate General of Sea Communication.
Ir. Sadhu Adisasmita, Dipl.HE:	Director of Directorate Port and Dredging.
Ir. Basuki Mangunwasito:	Chief of Sub Directorate of Dredging.
Mr. M.M. Mozes:	Ditto, succeeded to post in October 1989.

DGSC-appointed counterpart members to assist the study team in its activities, i.e.,

Ir. Aripurnomo Kartohardjono:	Civil Engineer, Sub Directorate of Dredging.
Mr. Bagijono:	Oceanographer, Ditto, succeeded to post in October 1989.
Ir. Susi Darjuwati:	Civil Engineer, Ditto.
Ir. Sofwan Djauharianto:	Chief of Technical Division Perumpel III, Banjarmasin Office.
Ir. Herry Soebagio:	Ditto, succeeded to post in October 1989.

The following JICA advisors are attached to the DGSC during the study period, i.e.:

Mr. Toshiaki MIKI:	Advisor Port and Dredging, JMAT.
Mr. Nobuyuki NAKAMURA:	Maritime Advisor, JMAT, and
Mr. Satoru KURITA:	Ditto, succeeded to post in April 1990.

Chapter 4 Schedule of the Study

4-1 Study

The overall study schedule was planned as shown in Fig. A I.2-1. It is expected that the study will be completed at the end of March 1991.

Studies in Indonesia were undertaken according to the following schedule and places, except for those related to the field survey of natural conditions:

(1) Presentation of Inception Report and Progress Report (1)
Period: April 11 to July 8, 1988
Places: Jakarta, Banjarmasin, Surabaya, Balikpapan, Samarinda, Semarang and Palembang.

(2) Presentation of Progress Report (2)
Period: November 28 to December 12, 1988
Places: Jakarta and Banjarmasin.

(3) Study on REPELITA V and dredging
Period: March 5 to 16, 1989
Places: Jakarta, Banjarmasin and Surabaya.

(4) Study on Hydraulic Model Tests
Period: June 1 to 15, 1989
Places: Jakarta and Banjarmasin.

(5) Presentation of Progress Report (3)
Period: October 1 to 31, 1989
Places: Jakarta, Banjarmasin and Surabaya.

(6) Presentation of Technical Notes and Interim Report (1)
Period: May 5 to August 3, 1990
Places: Jakarta, Banjarmasin, Surabaya and Cilacap.

(7) Presentation of the Interim report (2)

Period: October 15 to 29, 1990

Place: Jakarta

(8) Presentation of the Draft Final Report

Period: January 21 to February 7, 1991

Place: Jakarta and Banjarmasin

Additional reports were presented separately on:

a. Natural Conditions Survey,

b. Numerical Simulations of Siltation, and

c. Hydraulic Model Tests,

in order to compile complete records of these study works in depth.

Seminars were held for the transfer of technologies in the relevant fields of the study, i.e.:

(1) Small Scale Seminar (1)

Date: December 2, 1988

Venue: Prumpel II, Tj. Priok.

(2) Small Scale Seminar (2)

Date: October 4, 1989

Venue: Prumpel II, Tj. Priok.

(3) Small Scale Seminar (3)

Date: July 25, 1990

Venue: Prumpel II, Tj. Priok.

(4) Large Scale Seminar

Date: January 30 and 31, 1991

Venue: Sari Pan Pacific Hotel, Jakarta

4-2 Field Surveys

A field survey was carried out from the 10th of September, 1988 to the 10th of September, 1989. Table I.4.2-1 and I.4.2-2 shows the processes of the field survey.

A technical transfer training was also held in Banjarmasin during the period of the field survey. The trainees learned how to operate the measuring equipment in the field. Four staff members from DGSC, Perum Pelabuhan II, and Perum Pelabuhan III participated in the training from the 14th of April to the 4th of May, 1989.

After the completion of the field survey, a seminar of training for the survey equipment was also held at Tanjung Priok (Perum Pelabuhan II) on the 8th of December, 1989.

4-3 Hydraulic Model Tests

The schedule of hydraulic model tests is shown in Fig. I.4.3-1.

Table I.4.2-1 Schedule of Field Surveys Executed for Natural Conditions (No.1)

ITEM	Month. Year / Day	September. 1988 (1 10 20)	October. 1988 (1 10 20)	November. 1988 (1 10 20)	December. 1988 (1 10 20)	January. 1989 (1 10 20)	February. 1989 (1 10 20)
Year-long Survey	Wind						
	Tide						
	Wave & Current						
Monthly Survey	Saline Wedge		11-.15- ①	11-.16- ②	10-.13- ③ 29-	.3- ④ 31-	.6- ⑤
	Discharge	24- ①		19- ②	6- ③	7- ④	9- ⑤
	Echo-Sounding in Narrow Area		8 (1st	stage) 22	(2nd stage)	14 (3rd 30	stage) 17 20 (4th stage) 21 (5th stage)
General Survey	Current 1	3 (1st stage)	7			17 (2nd	stage) 19
	Current 2(Buoy tracking)	30	2				14-16
	Tidal current	21	7			24	11
	Bottom material	9 13					21-23
Others	Echo-sounding in Wide Area				19	(1st stage)	
Remarks	Dredging Works						

Table I.4.2-2 Schedule of Field Surveys Executed for Natural Conditions (No.2)

ITEM	Month, Year / Day	March, 1989 (1 10 20)	April, 1989 (1 10 20)	May, 1989 (1 10 20)	June, 1989 (1 10 20)	July, 1989 (1 10 20)	August, 1989 (1 10 20)	September, 1989 (1 10 20)
Year-long Survey	Wind							
	Tide							
	Wave & Current							
Monthly Survey	Saline Wedge	16-.20- ⑥	30- ⑦	13- ⑦	7-.11- ⑧ 24-.28- ⑨	7-.10- ⑩ 22-.26- ⑪	6-.10- ⑫	
	Discharge	23- ⑥	26- ⑦	25- ⑧	20- ⑨	14- ⑩ 30- ⑪	13- ⑫	
	Echo-Sounding in Narrow Area	8 (5th) (6th	13 stage) 26	4 (7th stage) 25	3 (8th stage) 16 23 (9th)	6 18 (10th) 21	1 (11th) 7 14 (12th stage)	
General Survey	Current 1		10 (3rd stage)	14				
	Current 2(Buoy tracking)			10-12				
	Tidal current		13 30					
	Bottom material		17-20					
Others	Seabed level			13-14 (1st stage)	1-2 (2nd stage)		6 (3rd stage)	
	Echo-sounding in Wide Area	1	(1st stage)		15 18	(2nd stage)		
	Soil Boring				20	20		
Remarks	Dredging Works	1	Dredging Work Stop	29				
Training			14	4				

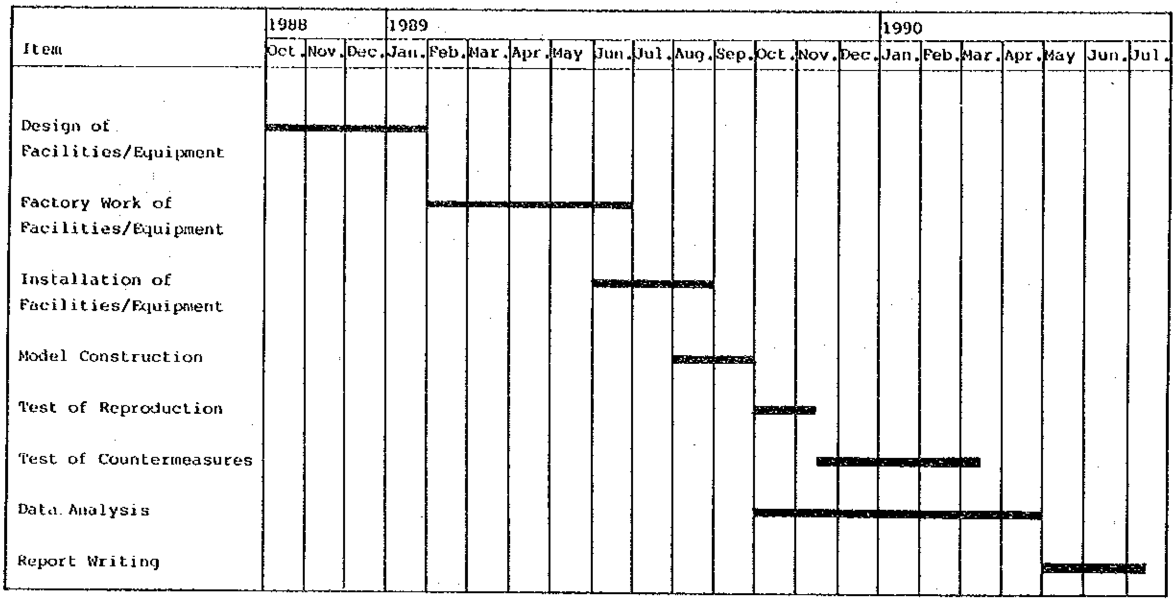


Fig. I.4.3-1 Schedule of Hydraulic Model Tests

4-4 Laboratory Tests and Numerical Simulations

Laboratory tests and numerical simulations commenced from October 1988 in Japan by the staff of PHRI. The schedule is shown in Fig.I.4.4-1.

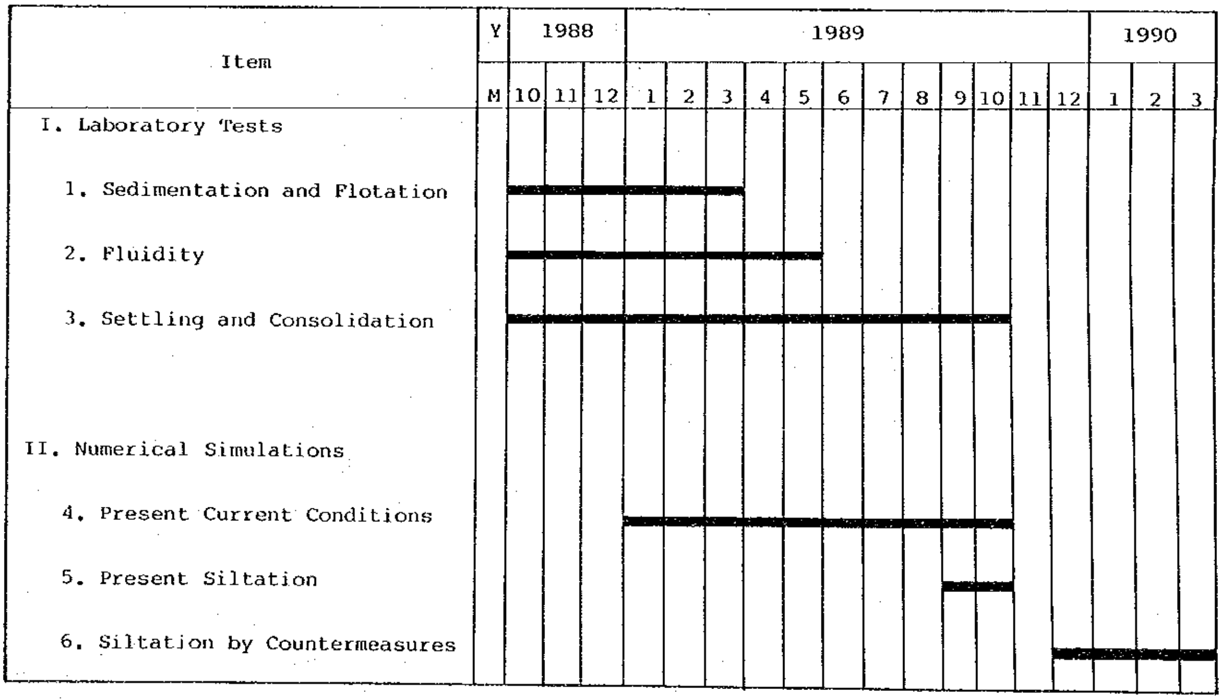


Fig. I.4.4-1 Schedule of Laboratory Tests and Numerical Simulations

PART II ANALYSIS OF PRESENT CONDITIONS OF THE PORT, ACCESS CHANNEL AND DREDGING

Chapter 1 Present Conditions Related to the Port and Access Channel

1-1 Socio-Economic Conditions of the Hinterland of Banjarmasin Port.

1-1-1 Land Area and Population

The hinterland or the service area of Banjarmasin Port was identified as shown in Fig. A II.1.1-1 by the Feasibility Study Team on the Development Plan of Banjarmasin Port in August 1977. The area covers the western part of the Province of South Kalimantan and the eastern part of the Province of Central Kalimantan, which are located in the south-eastern region of Kalimantan Island.

The land area and population in both provinces are tabulated in Table II.1.1-1. The areas in South and Central Kalimantan are 37,660 and 153,600 square kilometers(km^2), respectively. They compose 1.96 and 8.00%, respectively, or 10.0% in total against the total area of the Indonesian territory.

The population in South and Central Kalimantan provinces were 2,273 and 1,118 thousands, respectively, in 1985, which account for only 1.38 and 0.68%, respectively, or in total 2.1% of the population of Indonesia. The density of population is also sparse, i.e., 60 and 7 persons per km^2, respectively, compared with 85 for all Indonesia. The growth rate of population, however, is high in Central Kalimantan, i.e., 3.21% per annum (p.a.) on average for the past five years compared with that of South Kalimantan,1.94%, and even that for the whole of Indonesia, 2.15%.

The distribution of the population in both provinces is summarized by local region/city in Table A II.1.1-1. Banjarmasin City has the largest population, with 432,657, and the highest density, at 6,009 per km^2 in 1985 in the region.

1-1-2 Macro and Sectorial Economy

(1) Gross Regional Domestic Product (GRDP)

The values of GDP/GRDP at 1983 constant prices are given in Table II.1.1-2 for the past four years.

South and Central Kalimantan provinces had a GDP share of 1.2 and 0.7%, respectively, or in total 1.9% of the value for all Indonesia in 1985, which almost corresponds to their share of the nation's population.

The growth rates of GDP/GRDP for the same period of time were 3.8% p.a. for all Indonesia, 5.2% for South Kalimantan and 6.2% for Central Kalimantan. The economic growth rates in both provinces were much higher than the overall growth rate in Indonesia.

The economic scale of Central Kalimantan can be understood to be about 60% of that of South Kalimantan in spite of having an area four times as large.

(2) Growth of Economic sectors

GDP/GRDP by economic sector is summarized in Tables A II.1.1-2 to 4 for all Indonesia and South and Central Kalimantan.

The five major sectors are, judging from GDP/GRDP at 1983 constant prices, as follows:

	All Indonesia	South Kalimantan	Central Kalimantan
1)	Agriculture, forestry & fishery	Agriculture, forestry & fishery	Agriculture forestry & fishery
2)	Mining & quarrying	Trade, hotel & restaurant	Trade, hotel & restaurant
3)	Trade, hotel & restaurant	Social, personal, government service	Construction
4)	Manufacturing industries	Manufacturing industries	Manufacturing industries

Table II.1.1-1 Land Areas and Population in the Provinces of South and Central

	Area Km²	Population (x 1,000)				Density 1985 per Km²	Annual Growth 1980 - 1985 (%)
		1961	1971	1980	1985		
1) Indonesia	1.919.443	97.086	119.208	147.490	164.047	85	2.15
2) South Kalimantan	37.660	1.473	1.699	2.065	2.273	60	1.94
3) Central Kalimantan	153.600	496	702	954	1.118	7	3.21

Source : Statistical Year Book of Indonesia 1986 Central Bureau of Statistics.

Table II.1.1-2 GDP/GRDP at 1983 Constant Price

(Billion Rp.)

AREA	1983 (Share)	1984 (Share)	1985 (Share)	1986 (Share)
All Indonesia	73,698 (100 %)	78,144 (100 %)	79,911 (100 %)	82,475 (100 %)
(Growth Rate)		(6.0 %)	(2.3 %)	(3.2 %)
South Kalimantan	849 (1.2 %)	901 (1.2 %)	935 (1.2 %)	989 (1.2 %)
(Growth Rate)		(6.2 %)	(3.7 %)	(5.7 %)
Central Kalimantan	485 (0.7 %)	516 (0.7 %)	547 (0.7 %)	NA
(Growth Rate)		(6.3 %)	(6.0 %)	
South and Central Kalimantan	1,334 (1.8 %)	1,417(1.8 %)	1,482(1.9 %)	NA
(Growth Rate)		(6.2 %)	(4.6 %)	

(Source) Central Bureau of statistics: Monthly Statistical Bulletin "Economic Indicators" Jan, 1988, BAPPEDA KALIMANTAN SELATAN, and Statistical Year Book of Central Kalimantan 1986.

5) Public administration	Transportation & communication	Public administration

One of the characteristics of the economic structure in both provinces is that mining and quarrying is the most insignificant sector except for coal, while the economy of Indonesia on the whole relies heavily on oil and gas, specifically on their export. The agriculture, Forestry and Fishery sector ranks first for not only Indonesia but also for both South and Central Kalimantan. The Sub-sector of food plantation,including rice, maize, soybean, etc., is the major contributor to the agriculture sector. The Sub-sector of Fishery is second to food plantation, including fish production for local consumption and export of salted fish and shrimp. Forestry is the third-most important sub-sector in South Kalimantan. Since the banning of log exports to foreign countries in 1980, this sub sector has drastically decreased its share. On the other hand, sector of manufacturing industries grew because, after the said year, logs, except for domestic use, have been processed in the form of sawn timber, moulding and dowel or plywood. And these value-added wood products have been drastically increasing in export volume since then. Raw rattan is also anticipated to follow the same process as log did, whereas the portion of processed rattan or rattan carpet/mat will increase in the future.

In conclusion, it can be said that the economy of both provinces has, generally speaking, been developing rather steadily in the past few years.

1-2 Present Organization and Management of Ports and Navigation Channels

1-2-1 Organizational and Managerial Structure

(1) National Organization and Management

Ports and navigation channels, except for private ones, are under the jurisdiction of the MOC. The national organizational structure in relation to Banjarmasin Port is shown in Fig. A II.1.2-1.

In the MOC, the Directorate General of Sea Communication (DGSC), or specifically regarding ports, the Directorate of Port and Dredging under the DGSC is in charge of matters concerning port facilities, equipment, port services, pilotage and dredging. DGSC has other Directorates of Sea Transport Traffic, Navigation, Shipping and Marine Safety, Sea and Coast Guards Unit and Maritime Service. The MOC has District Offices of Communications (KANWIL), since January 1989 based on Pakno 21 (Package of Regulations No.21, November 1988). The KANWIL in the South Kalimantan Province is located in Banjarmasin. Under MOC, Harbour Administration Offices (ADPEL) are attached to each major port, i.e., 91 commercial ports, including Banjarmasin Port.

The Harbour Administration Offices have strong authority; besides their role concerning traffic and harbour affairs, navigation control, and sea and coast guard, they coordinate locally such port-related institutions as Customs Agency, Immigration Agency, Quarantine, the State Enterprises (Perum Pelabuhan/Perumpel) and others.

On the other hand, actual management and operation of the 91 commercial ports, including provision of port services, collection of port tariffs and construction and maintenance of port facilities, are undertaken by the Perumpel under the MOC, which is divided into four according to the regions in Indonesia. Banjarmasin Branch Office belongs to Perumpel III, located at Surabaya. These Perumpel were created in 1983 and became effective in 1984.

(2) Port

In Indonesia there are 494 ports which are under the control of the DGSC. These ports are divided into three categories: i.e., commercial ports, non-commercial ports and pioneer (perintis) ports.

Commercial ports number 91 and are further divided into five classes, reflecting the importance of the roles of each port. There are 4 ports in Class I, 14 in II, 22 in III, 32 in IV, and 18 in V. Banjarmasin is one of the 15 ports of Class II.

(3) Access Channels

There are 49 ports where access channel and/or basin are identified and a list of them is shown in Table A II.1.2-1. The access channels of Banjarmasin Port ranks 12 in length, i.e. 14,300m (originally planned length in the Master Plan).

Access channels are directly managed by the DGSC in principle, whereas basins are managed by each Branch Office of Perumpel as far as their maintenance is concerned.

1-2-2 Management of Banjarmasin Port

(1) Manpower of Perum Pelabuhan III, Banjarmasin Branch Office.

After the creation of Perum Pelabuhan in 1983, the composition of manpower of Banjarmasin Branch Office decreased from 311 persons in 1983 to 231 at the end of 1989. The managements of the office have been making efforts to rationalize the scale of employees.

(2) Budgetary System

As far as port facilities and navigational aids at Banjarmasin Port are concerned, there are the following budget items for Perum Pelabuhan III Banjarmasin Branch Office and for the Harbour Administrator Office, Banjarmasin :

a) DIP (Daftar Isian Proyek) for the development of port facilities.
b) External loan for the development of port facilities and equipment.
c) Internal Budget (Exploitasi) of Perumpel III Banjarmasin Office for development and maintenance of equipment, and
d) DIK (Dafter Isian Kegiatan) of the Harbour Administrator Office for the maintenance of navigational aids.

In addition to those, special budget funds from the President, i.e., BANPRES (Bantuan Presiden) are sometimes allocated when urgently required by ports. DIP for navigational aids development has not been allocated to Banjarmasin Port.

The DIP for port development in the past ranges from Rp.420 to 1,310 Million. An external loan of US$37.10 million is allocated in the Asian Development Bank (ADB)'s 8th port project and for the development of New Trisakti Wharf, New Martapura Wharf, access channel dredging (semi-capital dredging), and others which is to be provided by ADB, Nordic Investment Bank (NTB) and Exim Bank of Japan.

The exploitation, of which major income comes from port tariff, has been in deficit for the past years since 1985, but turned to surplus in 1989. The DIK for maintenance of navigational aids has been less than Rp.70 million. It is to be noted that this budget has to cover the maintenance of 44 facilities and 5 houses in the region, not only that of Banjarmasin.

(3) Port Tariff Structure

After INPRES 4/85, port tariff was changed (Keputusan Menteri Perhubungan, No.KM 92/PR.302/Phb-85) and its structure consisted of the following items:

a. Anchorage fee (against ship, based on GRT and time)
b. Berthing fee (against ship, based on GRT and time)
c. Pilotage fee (against ship, based on ship size and trip)
d. Drinking water supply fee (against ship, per m^3)
e. Wharf fee (against loaded/unloaded cargo volume per ton, m^3, TEU, etc.)
f. Storage fee (for usage of warehouse and open storage, against stored cargo per ton or m^3 per day)
g. Mechanical equipment fee (against usage of equipment and work vessel, per hour)
h. Admission fee (against the entrance of passengers, trucks, and animals into the port area).

The anchorage fee is applied even to the ships which are not anchoring at an anchorage, but berthing directly alongside a quay, regardless of whether they are public or private wharves, which means this is a kind of port entrance charge for those ships. Wharf fees are also levied upon special (private) wharves at the rate of 50% that of public wharves.

1-3 Past and Present Conditions of Banjarmasin Port and its Access Channel

1-3-1 Banjarmasin Port

(1) Outline of Port Development

Located in the capital city of the province of South Kalimantan, Banjarmasin Port has been playing an important role as the gateway of cargoes and passengers in not only South Kalimantan but also the eastern part of Central Kalimantan.

The present Harbour Area is shown in the third cover picture. The area covers the Barito River mouth up to Banjarmasin as well as its estuary and offshore inclusive of the access channel. Before the opening of the access channel, the Harbour Area was limited at the river mouth, or boundary was on the line connecting Tanjung Pedada Tua, and Tanjung Burung.

Banjarmasin Port is situated around 26 km from the mouth of the river, which vessels calling at Banjarmasin Port have to navigate.

The port has two Port Areas, or Custom Bond Areas. The first one, which is best known as "Pelabuhan Martapura", or Martapura Harbour, is located on the right bank of the Martapura river. The wharf at Martapura, which is made of hard wood (kayu ulin or iron wood), was built in 1948. A map of the present Martapura Wharf is shown in Fig. A II.1.3-1. A 140m portion, which is the right-hand side of 348M wharf, was reconstructed by concrete by means of 1984/85 and 1985/86 DIP budget.

The other Port Area is located on the left bank of the Barito River, which is called the Trisakti Wharf, map featuring this wharf shown in Fig. A II.1.3-2. The upper river portion of 200m was constructed in 1965 using French funds. The remaining of 120m was extended by DIP budget in 1981/82, 1982/83 and 1983/84 and became operational in 1984.

(2) Present Port Facilities and Equipment

Facilities owned by Perum Pelabuhan III, Banjarmasin Branch Office as of January 1990 are as follows:

1) Trisakti Wharf

Quay (concrete):	Length 320m (depth about 9m)
Cargo shed, Line I:	Area 4,800 m^2 (1 shed)
Open storage:	Area 9,146 m^2

2) Martapura Wharf

Quay (Wood):	Length 288m (depth about 5m)
Quay (Concrete):	Length 140m (ditto)
Cargo shed, Line I:	Area 4,672 m^2 (5 sheds)
Open storage:	Area 4,287 m^2

3) Cargo handling Equipment

5 Ton forklift:	1 Unit
3 Ton forklift:	6 Units
2 Ton forklift:	5 Units
25 Ton mobile crane:	1 Unit
15 Ton mobile crane:	1 Unit
12.5 Ton mobile crane:	1 Unit

4) Other Equipment and Work Vessels

Fire Engine:	2 Units
Mooring boat (8 HP):	2 Units
Tug boat:	1 Unit
Speed boat:	2 Units
Water bunker:	Capacity 25 m^3/hr
Fuel oil bunker:	

Computer for administrative service: 3 Units

The design dead load of Trisakti Wharf is 2.5 tons/m^2, which does not allow loading of fully loaded 40 footer containers.

Equipment and work vessels are for the usage at Trisakti Wharf. Computers were introducted in 1985 and will be increased in number and capacity in order to make faster settlement of services.

A coal stockyard with an area of 12,500 m^2 wad developed to the south of ADB project site at Trisakti and became operational in June 1990.

(2) Cargo Handling Works

Cargo handling work in Trisakti Wharf is done by equipment and/or labourers, whereas those in Martapura Wharf are run mostly by labourers with hand barrow equipment.

There are currently 7 cargo handling companies in Banjarmasin Port, including Perumpel's Terminal Division itself. Before the issuance of IPRESS No.4/85, cargo handling in port was governed by shipping lines, and the labour force was organized by the UKA.

(3) Future Port Development Plan

As already touched upon above, Port of Banjarmasin Phase I Development Project became effective in October 1987 funded by ADB (US$ 26.3 million) and NIB (US$ 10.8 million) as one of the ADB's 8th Port Projects.

The project includes the development of the following facilities:

1) New Trisakti Terminal

New Wharf (-9m in depth):	120 m x 20 m
Transit shed:	70 m x 35 m
Open storage area:	75 m x 67.5 m
Truck Terminal:	75 m x 67.5 m
Warehouse area:	137.5 m x 50 m

2) New Martapura Terminal

New Wharves(-5m in depth):	350 m x 15 m
Transit sheds:	50 m x 20 m
Open storage:	50 m x 40 m
Truck Terminal:	120 m x 13.5 m
Warehouse:	110 m x 94 m
Green Zone:	21,000 m^2

3) Administration Building: 36 m x 16 m

4) Tug boat: 1 Unit (800 HP)

5) Access Channel dredging: LWS-6m x 60m
(Semi-capital Dredging)

The location of above port facilities is shown in Fig.A.II.1.3-2. The project experienced a slight delay in time schedule and is expected to be completed by October 1991.

1-3-2 Access Channel in Banjarmasin Port

We could not find any record of artificial channel development before 1969. In those days it seems that mainly small sailing boats passed through the Barito River estuary (bar), and that large ocean-going vessels such as log carriers might use the offshore basin, i.e., the Tabanio Basin.

One navigational chart (U.S. Navy, No.72,060, Fig. A II.1.3-6), suggests the condition of the estuary. The contour of one fathom, after entering to the sea toward the south-south-west direction, bends to the south-south-east direction in the middle of the estuary. This might be a proof of the saying that in the old days, the ship route was toward the south.

After the completion of Trisakti Wharf in 1965, the first dredging work was undertaken by the Harbour Administrator Office from December 1969 to June 1970.

A sounding record which was taken one month to six months after the dredging works illustrate that, as shown in Fig. A II.1.3-3, the channel was dredged up to 3 to 5 m in depth and 50 m in width. The direction of the channel was 206.5 degrees, and the dredging area was divided into two portions, 2,380 m and 825 m in length each. Hence the channel was not completely opened. It seems that siltation after one month was around 1.3 m.

With the advent of the log export era, the channel was planned to be exploited to accommodate a 6,000 DWT class cargo vessels. The dimensions of the channel designed were as follows:

Length:	14.3 km
Depth:	LWS - 6.0 m
Width:	100 m
Side slope:	1/10 and 1/8, and
Direction:	208.5 degrees (approximately SSW).

Initial dredging, which is called Capital Dredging, was conducted from August 1975 to June 1976 (total volume of 13.0 million m^3) and Sweeping Dredging from July to September 1976 (total volume of 2.7 million cubic m).

The plan of the access channel and its profile are shown in Fig. II.1.3-1 and Fig. A II.1.3-4, respectively.

During the dredging period of 11 months, siltation of about 4.7 million m^3 was experienced, and immediately after the completion of the work, siltation of about 4.5 million m^3 occured within half a year.

Since this capital dredging, maintenance dredging has been performed once or twice a year, keeping to the same planned dimensions. However, actual maintenance dredging was normally limited to a depth of 5 m and width of around 60 m, as understood from Fig. A II.1.3-5. Furthermore, a bend of 5 degrees initially planned at 1,400 m downstream from the upper tip of the channel (Spot 12,900) has been straightened since around the end of the 1970's.

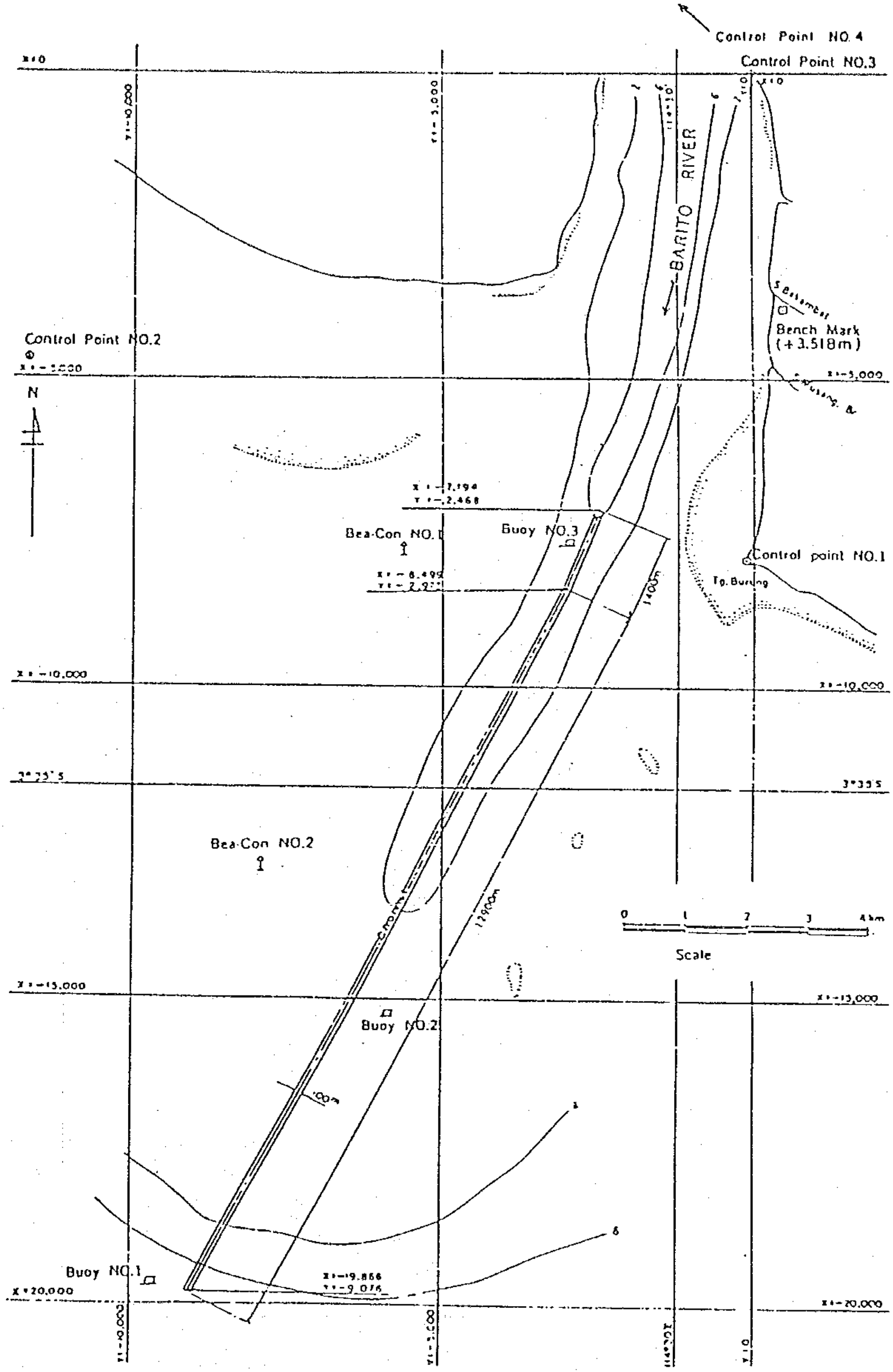


Fig. II.1.3-1 Plan of the Channel for Capital Dredging in 1975/1976
(Source) P C I : Survey and Design Report, April 1975

Chapter 2 Natural Conditions

2-1 Tide, Wind and Wave

The observation points are shown in Fig. II.2.1-1. The Pilot Station where tide and wind observations were carried out is located in the mouth of the Barito River and St.1 is located in the off-shore end of Access Channel. Waves were observed at St.1. These observations were carried out continuously for one year.

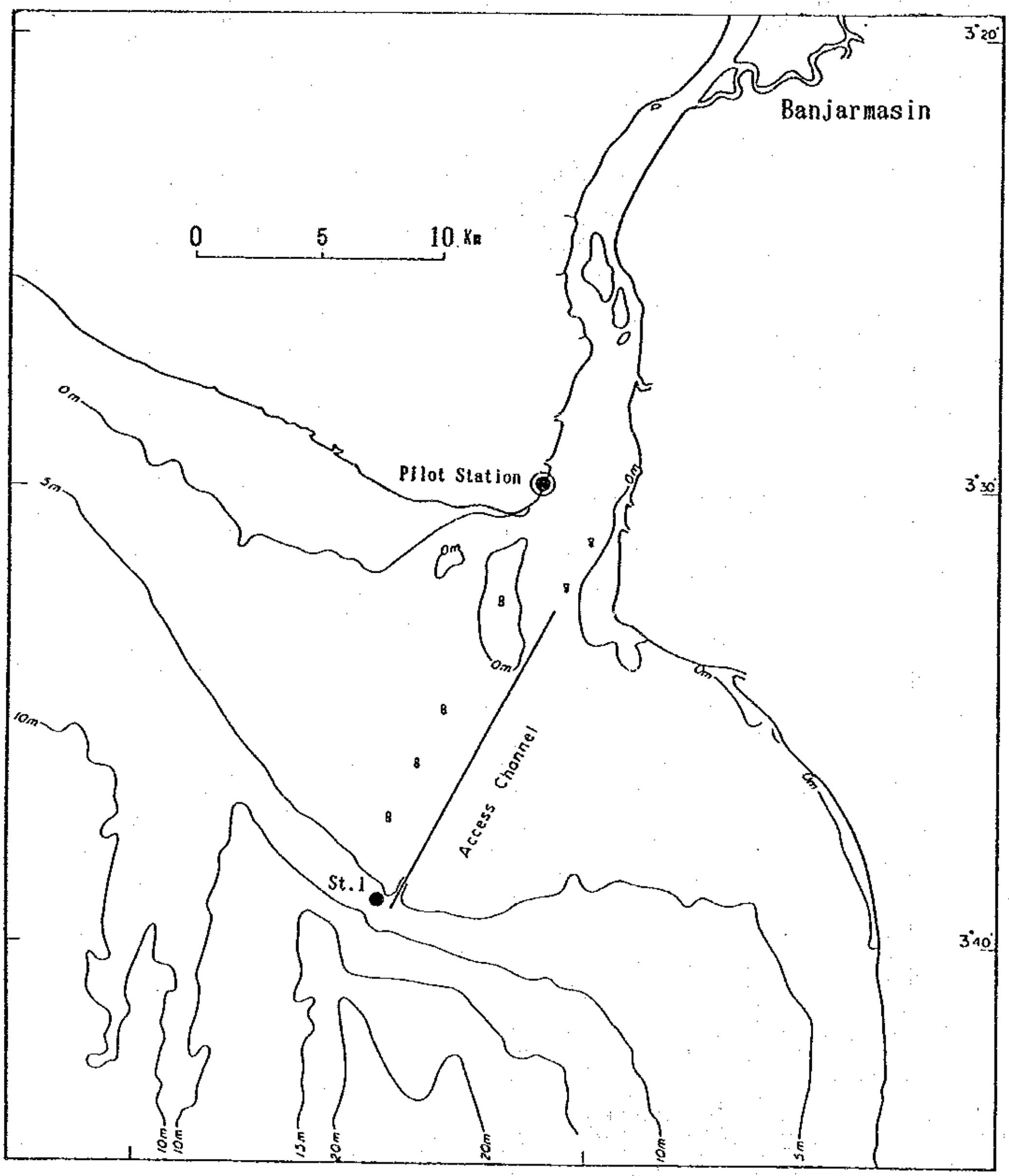


Fig. II.2.1-1 Tide, Wind and Wave Observation Points

2-1-1 Tide

The records for tidal levels observed at the Pilot Station along with water depth data measured with wave height observation at St.1 were taken. At the same time, tidal data at Trisakti in Banjarmasin Port were collected.

(1) Results of the Tidal Harmonic Analysis

Results of the tidal harmonic analysis at the Pilot Station and St.1 were obtained with the method of least square using data for one year.

The results of the four principal tidal constants are shown in Table II.2.1-1(1). Data for Trisakti in Banjarmasin Port was for only 8 months, however. So the results of the harmonic analysis at Trisakti shown in the present report (Final report of Technical Survey for Port of Banjarmasin, Dec. 1984) are as in Table II.2.1-1(2).

The Table shows the dominant tidal constant was a K1 component of tide and next the dominant constant was an M2 component. The amplitude of these components in the upstream area of the Barito River were smaller than those in the downstream area.

Table II.2.1-1(1) Results of Harmonic Analysis for Principal Four Tidal Constants (at Pilot Station and St.1)

Position	Pilot Station				Station 1			
Components	K1	O1	M2	S2	K1	O1	M2	S2
Amplitude (cm)	59	30	32	2	63	33	32	4
Phase (deg.)	337	287	159	69	331	282	139	63

Table II.2.1-1(2) Results of Harmonic Analysis for Principal Four Tidal Constants (at Trisakti in Banjarmasin Port)

Position	Trisakti			
Components	K1	O1	M2	S2
Amplitude (cm)	50	25	26	4
Phase (deg.)	339	280	157	343

(2) Relation Map for Tide Level

The relation map for tide level at Pilot Station is shown in Fig. II.2.1-2. The maximum tide level through the total survey term was 3.23m above L.W.L and the minimum level, 0.34m. The mean sea level which is the sum of the principal four tidal constants(ZO) was 1.627m.

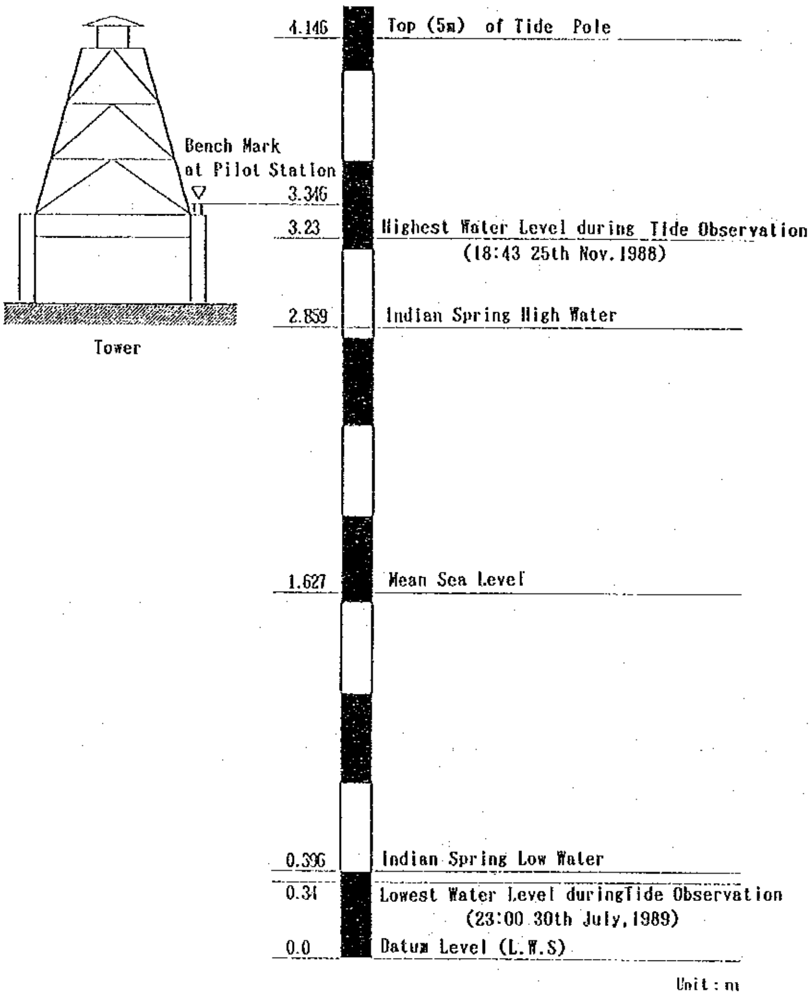


Fig. II.2.1-2 Relation Map for Tide Level at Pilot Station

2-1-2 Wind

Wind observation was carried out continuously for one year at the Pilot Station. According to the data observed, tendencies in the dry and rainy season were slightly different. The wind data were classified in the following periods and the frequencies obtained.

All seasons: 1st Sep. 1988- 1st Sep. 1989

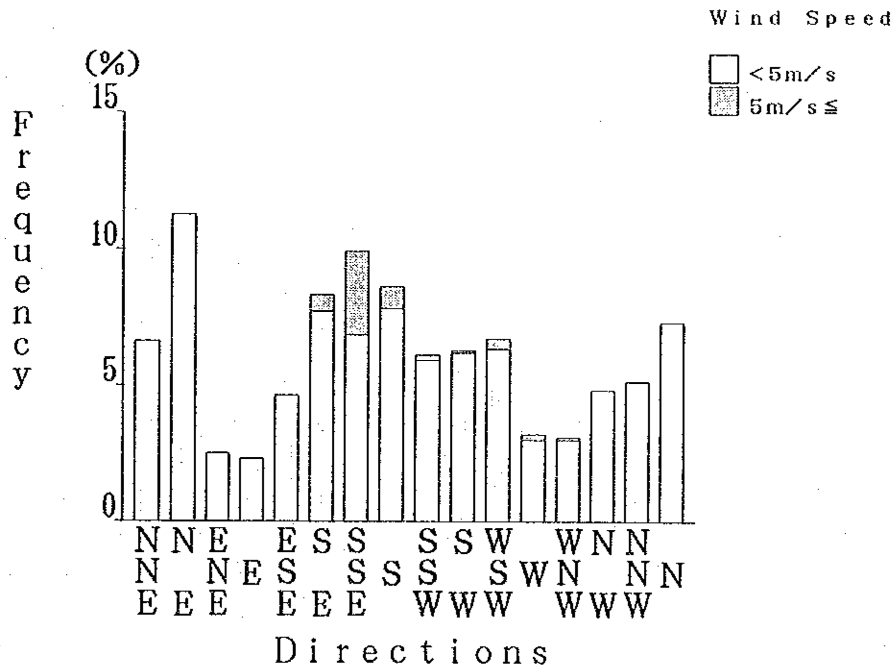
Rainy season: 1st Nov. 1988-30th Apr. 1989

Dry season: 1st Sep.-31st Oct. 1988 and 1st May -31st Aug. 1989

(1) Frequency Distribution of Wind in the All Seasons

The frequency distribution of wind through all seasons is as shown in Fig. II.2.1-3.

The frequencies of wind direction can be separated into three principal directions as dominant wind directions i.e. 27% in SE-S, 25% in N-NE and 19% in SSW-WSW through the observation periods.



All seasons

Fig. II.2.1-3 Frequency Distribution of Wind Speed by Wind Directions

(2) Frequency Distribution of Winds in the Rainy and Dry Seasons

The frequency distributions of winds in the rainy season and dry season are shown in Fig. II.2.1-4.

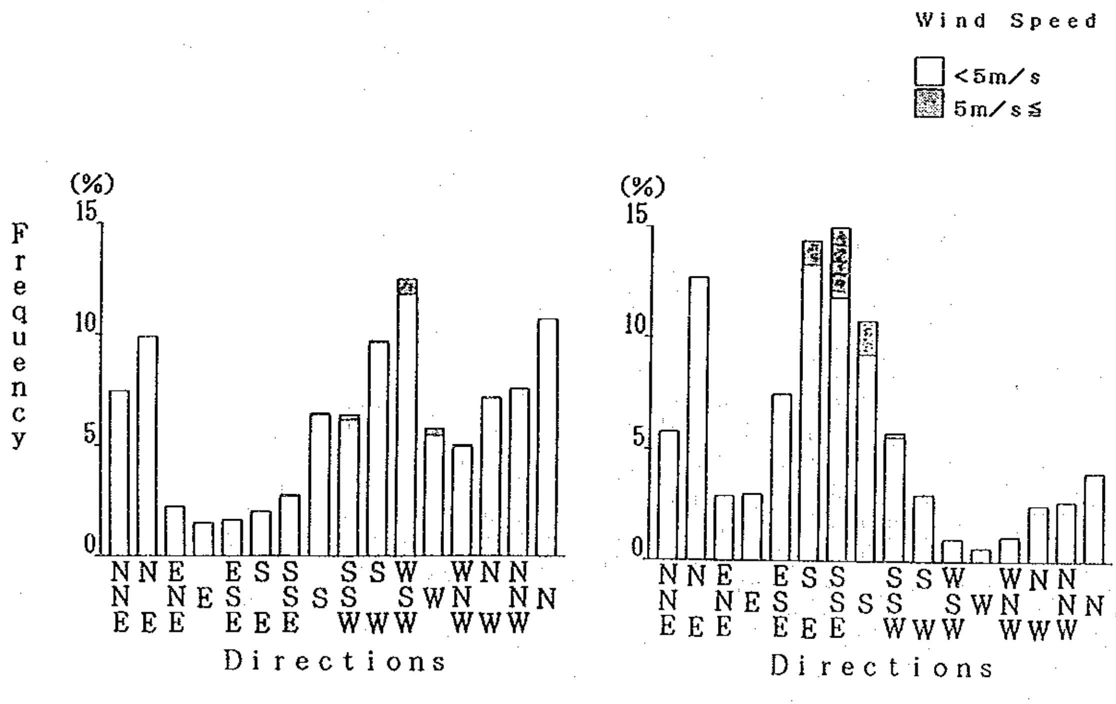
1) Rainy season

Wind directions are separated into two groups, i.e., WSW and Northern; the principal directions. Comparing the wind speed between the WSW and Northern groups, frequencies over 5m/s in rank in the former appeared higher than in the later.

2) Dry season

Principal wind directions are separated into two groups, i.e., the SSE group and NE group. In the case of the SSE group, frequencies higher than 5m/s in rank of wind speed appeared.

The winds were generally weaker in the rainy season than in the dry season.



(1) Rainy season (2) Dry season

Fig. II.2.1-4 Frequency Distribution of Wind Speed by Wind Directions

2-1-3 Waves

Observations of wave height, period and direction were carried out at St.1 (water depth about 10m) over a period of one year. These observational data were calculated for significant wave and wave direction.

(1) Maximum 10 Significant Waves through the Survey Periods

The maximum ten waves extracted from all the data on significant waves through the one year period are shown in Table II.2.1-2. The maximum 9 waves in this case appeared in the rainy season (Nov.-Apr.) and the wave direction S-SW was the most prevalent.

Table II.2.1-2 List of Maximum 10 Significant Waves in One Year

Rank	Date	Significant Wave		
		Height (cm)	Period (sec)	Dir.
1	18h 27th Nov. 1988	172	5.8	S E
2	2h 25th Jan. 1989	150	5.7	S W
3	10h 1st Feb. 1989	139	5.0	S W
4	12h 9th Dec. 1988	132	5.3	S E
5	16h 18th Nov. 1988	130	4.9	SSW
6	18h 25th Dec. 1988	130	4.6	SSE
7	2h 7th Dec. 1988	129	4.8	SSE
8	20h 20th Feb. 1989	127	4.8	S W
9	18h 11th Dec. 1988	120	5.0	S
10	16h 16th Jun. 1989	107	4.7	S W

(2) Frequency Distribution of Significant Waves

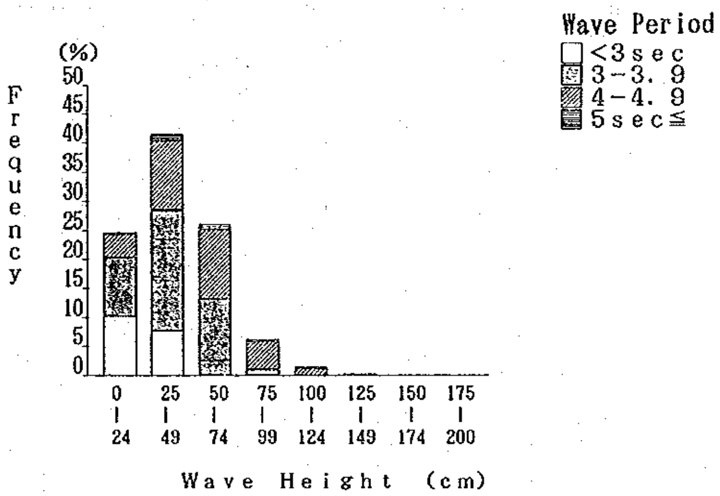
The significant waves observed were classified into the following three periods. The frequency of distribution of wave height by period and the wave direction by wave height are shown in Figs. II.2.1-5 and II.2.1-6, respectively.

All seasons: 10th Sep. 1988-10th Sep. 1989
Rainy season: 1st Nov. 1988-30th Apr. 1989
Dry season: 10th Sep.-31st Oct. 1988 and 1st May-10th Sep. 1989

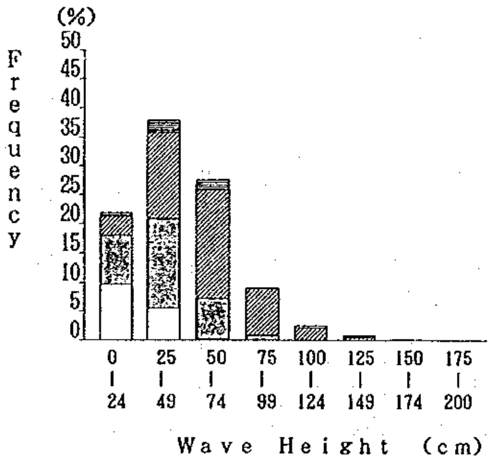
1) Wave Height and Period

Figs. II.2.1-5(1)-(3) show the frequency distribution of wave height by wave period for the three periods.

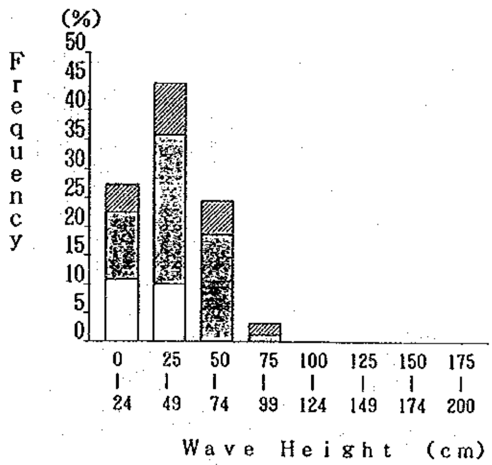
In all seasons, the typical wave height and period were 25-49cm in rank of height and 3-3.9sec in rank of period, respectively. Such waves accounted for 20.8% frequency of all significant waves. In the dry season, such waves accounted for 25.9%, the same as in the all seasons. However, in the rainy season, the typical wave height was 50-74cm in rank of height and typical wave period was 4-4.9sec in rank of period. Such waves accounted for 18.7% of the total waves. The waves in the rainy season were higher than in the dry season with heights more than 1.0m appearing in the rainy season, while waves in the dry season were usually less than 1.0m.



(1) All seasons



(2) Rainy season



(3) Dry season

Fig. II.2.1-5 Frequency Distribution of Wave Height by Period

2) Wave Direction

Figs.II.2.1-6(1)-(3) show the frequency distribution of wave direction in the three periods, respectively.

In all the seasons, the wave direction SSE-SW through the survey periods occupied 76% of all frequencies. The waves in the southern direction which appeared 29% in frequency were predominant. The other principal wave directions were SW and SSE, and these directions accounted for about 20% each.

In the rainy season, the principal wave directions separated into three directions i.e., SW, SSW and SSE. In this case, the direction SW frequency was dominant. Waves in the SW and SSW directions appeared 52% distribution of whole frequency.

In the dry season, waves in the SSE-S direction accounted for 69% of frequencies including waves from the southern direction with a frequency of 50%.

Fig. II.2.1-7 shows the distribution of wave energy flux value by wave direction in the three periods. The wave energy flux values were calculated by eq.(1).

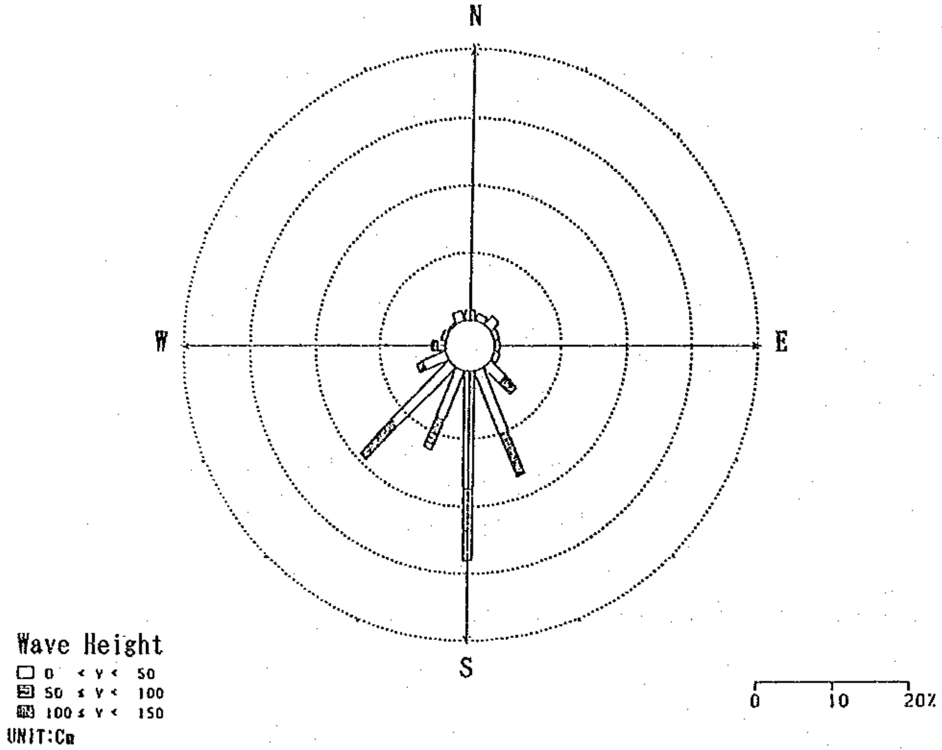
$$E = C \cdot H^2 \cdot T \quad \text{--------------------------} \quad (1)$$

where E is the wave energy flux value of one significant wave, H,T are the wave height and period of significant waves, and C is a constant value calculated from irregular wave distribution. The value in this case was C=0.5.

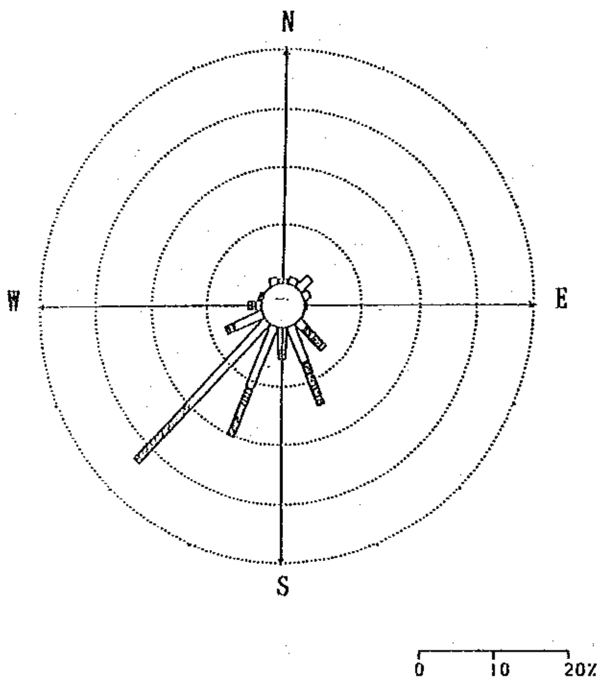
According to Fig. II.2.1-7, the dominant wave direction which had the maximum wave energy flux value was the southern direction. The next principal wave directions in energy flux value distribution were SW and SE directions, as in the frequency distribution of significant waves.

Comparing the total energy flux value in the rainy season with that in the dry season, the energy flux value in the rainy season was about twice that in the dry season.

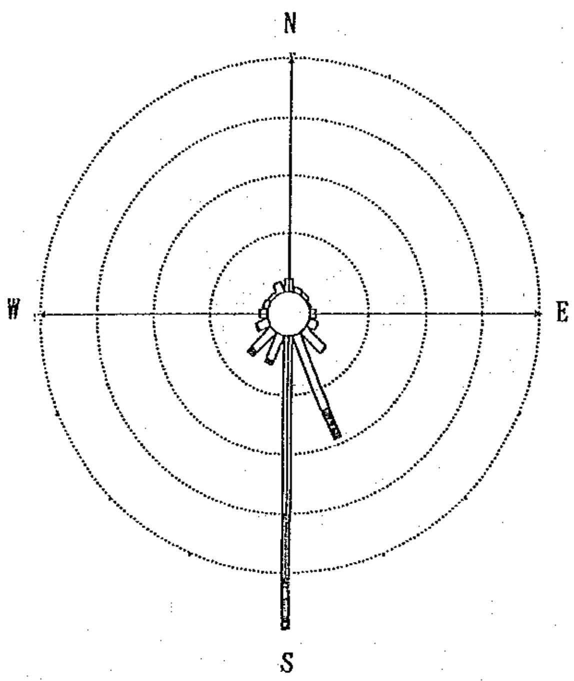
The wave direction was slightly to the west in all seasons, and the wave height was higher in the rainy season, than in the dry season.



(1) All seasons



(2) Rainy season



(3) Dry season

Fig. II.2.1-6 Frequency Distribution of Wave Directions

season	NNE	N E	ENE	E	ESE	S E	SSE	S	SSW	S W	WSW	W	WNW	N W	NNW	N	ALL
Dry	5.8	6.2	3.2	19.0	19.7	112.7	1072	3335	164.2	260.4	84.1	49.6	24.1	10.4	25.0	24.1	5547
Rainy	7.1	28.1	12.1	1.4	17.3	1186	1805	385.8	1785	2916	375.9	279.8	62.7	4.0	12.3	7.2	9334
All	12.9	34.3	15.3	20.4	37.0	1299	2877	3721	1949	3177	460.0	329.4	86.8	14.3	37.3	31.2	14881

UNIT: $x10^3$ kw/m

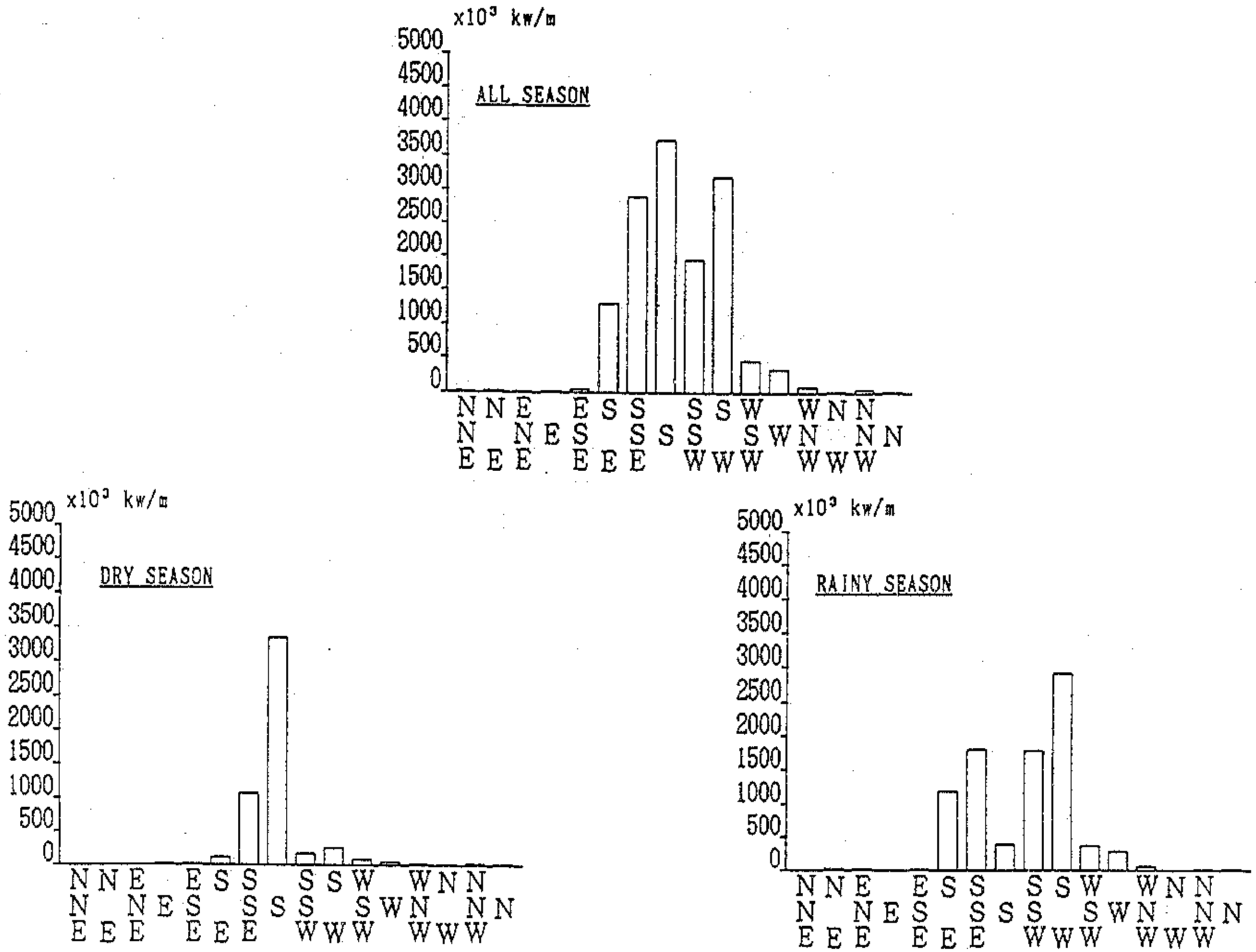


Fig. II.2.1-7 Distribution of Wave Energy Flux Value by Wave Directions

2-2 Rainfall and River Discharge Volume

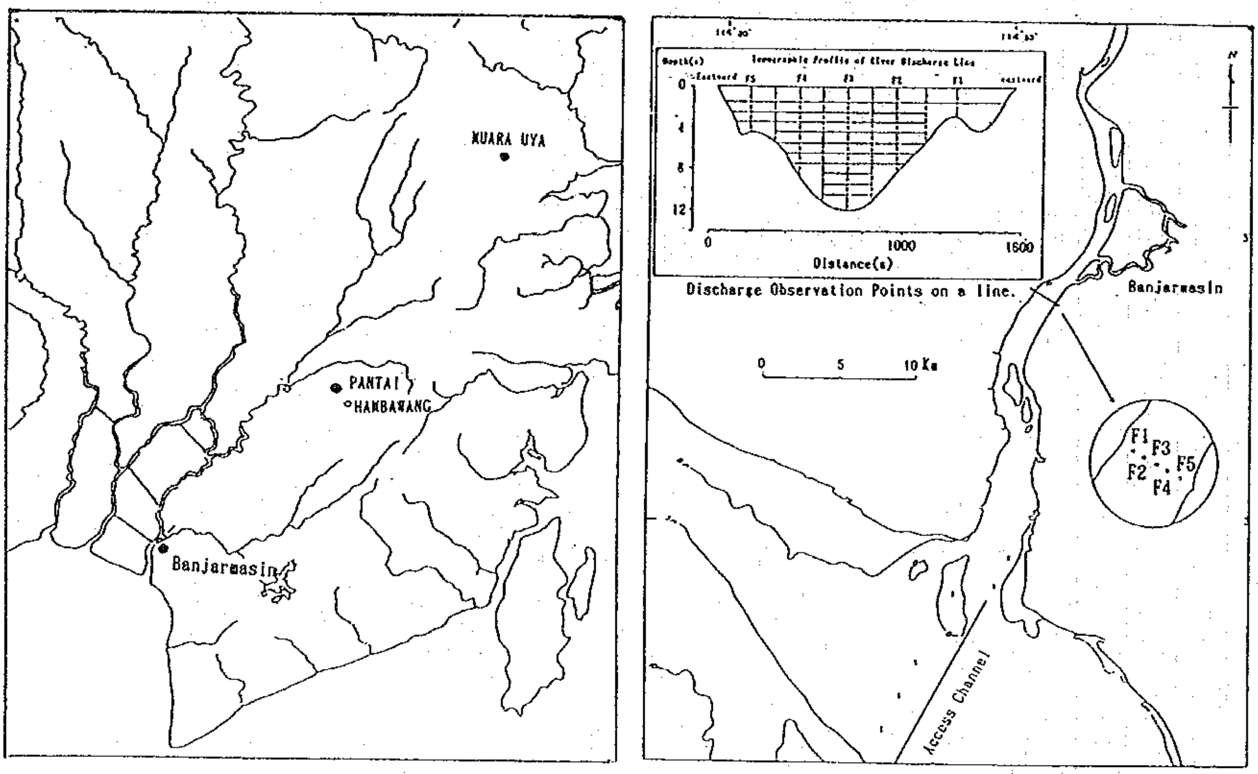
The annual variation of rainfall volume around the stream area of the Barito River, and existing rainfall data were collected for the following three observation points, as shown in Fig. II.2.2-1(1).

Muara Uya:	the upstream area of the Barito River
Pantai Hambawang:	the middle stream area
Banjarmasin:	the downstream area

The data was collected during the following periods :

Muara Uya:	1979 to 1988
Pantai Hambawang:	1965 to 1988
Banjarmasin:	1976 to 1988

The river discharge volume was observed at the five points shown in Fig. II.2.2-1(2). This observation was carried out from Sep. 1988 to Aug. 1989, on average, one time per a month for a total of twelve times.



(1) Rainfall Observation (2) River Discharge Survey Points

Fig. II.2.2-1 Rainfall and River Discharge Observation Points

2-2-1 Rainfall

(1) Annual Rainfall

Fig. II. 2.2-2 shows the time variation of annual rainfall at the three observation points.

The average annual rainfall volume was about 2,500mm/year at the various points. There was no great fluctuation in the amount of annual rainfall among the three points.

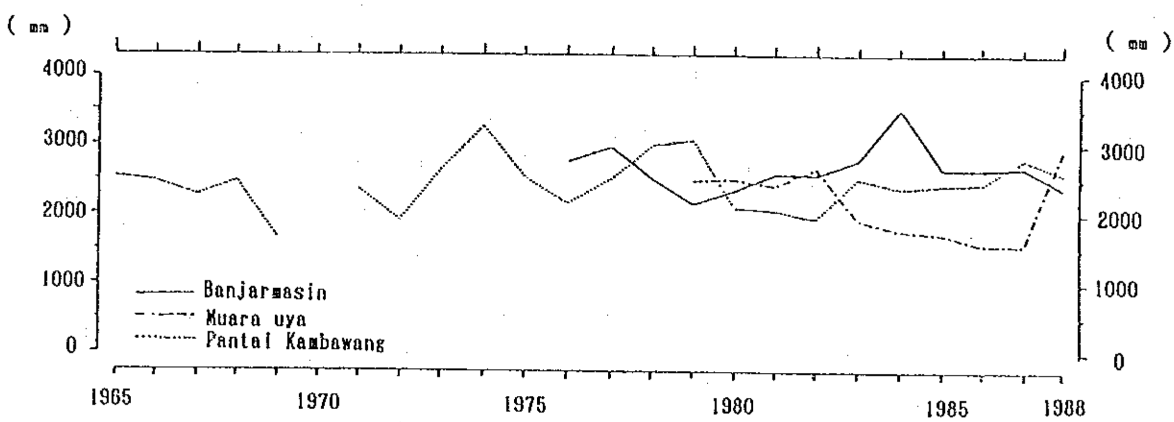


Fig. II.2.2-2 Time Variation of Annual Rainfall during the Observation Periods

(2) Monthly Rainfall

Variations of monthly rainfall volume made from the aforementioned data from Sep. 1988 to Aug. 1989 and mean data for about the previous ten years are shown in Fig. II.2.2-3.

The tendency for the last ten years at Banjarmasin showed a significantly higher mean than at other two stations. The maximum monthly data through the survey periods at Muara Uya showed double the rainfall at the highest point compared to the other two stations.

The monthly rainfall data from Sep. to Dec. 1988 at Pantai Hambawang and Banjarmasin were of an ordinary order.

At Banjarmasin, the tendency for the monthly rainfall volume from Jan. to Mar. 1989 was to be rather less than the mean monthly rainfall volume over the last ten years.

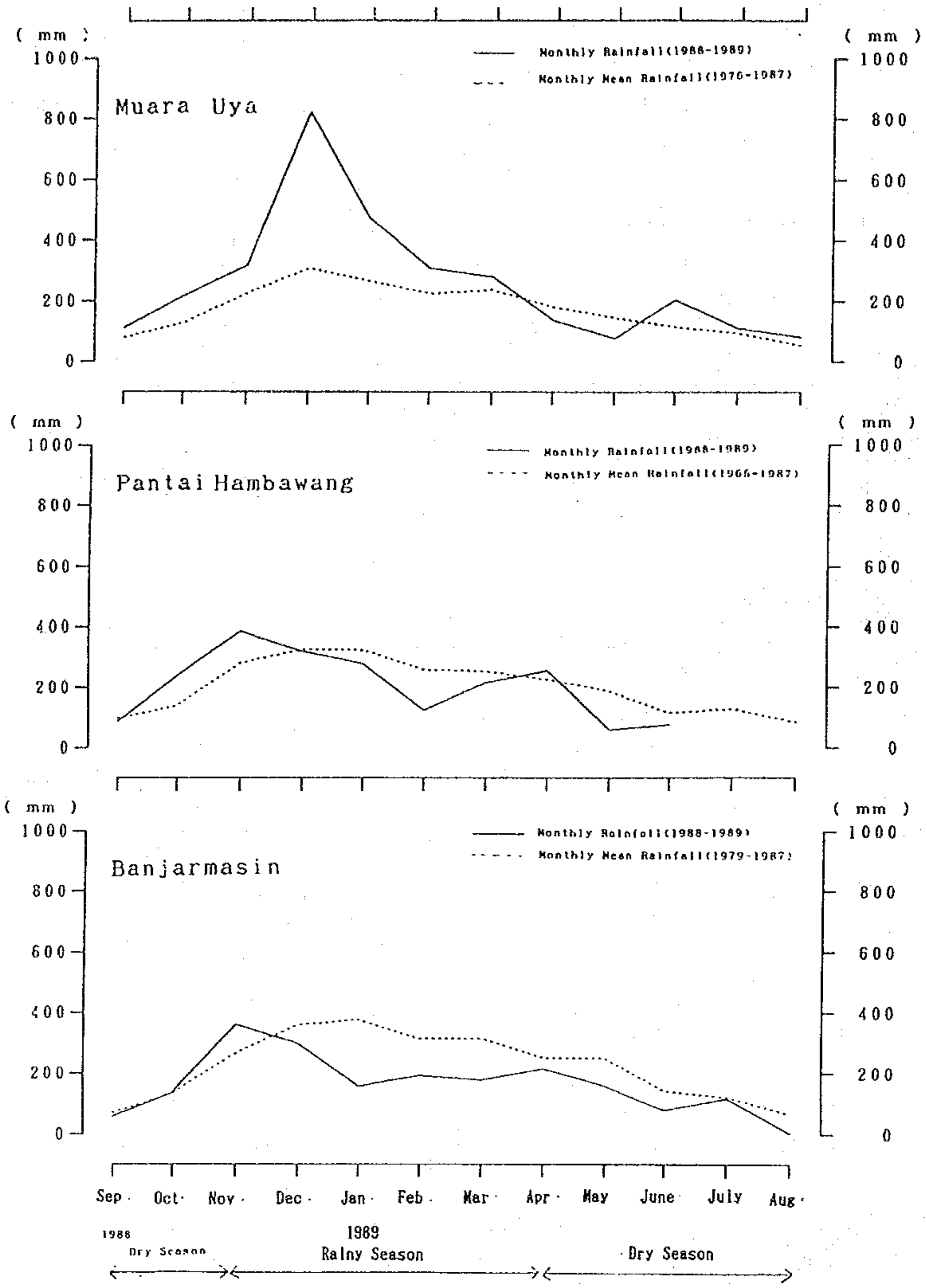


Fig. II.2.2-3 Variation of Monthly Rainfall Volume

2-2-2 River Discharge Volume

The variation in river discharge volume for one year as daily mean river discharge volume in a time series is shown in Fig.II.2.2-4. Daily mean discharge volume refers to the average discharge volume obtained from the River Discharge Survey (25 hours continuous observation).

The maximum daily mean discharge volume to appear during the survey period was about 4,600 m^3/s in the 3rd stage survey in December. The second daily river discharge volume, about 3,700m^3/s appeared in the 7th stage survey in April. Both results were in the rainy season.

In the other months of the rainy season, the river discharge volume in November and March appeared to be above 3,000m^3/s. However, in spite of it being the rainy season, the volume in January and February decreased. This value was less than half the volume in December. After May, as the dry season came along, the volume decreased gradually with the minimum appearing to be about 700m^3/s in August.

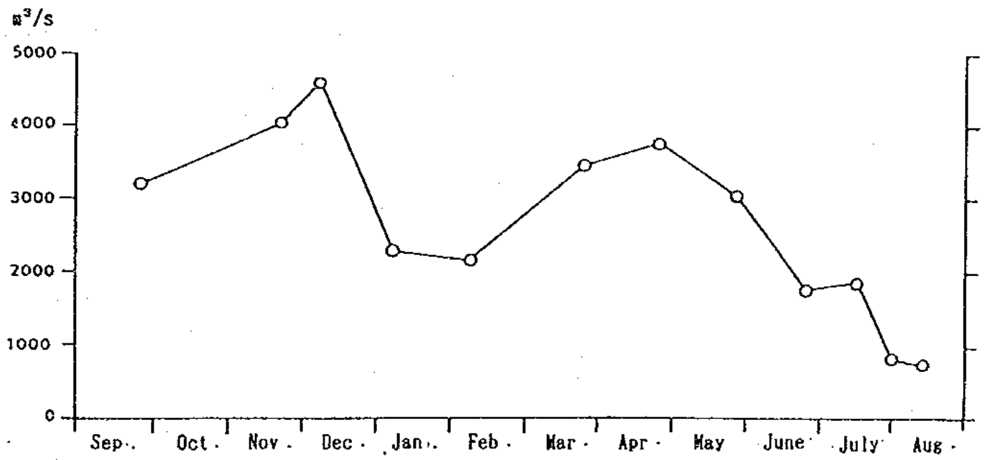


Fig. II.2.2-4 Variation of Daily Mean River Discharge Volume

2-3 Currents

The currents survey can roughly be classified into Fixed Point Observation and Buoy Tracking Observation. These observations were carried out during the following three stages:

1st Stage : in Sep. - Oct. 1988 (Dry season)
2nd Stage : in Jan. - Feb. 1989 (Rainy season)
3rd Stage : in Apr. - May 1989 (Intermediate season)

The observation points are shown in Fig.II.2.3-1. In the figure, St.I and II were off-shore tidal current observation points to the west and east sides of the boundaries of the survey area and St. 1 to 11 around the access channel.

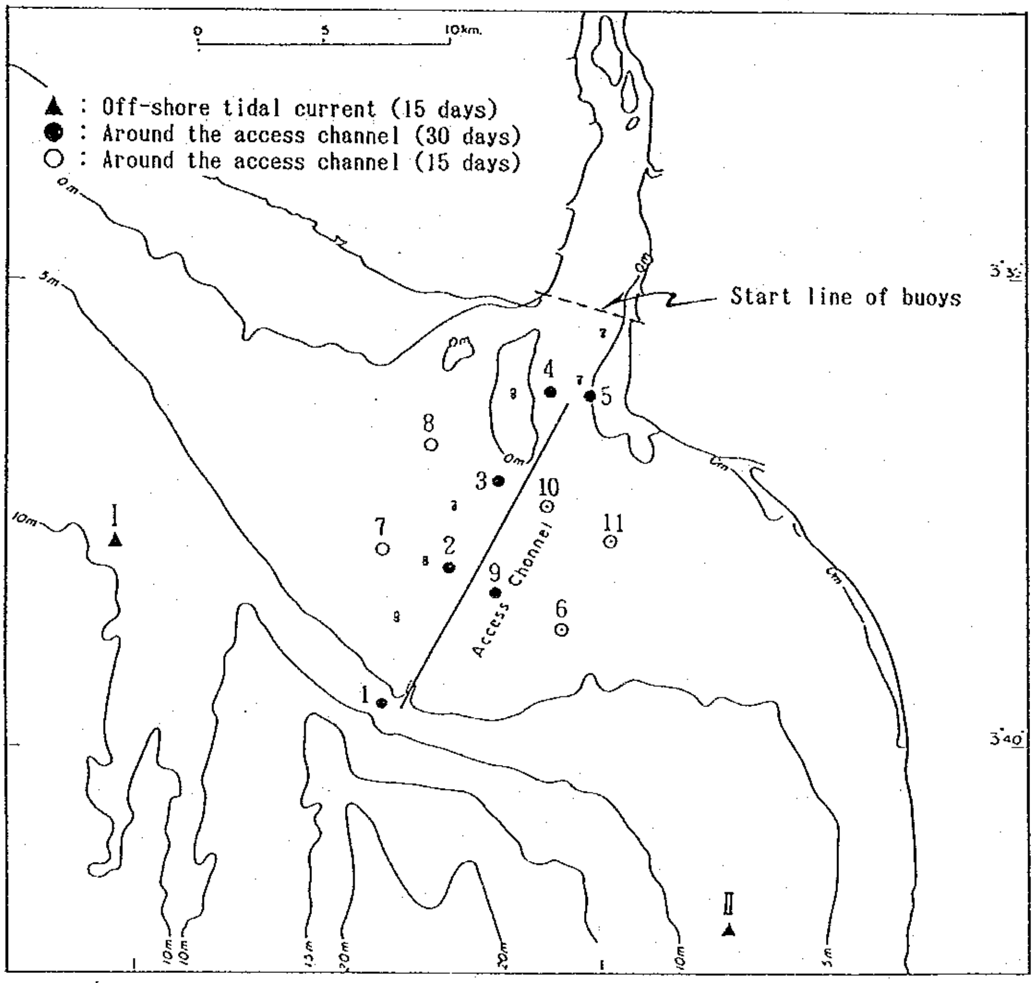


Fig. II.2.3-1 Current Observation Points

2-3-1 Tidal Currents

(1) Results of Harmonic Analysis

Harmonic analysis of tidal currents were made using data of each stage.

The results of the principal four tidal current constants at St.I and II are shown in Table II.2.3-1(1) while St.2 and 4 were shown in Table II.2.3-1(2). St.I and II were to the west and east sides of the boundaries of the survey area, respectively. St.2 was located closely to the off-shore end of the access channel while St.4 was in a location strongly affected by the river currents in the mouth of the Barito River.

At St.I and II, the K1 and M2 component were rather large among four principal components but the amplitude was less than 4cm/s. The tidal currents were generally weak. At St.2, the K1 and M2 component currents were predominant, and the amplitude for K1 and M2 were 13-15cm/s and 16-19cm/s, respectively. As for St.4, the K1 component current was dominant with amplitude 26-29cm/s while the M2 component was rather small with amplitude 6-14cm/s.

The dominant tidal current components were generally K1 and M2 components in these area.

Table II.2.3-1(1) Principal Four Tidal Current Constants

Stage	Position	Station I				Station II			
	Components	K1	O1	M2	S2	K1	O1	M2	S2
1	Amp. (cm/s)	1.9	0.6	2.0	0.7	1.7	0.2	1.5	0.4
	Phase (deg.)	246	154	41	319	240	101	332	241
2	Amp. (cm/s)	3.6	0.9	3.4	0.5	2.1	0.7	2.0	0.6
	Phase (deg.)	282	200	86	353	237	137	45	332
3	Amp. (cm/s)	3.9	0.3	3.2	0.4	2.8	1.0	2.3	0.3
	Phase (deg.)	270	146	81	305	247	187	59	302

Table II.2.3-1(2) Principal Four Tidal Current Constants

Stage	Position	Station 2				Station 4			
	Components	K1	O1	M2	S2	K1	O1	M2	S2
1	Amp. (cm/s)	15.0	8.2	18.6	5.0	28.8	14.3	5.7	4.2
	Phase (deg.)	280	233	75	340	266	203	144	93
2	Amp. (cm/s)	13.9	8.7	18.5	3.5	27.3	11.7	12.0	4.9
	Phase (deg.)	276	229	78	43	286	230	88	292
3	Amp. (cm/s)	12.9	8.2	16.2	2.9	26.2	15.9	14.4	6.5
	Phase (deg.)	264	315	68	245	291	233	112	26

(2) Horizontal Distribution of Current Ellipses

Figs. II.2.3-2(1)-(3) show the horizontal distribution of current ellipses of K1 component which was the dominant component in the survey area. The principal axis (Long axis) shows the direction the K1 tidal component current proceeds.

In the case of the east side of the access channel, the N-S direction is indicated and this agrees with the stream axis of the Barito River. However, in the case of the west side of the access channel, the K1 tidal component current avoided the sand bar on the west side. A Similar pattern can be seen in each season.

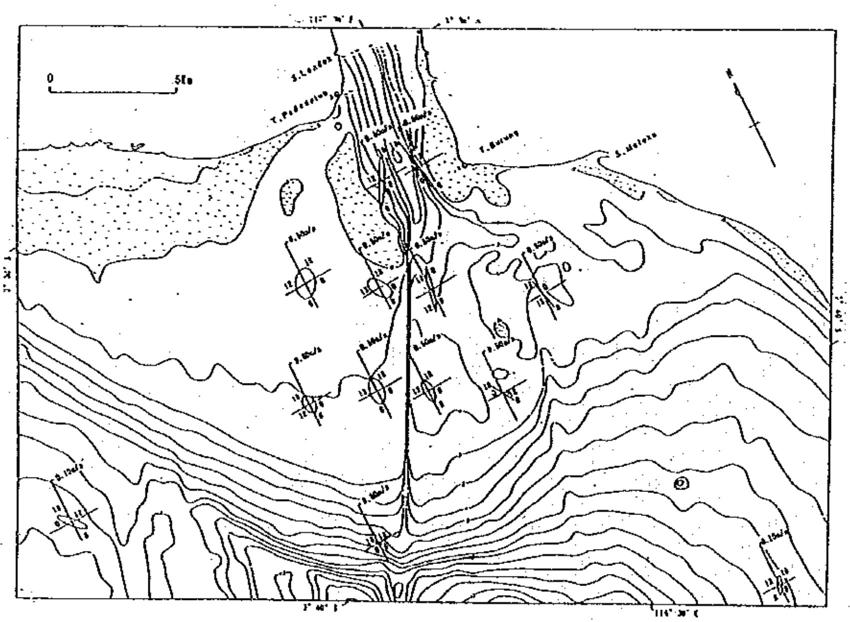


Fig. II.2.3-2(1) Current Ellipses of K1 Component Current (1st Stage)

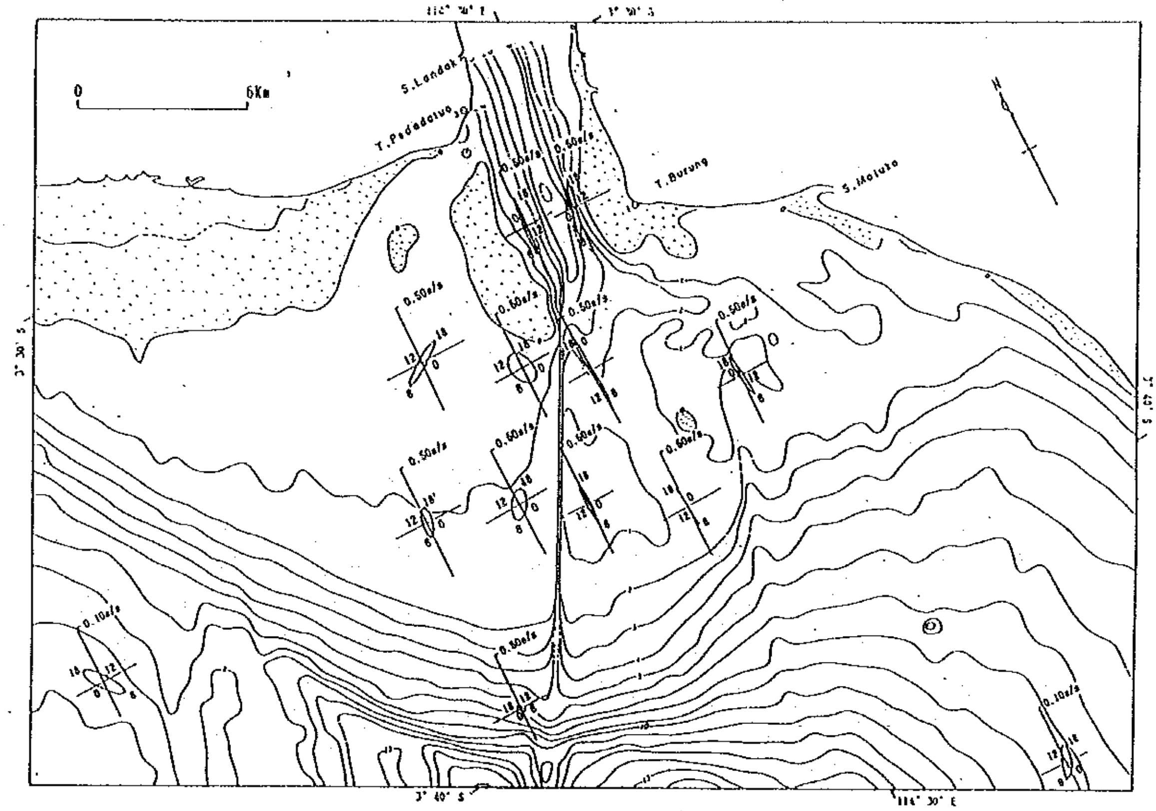


Fig. II.2.3-2(2) Current Ellipses of K1 Component Current (2nd Stage)

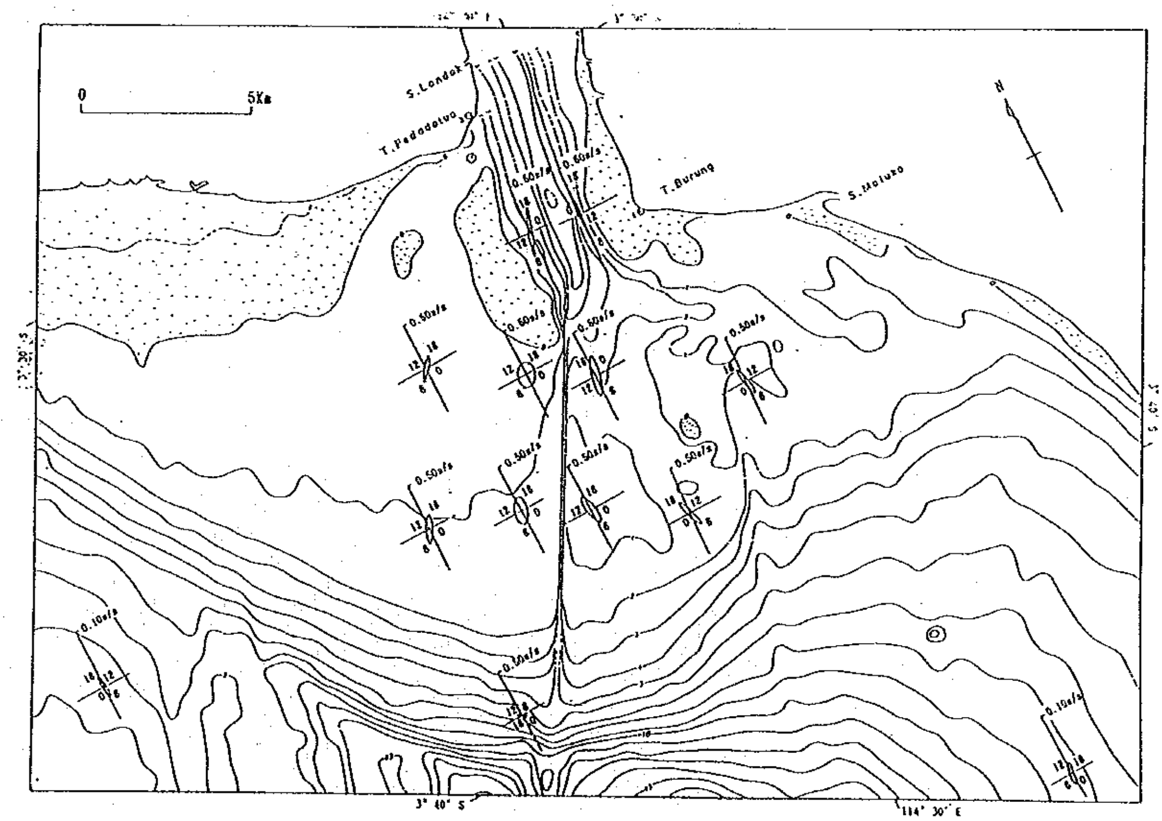


Fig. II.2.3-2(3) Current Ellipses of K1 Component Current (3rd Stage)

2-3-2 Results of Buoy Tracking

Fig.II.2.3-3 shows the principal patterns of current during ebb tide from the results of the 1st stage survey.

The buoys released from the center of the mouth of the river and from the east coast floated to the east while those released from the coast west of the mouth went to the west in a wide range. The velocities of the buoys to the east were over 1m/s but those to the west were about 0.5m/s.

The buoys seem to have avoided the shallows present west of the access channel.

Other results obtained were:
2nd stage: Time zone pursued from flood to high water and patterns of current streaming up the river.
3rd stage: Time zone pursued from flood to ebb tide via high water. Patterns of current alternating in current direction.

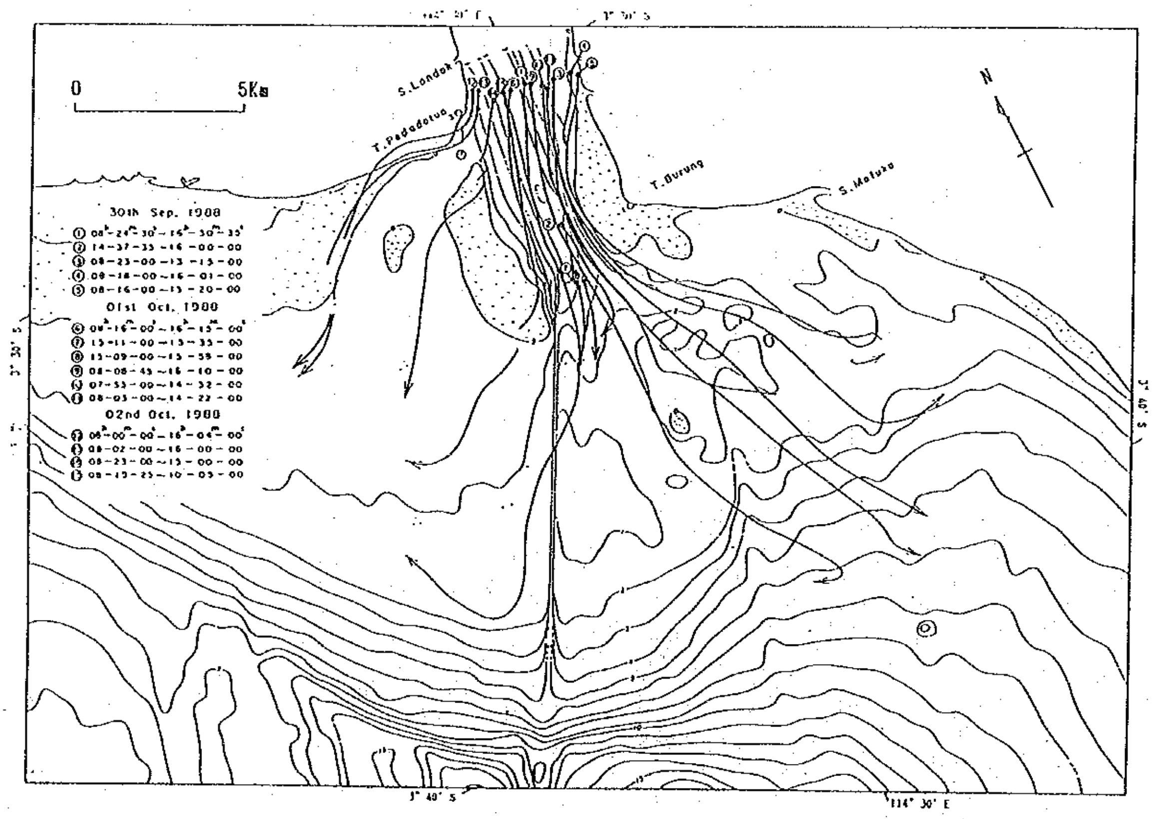


Fig. II.2.3-3 Result of Buoy Tracking (1st stage)

2-4 Saline Wedge

Saline Wedge surveys were carried out from Sep. 1988 to Aug. 1989 on average once a month for a total of twelve times.

Fig.II.2.4-1 shows the observation points. These were different in the dry and rainy seasons, i.e., Points A, B, C, D, E, F, G and H upstream in the dry season and points A, I, B, J, C, D, E and F upstream in the rainy season.

The eight points were divided into two groups and the survey conducted twice.

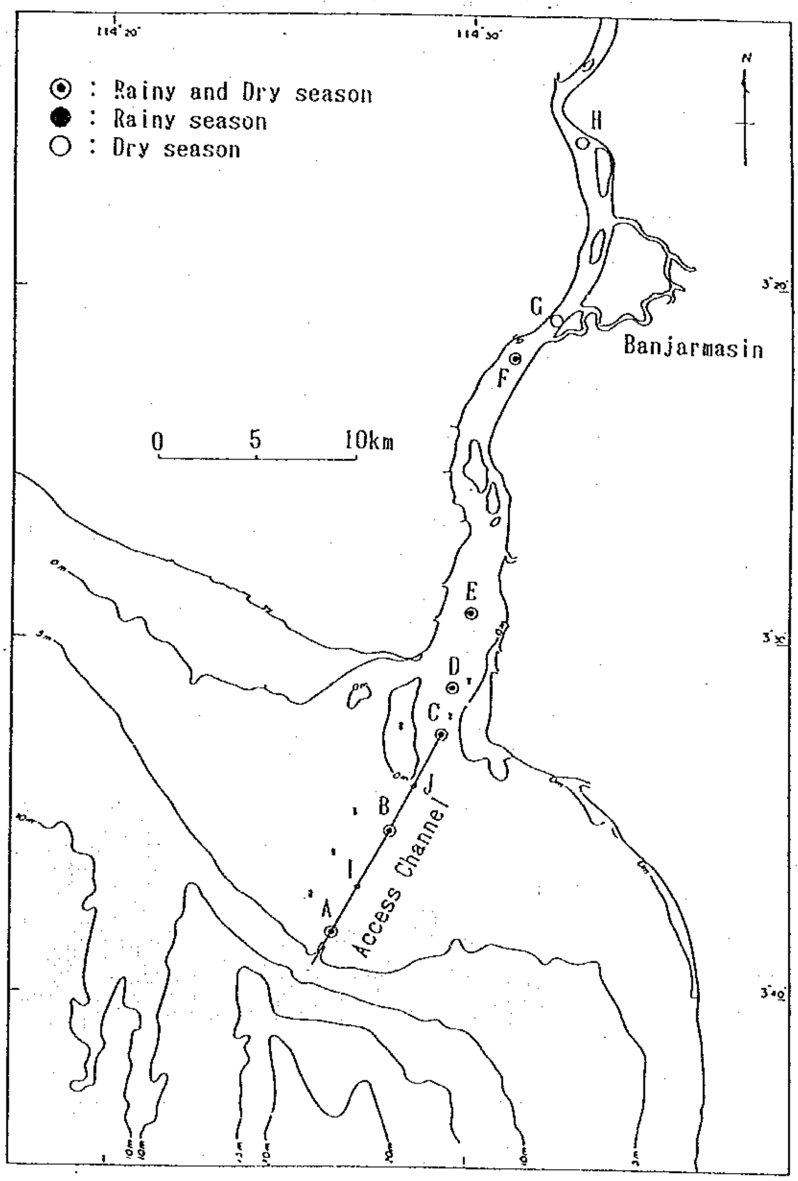


Fig. II.2.4-1 Observation Points of Saline Wedge

2-4-1 Profile Distribution of Salinity in Dry Season

Fig.II.2.4-2(1) shows the profile distribution for the Barito River in terms of daily mean salinity and current velocity from typical observation results in the dry season.

Regarding the distribution of salinity in the dry season, a front of salinity of level 20 reached around point G near Trisakti and the structure of the saline wedge from point C in the mouth of river to point G showed a weak mixed type. A layer in which the salinity concentration changed suddenly existed about 3m above the seabed.

Contrasting the salinity and current velocity, current containing high salinity of level 20 showed a tendency to flow-in at the lower layer and river water at surface layer showed a tendency to flow out.

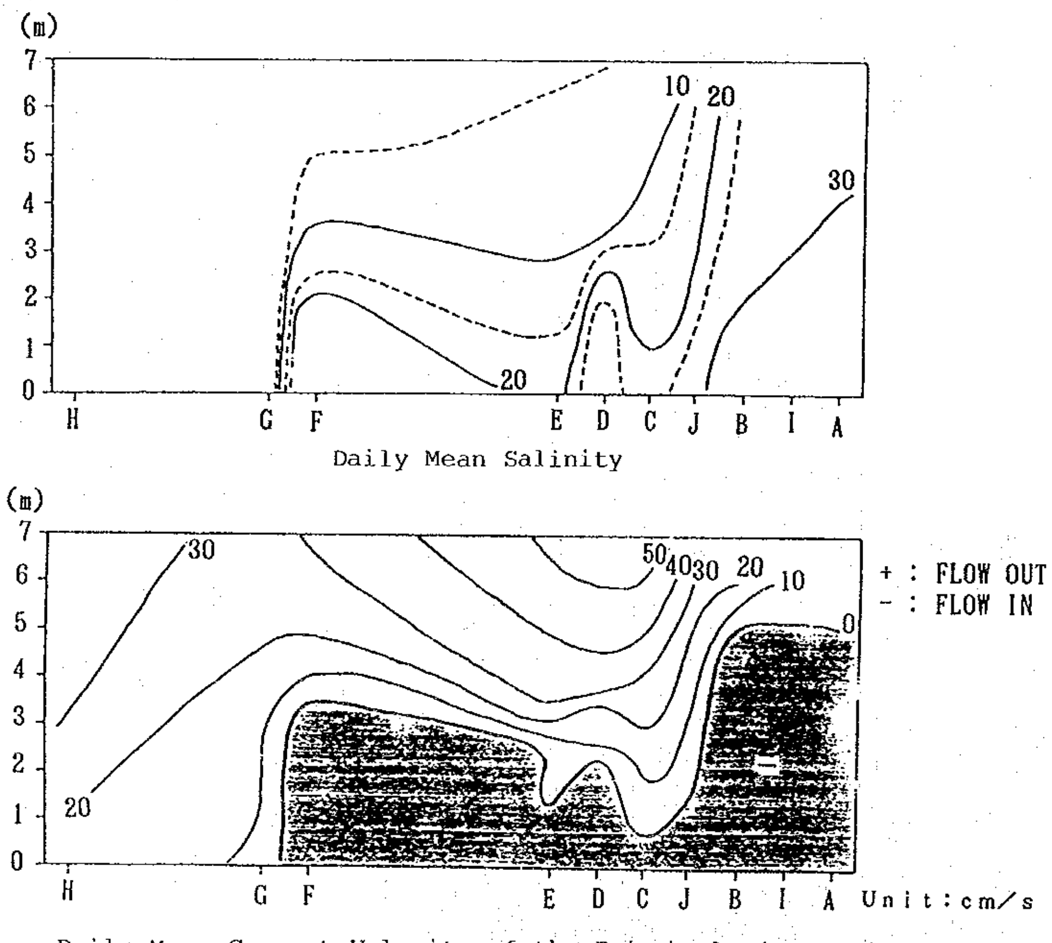


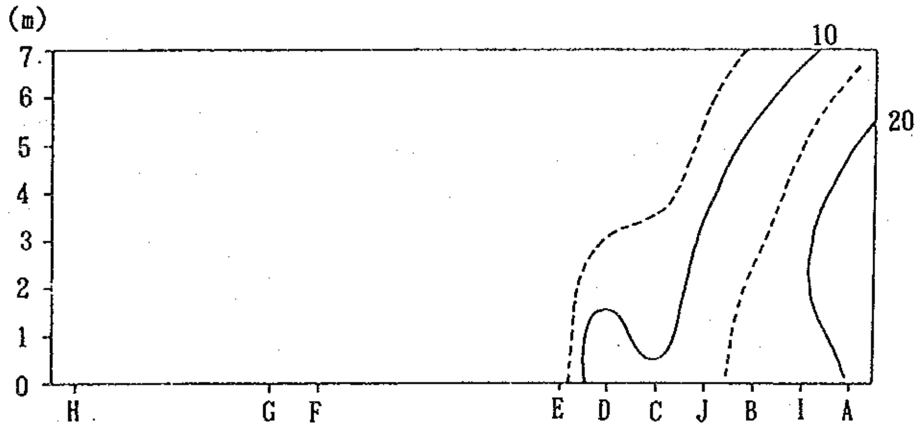
Fig.II.2.4-2(1) Profile Distribution of Salinity and Current Velocity in Dry Season (10th and 15th Oct. 1988)

2-4-2 Profile Distribution of Salinity in Rainy Season

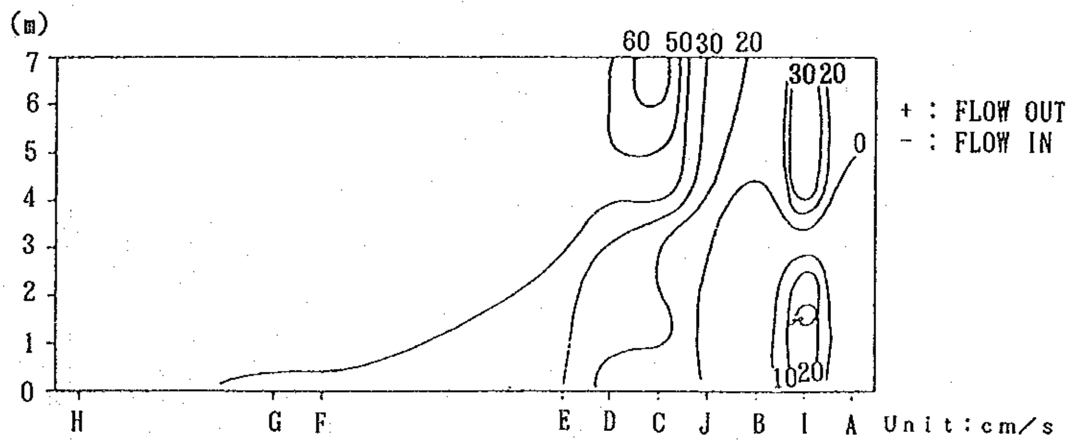
Fig. II.2.4-2(2) shows the profile distribution for the Barito River in terms of daily mean salinity and current velocity from typical observation results in the rainy season.

With regard to the distribution of salinity in the rainy season, a front of salinity of 20 pushed out to the off-shore end of the access channel due to the increased river water discharge volume while the saline wedge in the access channel showed distribution of a strong mixed type.

River water together with great regression of seawater reached the off-shore end of the access channel. The distribution of current velocity showed a tendency of strong mixed type.



Daily Mean Salinity



Daily Mean Current Velocity of the Principal River Axis

Fig. II.2.4-2(2) Profile Distribution of Salinity and Current Velocity in Rainy Season (10th and 13th Dec. 1988)

2-5 Bottom Materials

Bottom material surveys were carried out in the following two areas.

In the River and Access Channel: The observation points and periods were similar to those in the river discharge and saline wedge observations.

In the Estuary and Sea Area: The observation points are shown in Fig. II.2.5-1.

The number of sampling points totaled 26 from point "a" to "z". The survey periods were as follows :

1st Stage: 9th to 13th Sep. 1988 (Dry season)
2nd Stage: 21st to 23rd Feb. 1989 (Rainy season)
3rd Stage: 16th to 19th Apr. 1989 (Intermediate season)

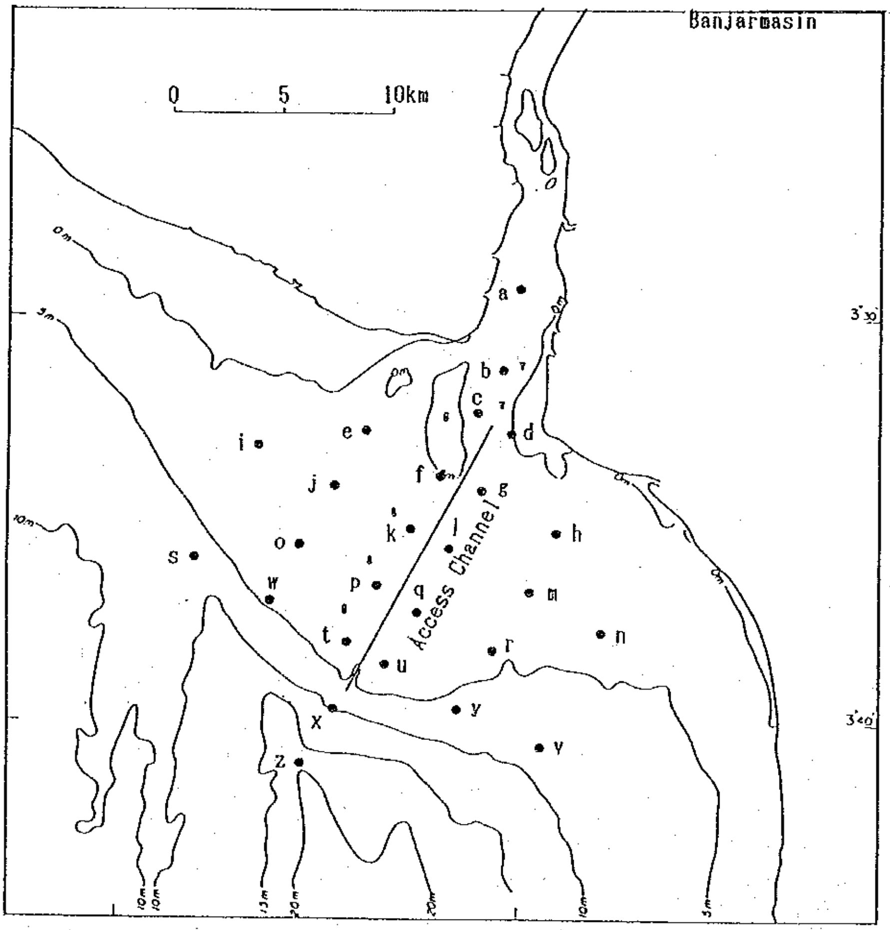


Fig. II.2.5-1 Observation Points of Bottom Materials in the Estuary and Sea Area

2-5-1 Bottom Materials in the River and Access Channel

The grain size distribution for three typical survey periods were selected from 12 survey periods and are shown in Fig.II.2.5-2. The 4th survey was in the rainy season, the 7th in the intermediate season from rainy to dry and the 10th was the dry season.

The bottom materials at all points consisted of principally silt and clay throughout the total survey period. The grain size distribution of the bottom materials in the survey area were:

In the River: The surveys in points G and H were carried out in the dry season, and the sand contents were high at these points, compared with the other points. At the point F4, the dominant material was sand in the rainy and intermediate seasons. At the other points, the contents of bottom materials fluctuated in periods.

In the Access Channel: At point D located upstream of the access channel, the sand content was high in the rainy and intermediate seasons while at point C it was high in the rainy season. At point B located in middle area of the access channel, the sand content was very high in the dry season.

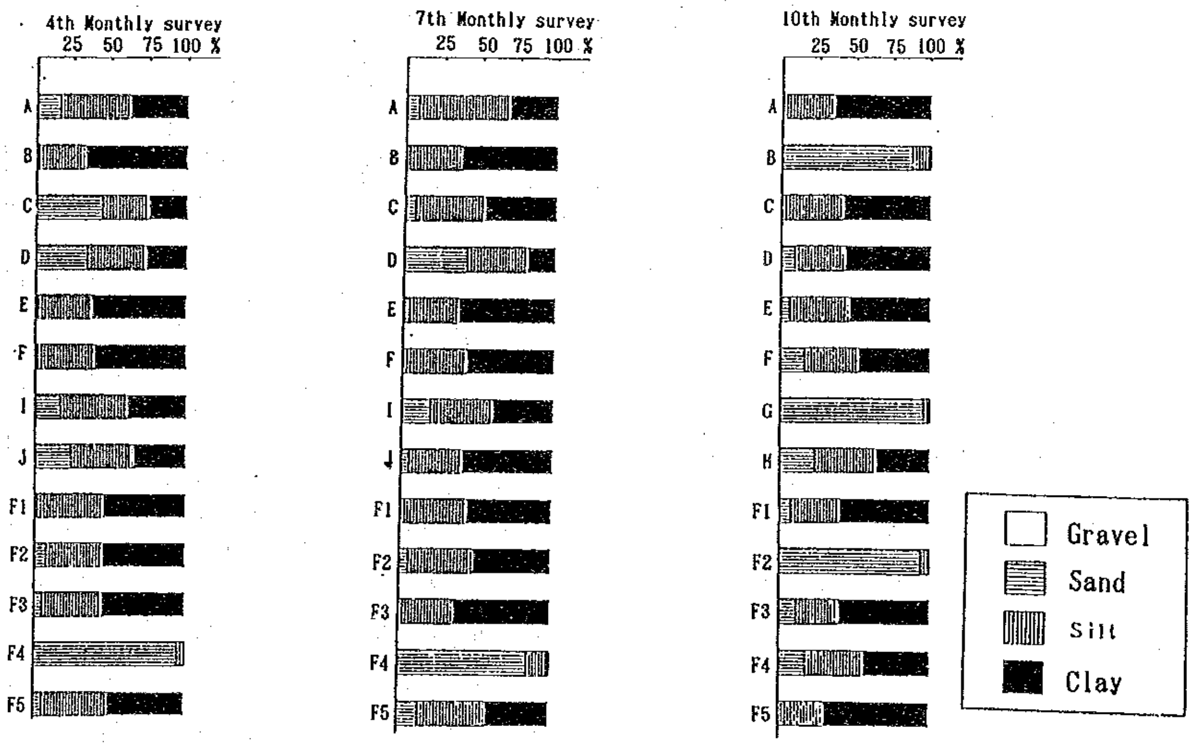


Fig. II.2.5-2 Grain Size Distribution of Bottom Materials in the River and Access Channel

2-5-2 Bottom Materials in the Estuary and Sea Area

Grain size distribution of bottom materials in the estuary and sea area are shown in Fig.II.2.5-3. The results of the 2nd stage survey can be seen. The distribution patterns did not change very much during the total survey period.

The grain sizes in the center of the survey area and the west side of the access channel in the near-shore area were large. In the off-shore area, the east side of the access channel and estuary areas, high contents of silt and clay appeared.

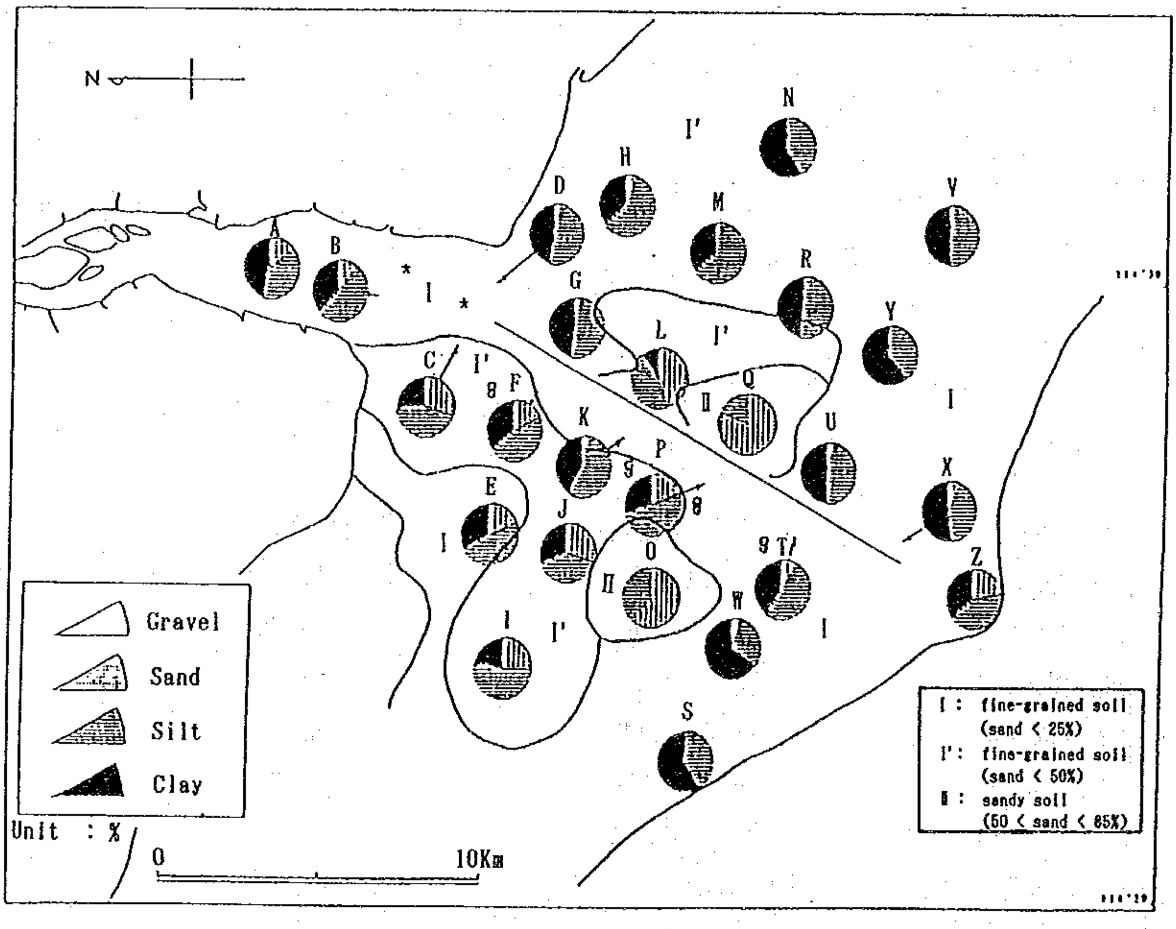


Fig.II.2.5-3 Grain Size Distribution of Bottom Materials in the Estuary and Sea Area

2-6 Bathymetric Change and Siltation Volume in the Access Channel

Sounding in the access channel was carried out from Oct. 1988 to Aug. 1989 about once a month for a total of twelve times.

The sounding area (0.3 x 15km) is shown in Fig.II.2.6-1, and sounding lines are at intervals of 25m transverse to the access channel.

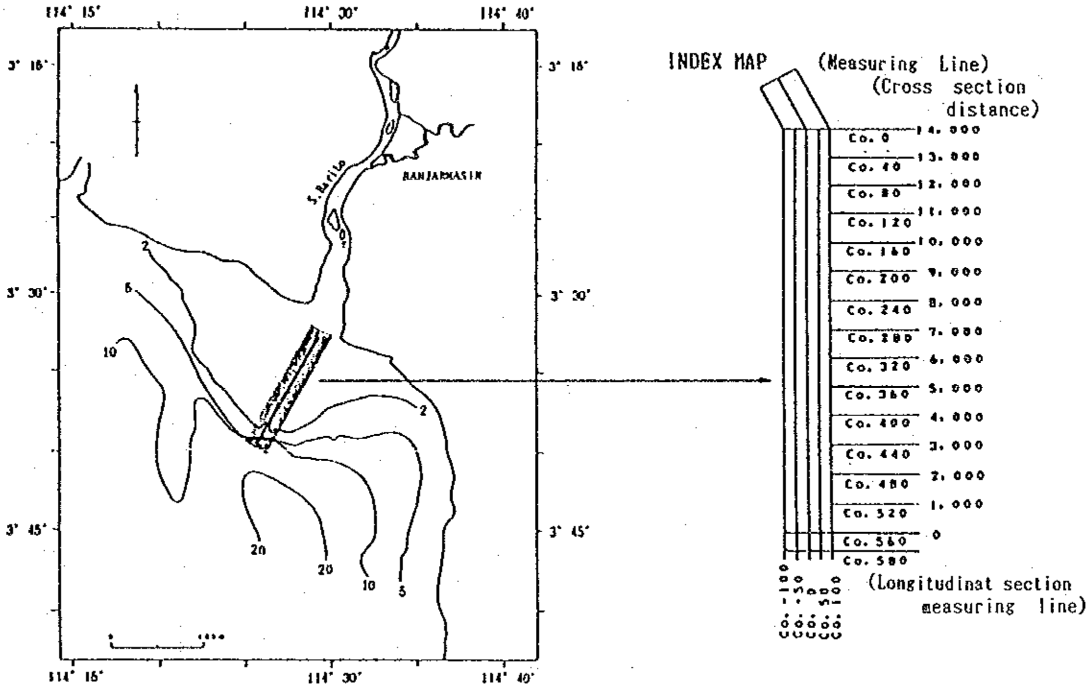


Fig. II.2.6-1 Echo-Sounding Area

2-6-1 Results of Echo-Sounding in the Access Channel

The logitudinal section overlapping drawings of the results at the center line in the access channel, from the 5th to 7th stage during a break in dredging are shown in Fig. II.2.6-2.

According to Fig.II.2.6-2, in the sounding record obtained during the break between the from 6th to 7th stage, two surfaces of the seabed appeared in the reflected planes. The upper reflected plane was from the 210KHz sounding and the lower was the 33KHz sounding.

In the 6th stage, the two surfaces showed some scatter but in the 7th stage, these the divide can be seen over most of area in the access channel.

There are some discrepancies in water depth between the two reflected planes. The discrepancies are about 2-3m and are presumed to be covered by a layer of fluid mud.

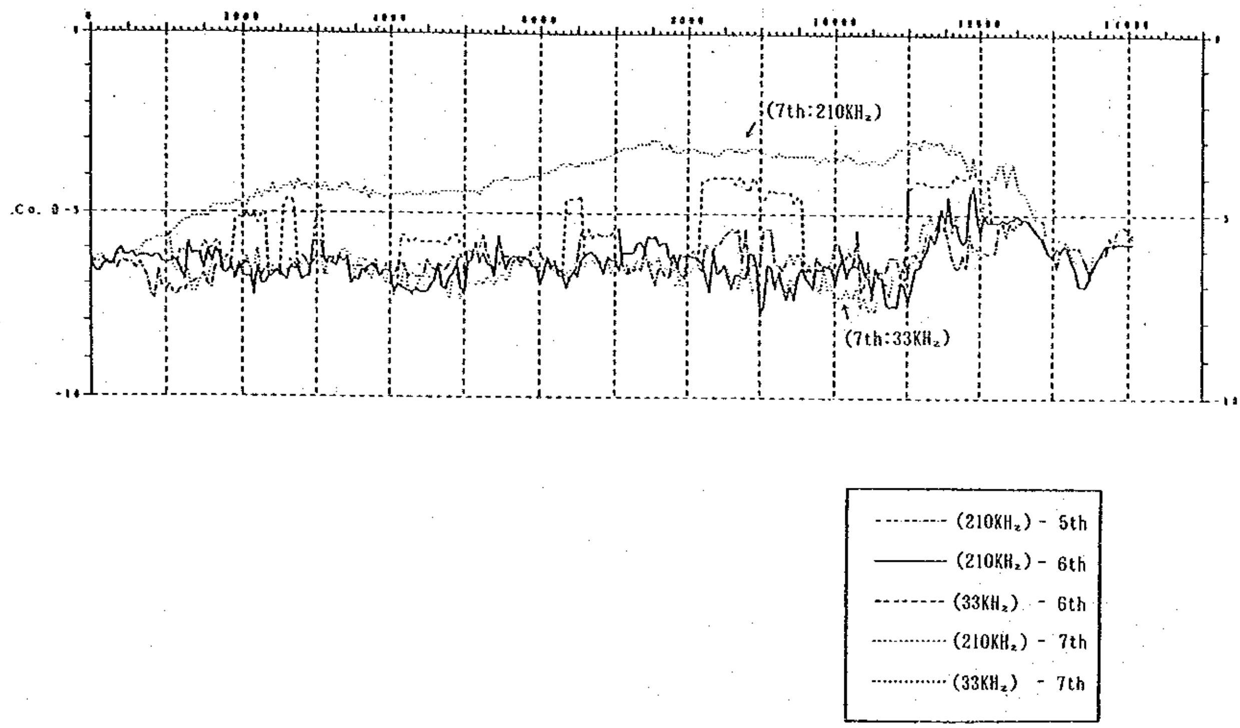


Fig.II.2.6-2 Longitudinal Profile of the Center Line in the Access Channel

2-6-2 Siltation Volume in the Access Channel

Table II.2.6-1 shows the siltation volume which was calculated from water volume change.

The Table shows in the case of the 1st to 4th stages, the siltation volumes decreased during dredging work.

On the other hand when the dredging work ceased, the siltation volumes increased. In particular, the volume in the 7th stage, two months after dredging had ceased, increased to the extent 1.72×10^6 m^3, increasing severe sedimentation was building up.

The volume decreased again after dredging work was resumed.

Table II.2.6-1 Comparison of Water Volume and Siltation Volume in the Access Channel

Stage	Water Volume (m^3)	Siltation Volume (m^3)
1	9,809,592	
		-339,253
2	10,148,845	
		-821,543
3	10,970,388	
		-73,238
4	11,043,626	
		233,858
5	10,809,768	
		269,892
6	10,539,876	
		1,721,419
7	8,818,457	
		61,251
8	8,757,106	
		-431,478
9	9,188,684	
		-180,511
10	9,369,195	
		115,795
11	9,253,400	
		-214,147
12	9,467,547	

2-7 Analysis of Landsat Data

In the study, six sets of Landsat digital data were obtained and are shown in Table II.2.7-1.

The date and time of each set of data were selected to assist a study of coastline changes over the long term, as well as for a seasonal investigation of water quality.

Rainfall and tide level data for the six stages from 1973 to 1989 were obtained for comparison.

Table II.2.7-1 Using Data from Landsat

Date / (Local time)	9 Oct. 1973 (10:01)	1 May. 1984 (10:01)	9 Oct. 1987 (10:02)	18 Apr. 1988 (10:05)	21 Jun. 1988 (10:05)	10 Jul. 1989 (10:02)
Satellite / Sensor	LANDSAT-1 MSS	LANDSAT-4 MSS	LANDSAT-5 MSS	LANDSAT-5 TM	LANDSAT-5 TM	LANDSAT-5 TM
Path-Row	126 - 62	118 - 62	118 - 62	118 - 62	118 - 62	118 - 62
Data form	uncorrected	uncorrected	uncorrected	BULK product	BULK product	uncorrected
Obtained from	EOSAT	TRSC	TRSC	TRSC	TRSC	TRSC
Others / Season	dry season	rainy season	dry season	rainy season	rainy season	end of rainy season
Tide stage	around low	higher low	ebb	ebb	flood around high	flood around high

Note 1 : EOSAT ··· EARTH OBSERVATION SATELLITE COMPANY (U.S.A)
Note 2 : TRSC ··· THAILAND REMOTE SENSING CENTER , NATIONAL RESEARCH COUNCIL OF THAILAND (THAILAND)

2-7-1 Mapping of Coastline Changes

Changes along the coastline of the Barito estuary from 1973 to 1989 are shown in Fig. II.2.7-1.

In the Barito estuary, mangrove vegetation was dominant at the boundary between the sea and the land.

A comparison with 1973 and 1984, showed the vegetation advancing on the Barito and Kapuas rivers.

In 1973, a tidal flat was recognizable along the coastline and this same zone was covered with vegetation by 1984.

Comparisons between 1984 and 1987, and 1987 and 1988, and 1988 and 1989, revealed no special changes comparable to 1973 and 1984.

It was concluded that no changes in the vegetation front were recognizable in the 1 to 3 years in Landsat images applied at a scale of 1:200,000.

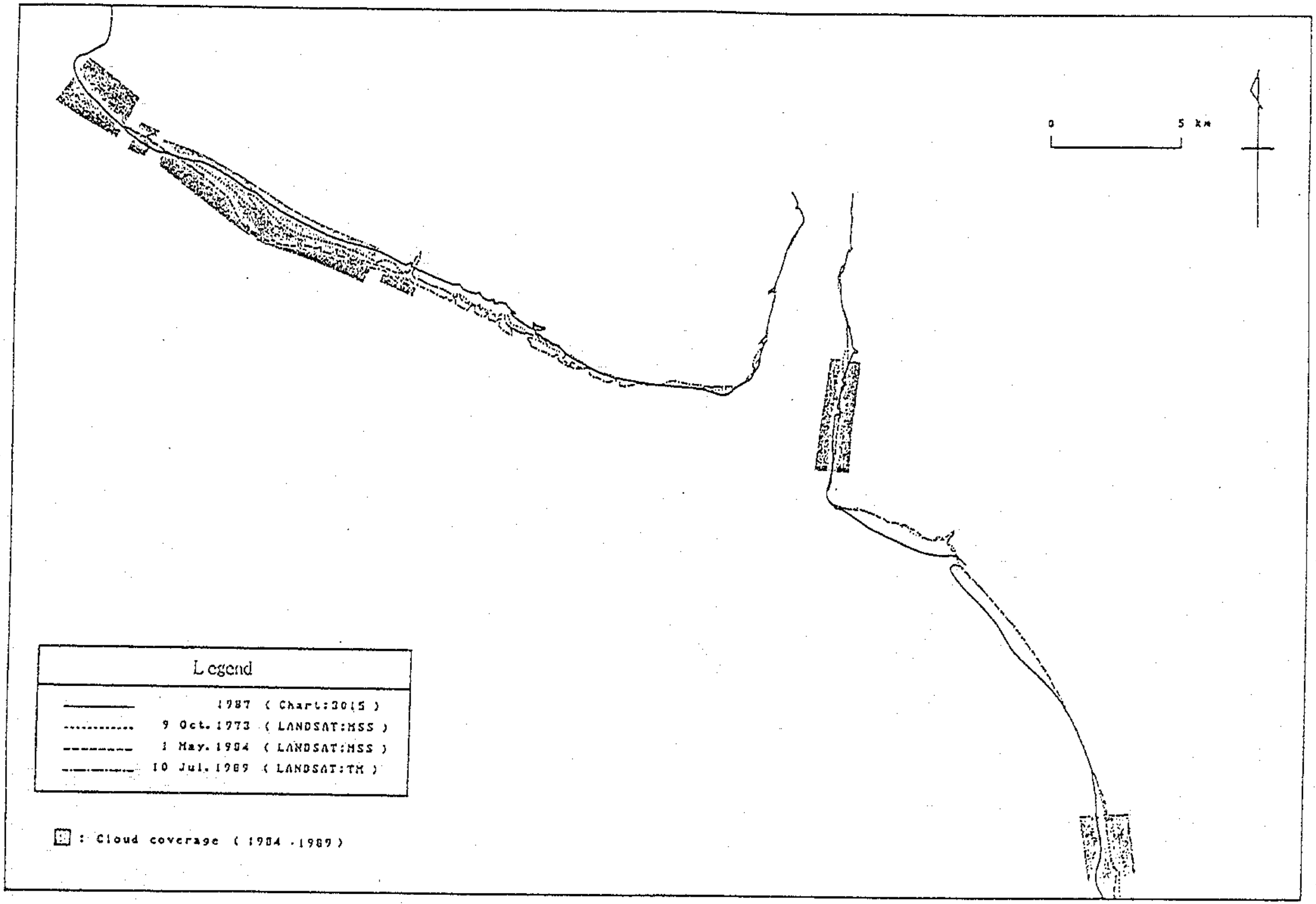


Fig. II.2.7-1 Coastline Change from Landsat Data Analysis

2-7-2 Distribution of Turbidity

Characteristics of the relative turbidity patterns for the six sets of Landsat data were summarized in Tables II.2.7-2(1),(2).

A common feature of the turbidity patterns was that the coastal water was more turbid than the river water in the dry season, whereas the river water became more turbid in the rainy season.

Distribution of turbidity of field observation results from 10:00 to 12:00 a.m. on 9th Jul. 1989, the observation points have already been shown in Fig.II.2.4-1, and the value of the first principal component (PC1) calculated from the Landsat data at 10:00 a.m. is shown in Fig. II.2.7-2.

The turbidity observed progressively decreased downstream along the Barito river, from point H to D, and at point B located in front of the river mouth, it was the minimum. The PC1 count varies in a similar manner.

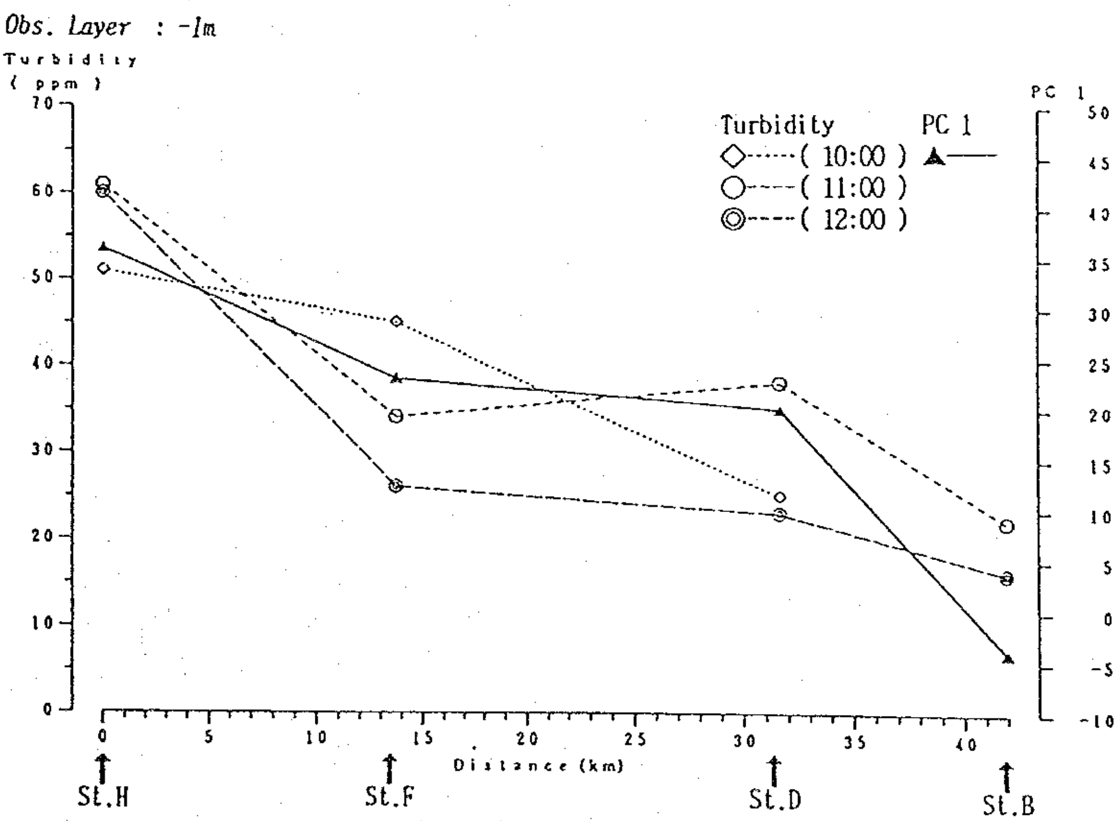
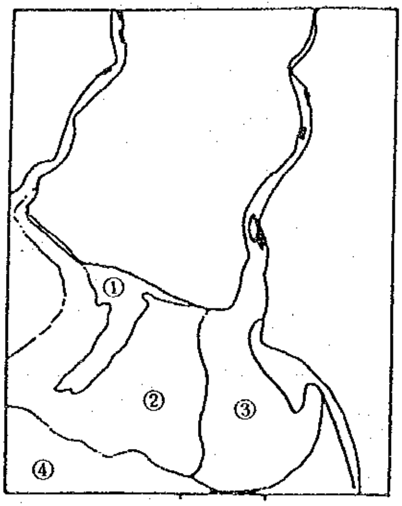
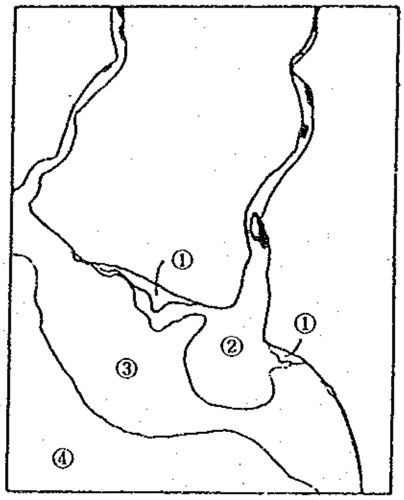


Fig. II.2.7-2 Values of Turbidity and PC1

Table II.2.7-2(1) Features of Turbidity Patterns (1)

Landsat Data	Season etc	Feature of Turbidity Pattern
9 Oct. 1973 (MSS)	· dry · around low tide	There was a clear front between river water and coastal water. River water flowed south. Relative Turbidity ① very heavy ..... coastal water ② heavy ..... coastal water ③ slight ..... river water ④ ocean water 
1 May 1984 (MSS)	· rainy · higher low tide	River water flowed south. River water showed spread pattern reaching the offing. Relative Turbidity ① very heavy ..... coastal water ② heavy ..... river water ③ slight ..... coastal water ④ ocean water 
9 Oct. 1987 (MSS)	· dry · ebb tide	River water flowed south. Relative Turbidity ① very heavy ..... coastal water ② heavy ..... coastal water ③ slight ..... river water ④ ocean water