ANNEX - AQ

AQUA-CULTURE STUDY

ANNEX - AQ

AQUA- CULTURE

TABLE OF CONTENTS

LIST OF TABLES

NOTE AQ-1
REVIEW OF STUDY REPORT PREPARED BY
INDONESIAN FISHERY EXPERT

1. Fresh Water Requirement

The Study Report has proposed the fresh water requirement of 13.54 m^3/s for 13,000 ha of brackish water culture in Sidoarjo area. This estimated requirement seems to be too little. The required fresh water is reviewed under the following considerations and assumptions which are given from the experimental data.

(a) Two crops, dry season and wet season crops, a year are considered

1st crop (Dry season): May to November
2nd crop (Wet season): November to May

J F M A M J J A S O N D	J F M A M J
2nd crop / 1st crop	2nd crop

(b) First two months in each crop are nursery and planting period. Water requirement is calculated dividing into two stages, initial water filling in fish pond and daily irrigation.

(c) Required salinity of brackish water and daily water change are given below.

		Recommended	(Study Report)
(i)	Water depth of fish pond	1.2 m	(1.0 m)
(ii)	Optimum salinity of water	20 ppt	(20 ppt)
(iii)	Sea water salinity	30 ppt	(30 ppt)
(iv)	Change of water for daily irrigation	10 % of pond water volume a day	(3 %)

Fresh water requirement is calculated below.

(1) Initial filling

Total brackish water volume required per ha

= 1.2m x 100m x 100m = 12,000 m^3/ha

Monthly brackish water requirement

= 12,000 m^3/ha ÷ 2 months = 6,000 m^3/ha or
2.31 m^3/s / 1,000 ha

Brackish water with 20 ppt of salinity is produced by mixing fresh water and sea water in the ratio of 1:2, thus

Sea water requirement = 2.31 x 2/3 = 1.54 m^3/s / 1,000 ha

Fresh water requirement = 2.31 x 1/3 = 0.77 m^3/s / 1,000 ha

(2) Daily irrigation

Pond water is changed daily by 10% of pond water volume.

Sea water requirement

= 12,000 m^3/ha x 0.1 x 2/3 = 800 m^3/ha
= 9.26 m^3/s / 1,000 ha

Fresh water requirement

= 12,000 m^3/ha x 0.1 x 1/3 = 400 m^3/ha
= 4.63 m^3/s / 1,000 ha

(3) Unit fresh water requirement per 1,000 ha

Unit fresh water requirement

(m^3/s / 1,000 ha)

Month	1st Crop			2nd Crop			Total of 1st & 2nd Crops
	Initial Filling	Daily Irrigation	Total	Initial Filling	Daily Irrigation	Total	
May	0.77	1.16	1.93		1.16	1.16	3.09
Jun.	0.77	3.47	4.24				4.24
Jul.		4.63	4.63				4.63
Aug.		4.63	4.63				4.63
Sep.		4.63	4.63				4.63
Oct.		3.47	3.47				3.47
Nov.		1.16	1.16	0.77	1.16	1.93	3.09
Dec.				0.77	3.47	4.24	4.24
Jan.					4.63	4.63	4.63
Feb.					4.63	4.63	4.63
Mar.					4.63	4.63	4.63
Apr.					3.47	3.47	3.47

(4) Gross fresh water requirement for Sidoarjo area

When Sidoarjo area is considered for brackish water culture, fresh water requirement is calculated as follows.

a) Fish pond area: Gross area 13,000 ha
Net irrigation area 11,150 ha

b) Water requirement for 11,150 ha

Total water requirement
for 11,150 ha irrigation

(m^3/s)

Months	1st Crop		2nd Crop		Total of 1st & 2nd Crops
	Unit req't	Total req't	Unit req't	Total req't	
May	1.93	21.5	1.16	12.9	34.4
Jun.	4.24	47.3			47.3
Jul.	4.63	51.6			51.6
Aug.	4.63	51.6			51.6
Sep.	4.63	51.6			51.6
Oct.	3.47	38.7			38.7
Nov.	1.16	12.9	1.93	21.5	34.4
Dec.			4.24	47.3	47.3
Jan.			4.63	51.6	51.6
Feb.			4.63	51.6	51.6
Mar.			4.63	51.6	51.6
Apr.			3.47	38.7	38.7

2. Available fresh water

All the fresh water in the Brantas river during dry season is already allocated to other purposes. There would be no room to allocate newly the fresh water to the above fish culture with so much amount of water as more than 50 m^3/s unless otherwise the fresh water is created newly or the fresh water being used for other purposes is transferred for fish culture.

The only possible means to collect water for fishery irrigation is to use return flow from Brantas delta irrigation for paddy field.

The irrigation water to the Brantas delta area which was actually diverted from the main Brantas through Porong and Mangetan canals is as follows:

Month	1980	1981	1982	1983	Average
Jun.	34.2	46.2	37.9	43.1	43.2
Jul.	33.9	41.1	33.2	39.0	39.3
Aug.	30.2	30.0	22.7	24.8	30.1
Sep.	27.4	23.6	18.7	20.1	24.6
Oct.	25.8	25.3	18.7	27.0	25.4
Nov.	48.7	35.4	17.2	42.7	38.7

Average minimum irrigation water to the Brantas delta was 24.6 m^3/s during dry season. Assuming a rate of return flow of 0.3, the available water at the tail of paddy field irrigation area would be 7.4 m^3/s only.

On the other hand, plenty of water is available during rainy season from November to May next year in excess of requirement for existing water usage. (refer to Annex-HY)

3. Proposed brackish water culture

(1) Present culture in Sidoarjo area

Traditional culture for brackish water fisheries in Sidoarjo area is represented as follows.

a) Fisn pond area

Gross area	13,000 ha	
Net area	11,150 ha	
Mono-culture with milk fish	9,750 ha	(87.4%)
Mixed-culture with milkfish and shrimp	1,400 ha	(12.6%)

b) Annual benefit from existing brackish water culture (traditional culture)

From Table AQ-12 of the Study Report (refer to NOTE AQ-2), the benefit from traditional culture is given as follows.

(Rp. 10^3/ha/yr.)

	Mono-culture (milk fish)	Mixed culture (milk fish and shrimp)
I. Fish farm output	1,100.0	2,270.0
II. Fish farm input	551.3	945.7
Note: Excluding costs for pump, materials, and interest in Table 12		
III. Benefit	548.7	1,324.3
(US$ equivalent)	(532.7)	(1,287.3)

Note: US$1.00 = Rp 1,030

Total annual benefit from 11,150 ha in traditional culture is calculated as follows.

Mono-culture	9,750 ha x 532.7 =	US$5,194 x 10^3/yr
Mixed culture	1,400 ha x 1,287.3 =	US$1,802 x 10^3/yr
Total	11,150 ha	US$6,996 x 10^3/yr

(2) Proposed brackish water culture

a) Alternative plans

Following alternatives are considered for comparative study purpose.

Case-1: Intensive culture for 11,150 ha in both wet and dry seasons (when fresh water required is created)

(1-a): 50% of total area for mixed culture with milk fish and shrimp, and 50% for mono-culture with shrimp

(1-b): Total area of 11,150 ha for mono-culture with shrimp

Case-2: Intensive culture for 11,150 ha in wet season only (traditional culture is adopted in dry season since no fresh water is available)

(2-a): 50% of total area for mixed culture with milk fish and shrimp, and 50% for mono-culture with shrimp

(2-b): Total area of 11,150 ha for mono-culture with shrimp

b) Unit annual benefit in intensive culture

Projected fish farm output and input for INTAM PROGRAM (refer to Table AQ-12) are applied.

(Rp 10^3/ha/yr)

	Mixed culture	Mono-culture
I. Fish farm output	5,950.0	11,200.0
II. Fish farm input	4,566.3	7,750.0
Note: Excluding costs for pump, materials, and interest in Table 12		
III. Benefit	1,383.7	3,450.0
(US$ equivalent)	(1,343.4)	(3,349.5)

Note: US$1.00 = Rp 1,030

c) Total annual benefit

Alternative	Pond area (ha)	Unit benefit (US$10^3/yr)	Total benefit (US$10^3/yr)
Case-1 (Intensive two crops per year)			
(1-a) 50% for mixed culture and 50% intensive culture			
- Mixed culture	5,575	1,343.4	7,489
- Mono-culture	5,575	3,349.5	18,673
Total			26,162
(1-b) Mono-culture with shrimp			
- Mono-culture	11,150	3,349.5	37,347

Alternative	Pond area (ha)	Unit benefit (US$10^3/yr)	Total benefit (US$10^3/yr)
Case-2 (One dry season crop of traditional culture and one wet season crop of intensive one)			
(2-a) 50% for mixed culture and 50% intensive culture			
- Traditional culture	9,750		6,547
- Intensive, mixed-culture	5,575	671.7	3,745
- Intensive, mono-culture	5,575	1,674.8	9,337
Total			19,629
(2-b) Mono-culture with shrimp			
- Traditional culture	9,750		6,547
- Intensive, mono-culture	9,750	1,674.8	16,329
Total			22,876

d) Net annual benefit

	With project	Without project	(US$10^3/yr) Net benefit
Case-1			
(1-a)	26,162	6,996	19,166
(1-b)	37,347	6,996	30,351
Case 2			
(2-a)	19,629	6,996	12,633
(2-b)	22,876	6,996	15,880

e) Construction cost

In all the alternative plans, the following rehabilitation works for the existing fish pond area are required

Structure	Length	Max. capacity
i) Fresh water collector	24 km	324 m^3/s
(To be constructed at the tail of paddy irrigation area or the head of fish pond area. The collector canal will also function as a flood way so that flood water is prevented from entering into fish pond)		
ii) Main canal for fresh water supply	32.4 km	28 m^3/s

Structure	Length	Max. capacity
iii) Main canal for sea water supply	37.8 km	56 m^3/s
iv) Secondary canal for fresh water supply	120.0 km	2.6 m^3/s
v) Secondary canal for sea water supply	120.0 km	5.2 m^3/s
vi) Tertiary canal for fresh water supply	about 50 m/ha	1.3 m^3/s
vii) Tertiary canal for sea water supply	about 50 m/ha	2.6 m^3/s
viii) Water mixing pond	about 11,000 m^3 x 120 units	
ix) Control gates structure	in each canal inlet or outlet as required	
x) Rehabilitation of ponds and dikes		

The construction cost is roughly estimated below.

Estimated construction cost

Work items	Quantity	Unit cost (US$)	Amount (US$ 10^3)
Excavation	13,600,000 m^3	1.5 $/$m^3$	20,400
Embankment	3,500,000 m^3	1.8 $/$m^3$	6,300
Gate	560 ton	4,500 $/ton	2,520
Concrete	97,000 m^3	120 $/$m^3$	11,640
Miscellaneous			4,090
Sub-total			44,950
E/S and Administrative expenses (20)			8,990
Contingency			10,790
TOTAL			64,730

f) Economic evaluation

Economic internal rate of return for this proposed fish culture program is calculated below under the following conditions.

i)	Construction period	5 years
ii)	Line time	45 years
iii)	Annual O/M cost	2.5% of construction cost
iv)	Build-up period	Full benefit upon completion of construction work

EIRR thus calculated is summarized below

Alternative cases	Construction cost (US$ 10^3)	Net benefit (US$ 10^3)	EIRR (%)
Case 1-a	64,730	19,166	18.9
1-b	64,730	30,351	30.0
Case 2-a	64,730	12,633	13.2
2-b	64,730	15,880	16.4

NOTE AQ-2

STUDY REPORT ON BRACKISH WATER CULTURE IN BRANTAS DELTA

STUDY REPORT ON BRACKISH WATER
CULTURE IN BRANTAS DELTA

1. Government Policy for Fisheries in East Java

1.1 Government Programme

During REPELITA IV, provincial fisheries service of East Java has planned a programme for developping fisheries in this region. The programme (Anonymous, 1984) consists of ;

(a) Programme in production

The programme aims at:

- intensification of fishing in the sea
- intensification and extensification of culture in brackish water, fresh water, combination between rice and fish (= mina padi culture) and marine culture.

(b) Marketting programme

The aims of this programme are:

- to raise the income of the fishermen / fish farmers
- to supply the fish of the high quality for the consumer with the proper price

There are two sub programmes:

- domestic and export

(c) Supporting industry programme

Supporting industry is very important to support the programme of production, and marketting. These industries involve inland transportation industry, ship industry, port industries, including cold - storage, ice factory etc.

(d) Supporting programme

The aims of this programme are such as to supply the facilities in the center of fish landing, rehabilitation and/or construction of the irrigation and drainage canals.

Among the above programmes, programme in production and supporting programme are briefed below.

(1) Programme in production

Provincial fisheries service of East Java has planned to raise the production of fisheries during REPELITA IV as following

Unit : ton/yr

Branch	Production at the end of REPELITA III	Projection of production at the end of REPELITA IV	Increase of production during REPELITA IV
1. Fishing			
- Sea	163,230	248,030	84,800 (51.9%)
- Open fresh water			

2. Aqua-culture			
- Tambak	33,233	52,180	18,947 (57.0%)
- Sawah tambak	20,955	23,730	2,775 (13.2%)
- Fresh water pond	2,971	4,600	1,629 (54.8%)
- In the rice field	117	160	43 (36.8%)
Total	229,606	338,800	109,194 (47.6%)

The above data shows that the most important sectors of fisheries in East Java are the fishing in the sea and culture in tambak (brackish water pond). To reach or realise the above target or projection, it is obliged to carry out the intensification, extensification, deversification and rehabilitation in fishing as well as in aqua-culture.

The efforts in brackish water culture

(a) The main emphasis of the brackish water culture development are intensification of culture and rehabilitation of the irrigation system. Intensification means use or practise the new method in this culture, which consists of:

(i) improving the pond construction
(ii) regulating the watering of the pond
(iii) using fertilizer
(iv) eradicating the pest/infection
(v) using the fine fry of milk fish and tiger prawn.
(vi) improving the marketting system
(vii) using the proper management

Government hopes, with the above renovation, are: the increase of production of monoculture of milk fish from 700 kg/ha/yr to 1000 kg/ha/yr. The production of mixed-culture of milk fish and tiger prawn is raised from 600 kg/ha/yr of milk fish and 200 kg/ha/yr of tiger prawn up to 800 - 1000 kg/ha/yr of milk fish and 400 - 500 kg/ha/yr of tiger prawn at the end of REPELITA IV. The production of monoculture of prawn from 250 kg/ha/yr will be raised up to 800 kg/ha/yr in semi-intensive culture and 1600 kg/ha/yr in intensive culture.

(b) The area of brackish water pond which could be planted with tiger prawn (mixed with milk fish and/or monoculture) is about 40,000 ha or 89.9 % of the total area in East Java. It means that during REPELITA IV the acreage of the prawn culture amounts to about 320 % of that in 1983 (12500 ha).

(c) The consequence of the intensification and extensification of the prawn culture is that East Java will need more fry of tiger prawns (benur). Each year during REPELITA IV, this region needs at least 800 million fry for two crops a year, based on the density of the fry of about 10,000/ha/season. The government will promote the establishment of the private enterprises of prawn hatchery as well as government's hatchery station.

(2) Supporting programme

This programmes consist of :

- sub project of fisheries infra-structure development
- sub project of renovation of small scale fisheries
- sub project of extension service
- sub project of post harvest handling and fisheries management
- sub project of "Perusahaan Inti Rakyat = PIR"
  (= nucleus establishment)

During the REPELITA IV, the programme which has the direct relation to the development of brackish water culture is the rehabilitation of the irrigation and drainage system in the pond areas, especially in Gresik, Surabaya, Sidoarjo, Pasuruhan and Bangkalan (Madura). The first step, in 1984/1985 will be a rehabilitation of tertiary canal irrigation in Gresik and Sidoarjo, 45 km respectively. This programme is financed by the soft loan of ADB. There will be also a programme to supply and rehabilitate the facilities in the centre of fish landing. To rehabilate the existing irrigation and to create a new one is very expensive. Directorate general of fisheries doesn't have facilities and doesn't have enough budget to create such program. It should be the directorate general of irrigation which construct a new irrigation system or rehabilate the existing irrigation. Up to the present time the intention of the works of this institution is supporting the development of irrigation system in paddy field or food crop.

Since 1982, there is protocol of Joint Agreement on:

$\frac{\text{HK - 083 / D5. 4034 / 82K}}{\text{230 / Kpts / Dirjen Air / 82}}$ between directorategeneral of irrigation and directorate general of fisheries, which arrange the construction, rehabilitation and management of the irrigation in the fisheries regions. It is the time for the Brantas Project to give its intention to the irrigation system in the Tambak region, especially in the Brantas delta.

1.2 Brackish Water Culture Supporting Facilities.

(1) Research and extension services

In the Brantas delta, the experiment station of Brackish water culture has been established since 1978 in Bangil, Pasuruan. The main work and function of that station are to practice the new method of brackish water pond culture (Sapta usaha = seven programs of culture : (i) improvement of the pond construction; (ii) regularisation of the water supply; (iii) eradication of pest and desease; (iv) preparation of the soil, fertilization and feeding; (v) utilization of the high quality of seed of milkfish and prawn; (vi) post harvest handling and marketing and (vii) using rational management and giving the extension service or technical guidance to the fish framers about the above method.

(2) Financial facilities

Generally fish farmers have stortage in capital. Since 1980 the Government has supplied a portion of such capital in the form of credit. This program provides extension of advice and credits for inputs of fertilizers, chemicals, cost of living allowance, pond preparation and seeds of milk fish and prawn. Besides that there are also credit for small investation (KIK = Kridit Investasi Kecil) and KMKP (Kredit Modal Kerja Permanen) or Credit of Operational Permanent Cost. Since 1975, there are credits from IBRD/IDA, RCP, and Kredit Pola Bimas (Bimas type credit, and KUD type).

Type of credits which have been held in East Java are:

Source of Credit	Area Ha	Total of credit Rp
1. IBRD / IDA	3,204	598,542,000
2. RCP	2,250	1,885,750,000
3. Pola Bimas (Bimas type)	2,530	1,143,892,000
4. Pola Bimas (KUD type)	2,197	1,674,228,000
Total	10,181	5,302,412,000

There will be an INTAM (program Intensifikasi Tambak = Intensification of brackish water pond culture) which will be held in planting season 1984 (November, 1984). Each fish farmer will receive a credit for Rp. 6.32 million per ha, which consists of investation capital for 2.675 million and operation cost for 3.695 million for the monoculture of shrimp and Rp. 3.34 million for the mixed culture of shrimp and milk fish. The interest of credit is 12 % and the period of credit is 3 - 5 years. The target of this program is to raise the shrimp products from 350 kg/ha/yr up to 1,600 kg/ha/yr (mono-udang or mono-shrimp type), and in mixed culture the target is to raise the production of shrimp and milk fish up to 800 kg/ha/yr and 500 kg/ha/yr respectively.

This intensification program is the first time held in Indonesia. For the sake of security of the credit and also the farmers, the participants are limited and they have been choosen carefully. The requirement of the participants who have been choosen are:

- their tambaks are not inundated in rainy season
- the supply of salt water and fresh water is guaranteed whenever required
- they should practice the new method (Sapta usaha pertambakan).

This year the participants from Brantas delta region only 9 fish farmers (total area of 18 ha). If the result of the first year program (1984/1985) is good, the program will be extended next year.

2. Fisheries Production and Fish Pond Area

2.1 Brackish Water Pond Production

The main products of the brackish water pond culture are bandeng (milk fish), and udang windu (tiger prawn). The others are udang putih (banana prawn), mujair (tilapia), belanak (mullet), udang api-api (endeavour), rebon (mycids) and kepiting (crabs). Tables 1 to 3 show the brackish water pond production by species mentioned above. The most valuable product is tiger prawn, but the production is not as high as milk fish. This commodity needs special condition in its culture (salinity of the water 10 - 25 o/oo the optimal depth of the water 80 -100 cm). Unfortunately in this region, only a little portion of the area of the brackish water pond has that condition. Besides that, East Java lacks about 60 % of the need of the fry of tiger prawn. So that the price of this fry is expensive in the planting season (November - December). As the result, first, the density of fry planted is very low, and secondly, not all the ponds are cultivated with tiger prawn.

The total production of the brackish water pond in Brantas delta is as following:

Unit : ton
: in brackets: Rpx1000

	1978	1979	1980	1981	1982
Brantas delta					
1. Surabaya	1,361.4 (541,843)	4,042.3 (2,943,252)	3,276.0 (2,547,220)	5,152.0 (3,241,450)	5,702.0 (5,812,405)
2. Sidoarjo	6,748.0 (3,042,970)	7,778.8 (9,328,470)	7,553.0 (7,265,861)	8,290.4 (8,996,880)	9,654.7 (9,208,281)
3. Pasuruan	1,305.0 (588,018)	518.0 (421,690)	1,531.0 (1,974,793)	6,617.7 (7,994,920)	2,939.5 (4,059,075)
Total	9,414.4 (4,172,831)	12,339 (12,693,421)	12,360 (11,787,874)	20,060 (20,232,250)	18,296.2 (19,079,761)
Total production of brackish water pond from East Java	16,607.4 (7,351,649)	25,523.8 (20,075,087)	22,940 (17,927,986)	30,779.8 (26,264,729)	30,203 (27,041,675)

Remarks : 1. US$ = Rp 625 : since Nov. 1978
US$ = Rp 970 : since March 1983

The above data shows that Brantas delta is vary important from the point of view of fisheries in East Java. It contributes about 48 - 65 % of the production in East Java (in biomass) or 49 - 70 % in value (Rupiah).

Total fisheries production from East Java in 1982 :
214,803 ton or 90,244 billions rupiah.

2.2 Brackish Water Pond Area in Brantas Delta

East Java has the brackish water pond areafor 46,000 ha or about 22.5 % of the total brackish water pond in Indonesia. In Brantas delta, there are about 22,500 ha and contributes about 49 % of the total pond in East Java (Table 4). This table shows that there is only a little change of area during the last five years, until 1982. But in the last year and may be in the future, the expansion of the industries and housing tend to reduce the area of the pond, especially in Surabaya. The extension of the pond area is limited because to construct a new pond is very expensive and the farmers have difficulty to pay that cost.

The distribution of the brackish water pond in Brantas delta is presented in Table 4. There are three major pond areas namely Surabaya, Sidoarjo and Pasuruan. Economically the three areas are very important because they are situated near big town and port harbour of Surabaya.

2.3 Fish Pond Holder and Average Area per Holder

The total acreage of brackish water pond in Brantas delta was about 22,500 ha cultivated by 6,167 holders in 1982. An average size of holding is 3.6 ha per holder.

Table 5 shows the number of pond households classified by the size of pond in their holding. It shows that average area per holder in Surabaya, Sidoarjo and Pasuruan is about 2.0 ha 6.0 ha and 3.4 ha in 1982 respectively. Economically, such situation is better than average area per farm house hold in paddy farming system. According to RABANAL and JAMANDRE (1975), the average size per holder in Sidoarjo is viable enough for economic management, considering present practice of extensive type management. More studies on this aspect should be required. With improved pond practices together with the establishment of proper irrigation system, the pond production per unit area could be raised. The intensification practices could be carried out in this region.

3. Brackish Water Culture Practice.

3.1 Types of Culturing in Brackish Water Pond.

The types of culturing in brackish water pond in Brantas delta can be roughly classified into three types as following:

Type of Culturing	Kind of fish being planted	Planting time	Harvesting
Type 1			
1st crop	milk fish	Nov. - Dec.	May - June
2nd crop	milk fish	June - July	Oct. - Nov.
Type 2			
1st crop	combination of milk fish and shrimp	Nov. - Jan.	May - July
2nd crop	combination of milk fish and shrimp	June - Aug.	Oct.- Dec.
	or mono milk fish	June - Aug.	Oct.- Dec.
Type 3			
1st crop	shrimp	Nov. - Jan.	May - July
2nd crop	shrimp	June - July	Oct.- Dec.

According to the data on the number of brackish water household by species of fry and regencies (annual report, East Java Province Fisheries Servive) during 1978 - 1982 period, the area of each type of culturing in Brantas delta is compiled in Table 6. It shows that most fish farmers plant milk fish only.

It is caused by following:

(1) The supply of the shrimp fry is limited especially in October - December period. Consequently, the price of shrimp fry is very high in this season, whereas the fish farmers are generally of shortage of capital.

(2) Technically the tambaks in this region are not yet favourable for culturing shrimps. The existing canal system does not support the shrimp culture yet.

Recently, fish farmers began to culture the shrimps. According to the chief of brackish water culture station in Bengil (Pasuruan), about 75 % of the total brackish water pond in Pasuruan are cultivated with shrimps. The high price of the shrimp promotes the spreading of the shrimp culture.

3.2 Fish Farming Practice

(1) Type of tambak
In Brantas delta region there are three types of tambak based on the distance of the tambak from the sea as follows.

(a) "Tambak darat": this type of tambak has nearly fresh water pond characteristic in rainy season. The salinity is about 0-5 ppt, but in dry season the salinity is very high, about 40 - 60 ppt. In this season, the fish farmers have difficulty to change the pond water, especially fresh water. In rainy season the fish farmers cultivate the fresh water fish, like tawes (Punctious sp), mujair (Tilapia sp) as well as brackish water fish, milk fish (Chanos chanos); whereas in dry season they cultivate milk fish. This tambak is located farther from the sea.

(b) "Tambak payau": this type of tambak is really brackish water pond. In rainy season the salinity is about 5 - 20 ppt and in dry season is 20 - 40 ppt. In the both seasons fish farmers cultivate milk fish and shrimp. This type of tambak is located between the Tambak darat and the Tambak asin.

(c) "Tambak asin": this type of tambak is saline water pond. In rainy season the fluctuation of the salinity is about 10 - 25 ppt and in dry season it is about 20 - 40 ppt. Its location is the nearest to the sea. In the both seasons the fish farmers cultivate both milk fish and shrimp.

In Pasuruan regency there is only one type of tambak, that is tambak payau(brackish water pond), whereas in Surabaya and in Sidoarjo there are all types of tambak.

(2) Stocking rate

The species of fish/shrimp cultivated by the farmers are tawes (Punctius javanicus), tilapia (Tilapia mossambica), milk fish (Chanos chanos), and tiger prawn (Penaeus monodon). In the traditional method of farming, gates are opened without fine filter at the spring tide and the fry of mullet, banana prawn and others enter with the salt water into the pond. These species are mullet (Mugil cephalus), banana prawn (P. merguensis), etc.

The stocking rate is as following

	Punctius	Tilapia	Milk fish	Shrimp
per season and per Ha	2000-5000	50-100	2500-5000	2500-5000
	In tambak darat		In tambak payau and asin	

The farmers who cultivate tiger prawn generally utilize fine filter when they open the gate.

(3) Fertilization

Most fish farmers in this region, since long time ago, have utilized fertilizer, the organic as well as the unorganic. Organic fertilizer is such as: manure of poultry, cow, sheep etc. The dose is 1000-3000 kg/ha/yr. Unorganic fertilizer is like UREA, TSP/DSP, of dosage at 50 - 200 kg/ha/yr. However, the quantity being used is lower than the amount recommended by the fisheries extention service.

(4) Supplementary feeding

Supplementary feeding of milk fish and shrimp culture is still in the early stages of development in this region. Most feeding is done to supplement natural productivity, or as an emergency measure when growth of the natural food in the pond become depleted. Types of feed used are;

(a) rice bran with trash fish, molusc, etc.
(b) toads sliced in two
(c) chicken feed (crumbles and fillets)
(d) dedak (bran)

(5) Control of predators, competitors and pests

The following has been identified as causing problems (Problem makers) in brackish water culture:

Predators	Competitors	Pest
fish: eel	snail	crak
crak	fish	Burrowing shrimp
bird	crab	shell
snake	shrimp	mud worm
other		
lizard		

The most effective method of control is prevention. If the proper precautions are taken in maintenance and pond preparation, all predators, competitors and pests will not ordinarily be a problem during the culture period.

The prevention efforts are followings:
(i) proper pond maintenance
(ii) drying the pond bottom
(iii) poisoning before cultivating
(iv) screening water as it enters to the pond.

When the number of predators/competitors/pest in a pond are large, the most effective method to get rid of them is the utilization of the selective poisons. It is recommended to use in monoculture of shrimp only. The use of natural products such as teaseed cake or derris root is recommended. These are safe for shrimp but very effective to kill other organism, especially the fish. They are not harmful to men in a small amounts and they break down and lost their toxicity shortly after application.

Chlorinated hydrocarbon group (DDT, Endrin chlordan, etc.) are not recommended for fish pond.

Sevin and Calcium carbide are effective in killing crabs, but they are also toxic to shrimp. Care must be taken in its utilization in a pond.

(6) In Brantas delta, fish farmers tend to cultivate more fish or shrimp in rainy season than in dry season. Even in Sidoarjo and Bangil, there are many farmers who do not want cultivate shrimp (tiger prawn) in dry season. They are afraid of high salinity in their pond, whereas they know that they can not supply fresh water in this season.

3.3 Labour Requirement and Fish Farm Input

(1) Labour requirement

The labour required presented in Tables 7 to 10. They show the difference in labour requirement among:

(a) traditional method held by fish farmers in this region,
(b) the practice in UPBAP - Bangil (Brackish water culture research station) and
(c) the practice which should be held by the INTAM participants.

In traditional method, fish farmers utilize labour of 150 - 190 md/ha/yr less than the labour of 170 - 219 md/ha/yr being used by UPBAP and the INTAM participants uses very much labour of 445 - 565 man days per ha per year. In the both methods of the traditional and UPBAP, labour requirement for mono milk fish culture is smaller than in mixed culture of milk fish and shrimp (150, 170 in mono milk fish and 190, 219 in mixed culture). The labour requirement in the traditional method and UPBAP practice is not much different, in mono culture of milk fish (150 in traditional method and 170 in UPBAP as well as in mixed culture of milk fish and shrimp (190 in traditional method and 219 in UPBAP).

(2) Fish farm input

Input being used by fish farmers in mono milk fish culture in traditional method is smallest compared with the input in the other type of culturing. The highest input used is in INTAM method. Tables 7 to 10 present the input used in each type of culturing. They show that the more advantage is the method of culturing, the more the input (quantity and quality) being used. The most advantage method is the INTAM program in mono shrimp culture, whereas the worst method is the mono milk fish in traditional type of culturing.

3.4 Production per Hectar and Selling Price

Table 11 shows the production per hectar and price of the main products in the Brantas delta region according to the type of fish farming. The production at present in this region consists of milk fish, shrimp (tiger prawn) and others (banana prawn, endevous, mullet, tilapia). In small scale fish farming, that consists of types 1, 2 and 2a and others (by-products) are also important. Generally this type of product is collected or caught daily by guardian, especially banana prawn and endevous, whereas mullet and tilapia caught at the harvesting time.

The better the method being used, in the brackish water culture, the higher the production of shrimp (tiger prawn) and the smaller the quantity of by product. In UPBAP Bangil and INTAM method, the by product: others, is excluded from the calculation.

3.5 Annual Income per Household

(1) Annual net profit for the main product is estimated based on the average yield of the product, fish farm price and production cost as shown in Table 12 and 13. As presented in those Tables, net profit for the main product at present is estimated at US$477.7/ha/yr for mono milk fish and US$1,145.4/ha/yr for mixed milk fish and shrimp, both in traditional method. Net profit for the main product from the brackish water Research station in Bangil, Pasuruan is estimated at US$247.7/ha/yr for the mono milk fish culture and US$981.5 for the mixed milk fish and shrimp. While the projection of the net profit in INTAM program has estimated at;

US$ 789/ha/yr for the mixed milk fish and shrimp and
US$2,286/ha/yr for the mono shrimp culture.

(2) Typical fish farm income

Annual primary fish farm profit of the existing typical farm is obtained by deducting the annual gross outgo from the annual gross income from the fish culture production.

As mentioned in paragraph precedent, there are three types of culturing in this region, namely, type 1 with double mono milk fish culturing, type 2 (1st crop) with double combination milk fish and shrimp, type 2 (2nd crop) with mixed milk fish and shrimp in rainy season and mono milk fish in dry season and type 3 with double mono shrimp culture. Unfortunately the last type of culture is absent at moment.

Annual primary profit in each type of fish farm is estimated based on the farm size (2 ha, 5.4 ha, and 3.4 ha per households in Surabaya, Sidoarjo and Pasuruan respectively), annual profit of the culturing as well as the culturing pattern.

If the average area of fish farm per house hold in Brantas Delta being used as a basis to calculate annual profit of the typical fish farm, the annual income and capacity to pay of fish farmers in this region is as seen in Table 14. As shown in this table, the minimum capacity to pay is in fish farm type 1 in Surabaya and type 1 in UPBAP Bangil.

4. Problems in Brackish Water Pond

There are three factors which support the tambak for the maximization of production. These factors are:

(1) Condision of land (pH 6.5 - 7 and not porous, etc.).

(2) Utilization of the proper method in caltivation of the fish/prawn such as fertilization, improvement of pond construction, fine fry of milk fish and prawn, etc.

(3) Good system of irrigation and drainage, so that the fish farmers could regulate the salinity in tambak between 10 - 25 PPT.

Among the above factors, the third is in bad condition at present. Nearly all of the irrigation and drainage systems, and the layout of the tambak in the five provinces of tambak - Aceh, West Java, Central Java, East Java and South Sulawesi are old enough. The layout plan and irrigation are irregular.

Technically, the problems in detail are as follows.

(1) The irregular layout plan of tambak causes the irrigation system tortouos and very long, so that it takes long time to fill the tambak with salty water, whereas the supply of such water depends on the length of time and the amplitude of the spring tide.

(2) The other consequence of the irregularity of the layout of tambak is that many of the tambak receive the salt water from the other one. This system of the water flow is called series.

(3) There is no separation between supply canal and drain canal.

(4) Many of the canals covered by sediment.

(5) There is only a little special fresh water irrigation system in the tambak region. Such system is important in the dry season as well as in the rainy season.

(6) There is not much plantation in the dyke of tambak, so that the evaporation is very high. This plantation functions as the wind braker.

4.1 Principal Function of Irrigation System in Brackish Water Culture

(1) Tambak needs salt water as well as fresh water. The salt water is needed daily, whereas the fresh water is needed in the dry season to dilute the water when the salinity rises up to 40 - 70 o/oo. The salt water enters into the tambak in the spring tide. This water should be able to fill the tambak through the main, secondary and tertiary canal. These cannals should be deep enough so that the water can flow fluently. Besides that, these canals should be short enough and straight, so that the water can reach the pond and fill it in a short time. Ideally, there should be a separate drain canal for the draining in the harvest time.

(2) In the dry season, from July until October, the salinity in tambak rises to about 50 - 60 o/oo. This condition is unfavourable to milk fish and especially to the shrimp. In the high salinity, the milk fish and shrimp can not grow or even they will die. This high salinity should be reduced. It means that in this season the farmers need fresh water to dilute the salt water in the pond. But unfortunately, such region generally lacks of fresh water. It is caused by following condition.

   (a) There is only a little special fresh water irrigation canal in tambak
   (b) This region shortage of fresh water, as a result of all the water used up by agriculture, industries and municipality.

(3) In the rainy season, January, February, March, in the tambak region, generally there is too much fresh water. The salinity decreases to almost zero ppt. Growth of P. monodon is reported to be slower at very low salinity.

From the paragraphs (2) and (3) mentioned above, it is concluded that the tambak needs irrigation and drain canal to supply fresh water in the dry season and to flow the excess/surplus fresh water to the sea in the rainy season.

4.2 Water Distribution System

If possible, brackish water ponds should have separate water intake and discharge canals. Water should be taken from one corner of a pond and discharged from the opposite corner. This is especially important for large pond complexs with extensive canal system.

A single canal for intake and discharge of water from a pond complex has the following disadvantages:

(1) All water drained from the ponds is usually not completely discharged from the canal and some of it will reenter the ponds the next time water is taken in.

(2) The spread of desease, parasite or unfavourable quality of water from one pond to another is encouraged because water from one pond can enter another one.

(3) There might be a conflict between farmers concerning usage. For instance, one mitht want high water level in the supply canal so he can harvest milk fish, while another farmer wants the water level low so he can harvest shrimp.

(4) If a single gate is used for both intake and discharge water, exchange of water within the pond will be poor water at the far end is just moved toward the front during draining and then pushed back when new water is taken in.

Separate water intake and discharge canals in a pond complex have the following advantages.

(1) Ponds can be filled better and will not be contaminated by the discharge from other ponds.

(2) The chance of spreading desease and parasite is greatly reduced.

(3) No conflict of usage occurs between farmers.

(4) A better exchange of water is provided for individual ponds.

4.3 Water Change

4.3.1 Teoretical Consideration

(1) Changes of water have a beneficial effect on water quality in a pond. In a pond with static water, accumulation of waste products or depletion of trace metals or organic matters can have a harmful effect on shrimp. Such occurences do not always result in mass mortality which would be easily recognized. They can exert small effects on growth which pass by unnoticed.

(2) It also prevents the build-up of H_2S and NH_3 (which are toxic to the fish and shrimp) in the pond. It is more important in pond culture, where the farmers introduce the fish food for the milk fish and shrimp. The degradation of the rest of the fish food will produce NH_3 and H_2S.

(3) The replacement of the water is to maintain the oxygen dissolved in the pond always more than 3 ppm, and to maintain the temperature of the water in the pond between 20° - 30°.

(4) Change of water is also to replace evaporations and to maintain the salinity constant at about 20 ppt.

(5) Frequent water exchange is also beneficial in introducing new food organism to a pond. In a pond where water is not changed for a long period of time, all the desirable food organism may be eaten or a species not well suited as a food organism may become dominant, suppressing growth of more desirable species. If heavy rains dilute the pond water, species dominant in the pond might not be well suited for growth at the lower salinity. These will die off or grow slowly.

4.3.2 Water Change in Different Types of Culture

(1) Traditional extensive type management

Water should be changed as often as possible. Ordinarily, it could be done on every high tide. This procedure ensures entry of the maximum number of young shrimps and young fish and brings in food organism.

(2) Extensive type management with fertilization

(a) Water is changed every 12 to 14 days. In changing water, one - third of the water in the pond is drained and replenished each day for two or three days. Fertilizer is applied after the water change and then again after six to seven days.

(b) One-half to one-third of the pond water is exchanged once a week. Fertilizer is applied after every change of water

(3) Feeding type management

This type of management requires frequent water change to dilute the waste products formed by the decomposition of unused food and also to ensure that adequate oxygen levels are maintained in the pond water. Decomposing food can easily use up all the dissolved oxygen in the water near the bottom. For this reason, water should be discharged from the bottom of the pond. Two types of water exchange which have been used successfully in ponds are;

(a) A one-third change of water daily by draining and refilling is used in Thailand. Refilling is by pumping.

(b) In Panama, it was reported that when the level of dissolved oxygen in a pond is 3 ppm or above, water is flowed through the pond at a sufficient rate to change 3 % of the water daily. If the level of dissolved oxygen in a pond decreases below 3 ppm, the flow of water is increased.

Directorate general of fisheries (Government of Indonesia) recommends replacement of water in brackish water pond for the INTAM programme by 10 % of the volume daily.

In fact there is no exact data about the volume of the water which should be changed and the frequency of change.

4.4 Fresh Water Requirement

To fill and to change the water in the brackish water pond, the fresh water is required, especially in dry season. The optimum depth of water and the optimum salinity in brackish water pond is one metre and 20 ppt respectively, while the salinity of sea water is about 30 ppt.

In the beginning of the season when the farmers fill the pond for the first time (April - June and October - December) they need much fresh water, they need about 30 % of the volume of water in their pond or about 3,000 m^3/ha.

Total fresh water required in Sidoarjo is:

13,000 ha x 3,000 m^3/ha = 39,000,000 m^3

Based on the theoretical consideration preciously mentioned, supposing that minimum 3 % of the water is changed daily, fresh water required in Sidoarjo is:

3 % x 3,000 m^3/ha x 13,000 ha = 1,170,000 m^3 or
= 13.54 m^3/s.

This water required from June to October. In rainy season there is too much fresh water in this region.

Source of the fresh water

The water source may be:

(1) Directly from the river (K. Porong and K. Surabaya).

(2) Drain water from the upstream rice field. This water is collected in special canal and then distributed into the brackish water pond. It should be garanteed that there is no toxic substances in the drain water.

Figures 2 and 3 show the above explanation.

4.5 Water Quality Requirement

(1) Salinity

In the on going shrimp culture or in the established brackish water culture, the most important quality of the water that influences the growth the development and the life of the shrimp is salinity.

Young shrimps can tolerate wide fluctuations of salinity. Changes in salinity should be as gradual as possible, because abrubt exposure to very low salinity can cause death. Of the important species cultured in these areas (Surabaya, Sidoarjo, Pasuruan, Gresik), it is generally considered that Penaeus monodon and most Metapenaeus spp can grow in almost freshwater, but the optimal growth of P. monodon was obtained over the range 10 - 25 ppt and P. merguiensis over the range 20 - 30 ppt.

Prevention of low salinity is best by locating ponds in areas where the normal range of salinity is within that tolerance of the species to be cultured. Accordingly, culture ponds for P. monodon can be further away from the shore.

To protect against abrupt changes in salinity, the following criteria should be met:

(a) There must be a capacity to change pond water rapidly and whenever it is required.

(b) Diversion canals should be provided to divert rain water runoff from the adjacent land away from the pond, to prevent destruction of dikes and flooding of the pond.

(c) Pond water should be at least 50 cm deep for temperature control. This also aids in control of salinity as the grater water volume provides more protection against dilution. For example, if a pond of 10 cm depth receives 10 cm of rainfall, salinity will drop by 50 %. If the pond water is being maintained at a depth of 50 cm, however, the same 10 cm of rain will only reduce the salinity by 17 %.

(d) To prevent high salinity resulting from evaporation, windbreaks such as tree or high dikes may be useful. Trees with or less evergreen leaves should be used because if a lot of leaves fall into a pond they may cause problem when they decompose.

(2) Oxygen

Maintenance of adequate levels of dissolved oxygen in the pond water is very important for shrimp. Many workers have suggested that the minimum level of oxygen dissolved needed for good shrimp growth is 2 ppm, even the others feel that when dissolved oxygen levels reach 3 ppm or below in pond, remedial efforts are necessary. Growth should be best at dissolved oxygen levels above 3 ppm, and that mortality will accour after short-term exposure at dissolved oxygen levels below 1.2 ppm (Mackay, 1974).

Remedial action when the dissolved oxygen levels reach below 3 ppm is;

(a) Water change, letting a new water into the pond.

(b) Installation of aeration equipment.

(3) PH and Ammonia

The normal pH of brackish water is 8.0 to 8.3.
A low water pH can affect the shrimp directly. Tiger prawn growth is reduced 60 % in a pond with pH of 6.4, in presence of inorganic carbon. A fall in the pH may have indirect effect also, for instance, resistance of the shrimp to pathogen might be reduced. High pH has an effect on ammonia toxicity because it increases the ration of toxic unionized ammonia in solution to the total ammonia present. According to WITKINS (1978), pH has a major effect with the percentage of toxic unionized ammonia being much greater at high pH than at low pH. In water with a temperature of 28°C, salinity of 24 ppt and pH of 6.8, the critical level of 0.1 mg/l unionized ammonia occurs when the total ammonia level is 26.1 mg/l. Maximum acceptable level at which growth would be reduced by only 1 to 2 percent is 0.10 mg NH_3 - N/l (free ammonia). But if the pH is raised to 8.4 (with the same temperature and salinity), a level of 0.1 mg/l unionized ammonia occurs when the total ammonia level is only 0.8 mg/l. Most of the ammonia in a pond is formed as waste products of the organism which are living in the pond. The higher the density of both the species being cultured and the organisms cultured for food, the greater the production of ammonia.

At presence of oxygen, this ammonia will be converted into nitrate, but there is a danger that ammonia produced will exceed the capacity of the pond to convert the ammonia rapidly enough to prevent it from exceeding toxic levels. Some species of algae such as Chlorella sp can utilize ammonia and nitrate directly. However it is very difficult to control the species of algae growing in a pond. An additional factor is that when dissolved oxygen levels are low, nitrates will be reduced to ammonia and low levels of oxygen also increases the toxicity of unionized ammonia, while an increase level of dissolved oxygen reduce toxicity. The simplest way to prevent the build-up of ammonia, the low pH and the other harmful substances is by changing water on a regular basis.

5. Conclusion

Although there is a shortage of valid supporting data, conclusion can be drawn from this study as follows.

(1) Brantas delta is a promising area for the development of brackish water culture in the future.

(2) Brackish water pond in Brantas delta really needs rehabilitation of its irrigation system.

(3) Determination of the minimum requirement of fresh water is very important. Such determination based on the chemical, physical and biological parameters of the water and the mud of the pond, which are tolerable to the shrimps, fish and other living organism. So far there is no valid data about this subject.

(4) In this study, tentatively it is suggested that the minimum fresh water required is 13.54 m^3/s for the Sidoarjo regency (13,000 ha).

(5) The fresh water requirement in future will always increase, whereas the debits in the Brantas river are seemingly constant (or even decrease?). Especially in the dry season, when the fresh water demand is constant, while the debits are very low, so the determination of the quantity of the water being discharged from the rice field (upstream of the brackish water region) is very useful and important. Such descharged water still can be used in brackish water.

LIST OF REFERENCES

1. _____ Laporan tahunan 1978 - 1982 (Lima buku) Dinas Perikanan Daerah Propinsi Tk. I Jawa Timur.
(Annual Report 1978 - 1982, five volumes - Fisheries Service, Province of East Java.in Indonesia).

2. _____ 1978. Manual on pond culture of penaeid shrimp, Asean National Coordination Agency of the Philippines, Ministry of Foreign Affairs, Manila (in English)

3. _____ Fisheries statistics of Indonesia 1976 - 1980 (Five volumes). Directorate General of Fisheries. Dept. of Agriculture, Jakarta. in Indonesia and English.

4. _____ 1982. Pedoman Pembenihan Udang penaeid. Balai Budidaya Air Payau, Jepara. Direktorate Jendral Perikanan Dept. Pertanian, Jakarta
(Manual on hatchery of penaeid shrimp. Centre of Brackish water culture, Jepara. Directorate General of Fisheries, Dept. of Agriculture. in Indonesia).

5. _____ 1983a. Pemupukan dan Makanan Tambahan Unit Pembinaan Budidaya Air Payan, Bangil, Pasuruan, Jawa Timur.
(Fertilization and Feeding Brackish water culture Experimental station, Bangil, Pasuruan, East Java. in Indonesia).

6. _____ 1983b. Pedoman Pemberantasan hama di Tambak. Unit Pembinaan Budidaya Air Payan, Bangil - Pasuruan, Jawa Timur. (Manual on Eradication of Pest and Infection. Brackish water culture experimental station Bangil - Pasuruan East Java. in Indonesia).

7. _____ 1983c. Laporan hasil survai sosial ekonomi Budidaya Tambak di wilayah pilot unit pelaksana proyek (UPP) Jawa Timur. Dirjen Perikanan, Deptan.

7. _____ (Report on Economics survey of brackish water pond culture in the pilot project unit in Bangil - Pasuruan East Java. Directorate General of Fisheries. Dept. of Agriculture.)

8. _____ 1984a. Pedoman Budidaya Tambak, Balai Budidaya Air Payau, Jepara. Dirjen, Perikanan. Dept. Pertanian.
(Manual on brackish water culture. Brackish water aqua culture development center, Jepara, Central Java. Directorate General of Fisheries. Dept. of Agriculture. in Indonesia).

9. _____ 1984b. Budidaya Udang Windu di Jawa Timur. Dinas Perikanan daerah Propinsi Dati I Jawa Timur. Diskusi Teknis Usaha Budidaya Udang Tambak di Jawa Timur. Juli 1984. (Tiger prawn culture in East Java. Technical discussion on tiger prawn culture in brackish water pond in East Java, July, 1984. in Indonesia).

10. _____ 1984c. Program Intensifikasi Tambak (INTAM) tahun 1984/1985. Sekretariat Badan Pengendali Bimas. Dept. Pertanian, Jakarta. (Brackish water intensification programme - INTAM - 1984/1985. Secretariat of the BIMAS control agency. Dept. of Agriculture, Jakarta. in Indonesia).

11. Iswahjudi, 1984. Pendayagunaan pemberian makanan pada Budidaya Udang Windu. Diskusi teknis usaha Budidaya Udang Tambak di Jawa Timur. UPBAP Bangil. (The efficiency utilization of feed on the culture of tiger prawn. A technical discussion of the culture of brackish shrimps in East Java. UPBAP = Brackish water culture research station, Bangil).

12. Jamandre, T.J.Jr. and H.R. Rabanal, 1975. Engineering aspects of brackish water aqua culture in the South China Sea Region. South China Sea Fisheries Development and Coordinating Programme. Manila, Deptember 1975).

13. Mudjiman, A. 1984. Masa Pemiliharaan dalam Usaha Budidaya Udang di Tambak. Diskusi Teknis Usaha Budidaya Udang Tambak di Jawa Timur. Surabaya Juli 1984. Proyek Pembenihan Udang Windu. Situbondo.
(Rearing period in shrimp culture in brackish water pond. Tiger prawn hatchery in Situbondo. East Java. July, 1984).

14. Soe'oed Elfandi, K and A. Purnomo, 1984. Masalah pengairan dalam usaha menunjang Pengembangan Budidaya Tambak. Lokakarya Udang Nasional. Jakarta, 27 - 29 Agustus 1984. (Irrigation problems in brackish water culture development. National symposium on Penaeid shrimp. Jakarta 27 - 29 August, 1984. in Indonesia).

10b. _____ 1984d. Rencana Pembangunan Lima Tahun ke IV (REPELITA IV), 1984 - 1989. Dinas Perikanan Daerah Tk. I Jawa Timur.
(The Fourth Five Years Development Plan, 1984 - 1989, Fisheries service, East Java Province in Indonesia)

TABLE AQ-1 BRACKISH WATER POND PRODUCTION BY SPECIES, REGENCY OF SURABAYA

Unit : ton

No.	Species	1978	1979	1980	1981	1982
1.	Bandeng (Milk fish)	680.2	1,916.8	959.8	1,517.1	2,156.7
2.	Mujair (Tilapia)	260.2	674.2	554.8	883.1	544.6
3.	Belanak (Mullet)	2.4	4.3	106.0	-	-
4.	Kakap (Barramundi)	9.3	8.6	11.3	-	-
5.	Lain-lain (Others)	72.8	430.8	792.0	1,554.0	1,603.4
6.	Udang Windu (Tiger Prawn)	86.4	293.6	177.8	277.3	487.9
7.	Udang Putih (Banana Prawn)	250.1	714.0	571.8	920.5	909.3
8.	Udang Api-api (Endeavour)	-	-	102.5	-	-
9.	Rebon (Mysids)	-	-	-	-	-
10.	Kepiting (Crabs)	-	-	-	-	-
	Total	1,361.4	4,042.3	3,276.0	5,152.0	5,701.9
	Total Product of East Java	16,607.4	25,523.8	22,940.1	30,779.8	30,203.4

TABLE AQ-2 BRACKISH WATER POND PRODUCTION BY SPECIES, REGENCY OF SIDOARJO

Unit : ton

No.	Species	1978	1979	1980	1981	1982
1.	Bandeng (Milk fish)	4,338.0	4,535.5	3,829.3	4,585.8	7,313.0
2.	Mujair (Tilapia)	757.0	977.6	654.0	265.4	299.1
3.	Belanak (Mullet)	-	95.9	30.9	130.4	79.2
4.	Kakap (Barramundi)	-	86.5	10.4	77.6	72.2
5.	Lain-lain (Others)	229.0	413.7	1,041.7	267.9	107.0
6.	Udang Windu (Tiger prawn)	-	1,240.8	1,281.1	1,718.9	866.1
7.	Udang Putih (Banana prawn)	1,374.0	274.2	557.7	1,054.4	857.4
8.	Udang Api-api (Endeavour)	-	43.0	-	-	-
9.	Rebon (Mysids)	-	65.1	116.2	78.1	69.7
10.	Kepiting (Crabs)	-	46.5	31.5	111.9	39.0
	Total	6,748.0	7,778.8	7,552.8	8,290.4	9.654.7
	Total Product of East Java	16,607.4	25,523.8	22,940.1	30,779.8	30,203.4

TABLE AQ-3 BRACKISH WATER POND PRODUCTION BY SPECIES, REGENCY OF PASURUAN

Unit : ton

No.	Species	1978	1979	1980	1981	1982
1.	Bandeng (Milk fish)	724.2	341.6	575.3	2,155.3	1,919.1
2.	Mujair (Tilapia)	249.6	25.1	327.3	1,565.4	150.3
3.	Belanak (Mullet)	14.6	6.7	19.9	296.6	55.9
4.	Kakap (Barramundi)	-	-	3.1	-	-
5.	Ikan lain-lain (Others)	82.6	46.4	92.1	607.5	215.8
6.	Udang Windu (Tiger prawn)	24.9	11.9	55.7	145.0	345.1
7.	Udang Putih (prawn)	197.6	85.1	383.8	1,755.4	199.6
8.	Udang Api-api (Endeavour)	-	-	9.0	-	35.5
9.	Rebon (Mysids)	-	65.1	-	-	-
10.	Kepiting (crabs)	11.7	1.3	64.9	92.5	2.3
	Total	1,305.2	518.1	1,531.1	6,617.7	2,939.5
	Total Product of East Java	16,607.4	25,523.8	22,940.1	30,779.8	30,203.4

TABLE AQ-4 AREA OF BRACKISH WATER POND IN BRANTAS DELTA AND IN EAST JAVE, IN HA (ANNUAL REPORT, 1978 - 1982, FISHERIES SERVICE, EAST JAVA PROVINCE)

	1978		1979		1980		1981		1982	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
A. Brantas Delta										
1. Surabaya	5,984	5,500	5,984	5,522	5,984	5,522	5,984	5,522	5,984	5,522
2. Sidoarjo	13,114	11,900	13,153	11,890	13,153	11,900	13,153	11,900	13,153	11,152
3. Pasuruan	3,363	3,260	3,363	3,260	3,363	3,260	3,363	3,260	3,382	3,260
Total	22,461	20,660	22,500	20,672	22,500	20,682	22,500	20,682	22,500	19,934
B. East Java	44,500	41,988	44,648	39,336	43,079	37,566	46,721	39,054	45,897	38,770

TABLE AQ-5 NUMBER OF BRACKISH WATER HOUSEHOLDER BY SIZE OF CULTURE IN BRANTAS DELTA AND EAST JAVA

Unit : Number

	Year	Average Area Per Holder					Average per holder (Ha)
		2 Ha	2-5 Ha	5-10 Ha	10 Ha	Total	
A. Brantas Delta							
1. Surabaya	1978	90	1,015	205	28	1,338	2.7
	1979	-	2,959	-	-	2,959	2.0
	1980	-	2,959	-	-	2,959	2.0
	1981	-	2,959	-	-	2,959	2.0
	1982	-	2,959	-	-	2,959	2.0
2. Sidoarjo	1978	450	800	500	303	2,053	6.4
	1979	-	625	1,700	-	2,325	5.6
	1980	-	496	1,700	-	2,196	5.4
	1981	-	496	1,700	-	2,196	5.4
	1982	-	2,196	-	-	2,196	6.0
3. Pasuruan	1978	88	373	471	36	968	3.4
	1979	247	464	172	84	968	3.5
	1980	372	450	98	48	968	3.4
	1981	321	466	176	5	768	3.5
	1982	336	487	184	5	1,012	3.4
B. East Java	1978	3,099	3,544	1,730	494	8,869	5.0
	1979	3,306	5,680	2,340	206	11,532	3.9
	1980	3,557	6,815	2,635	83	13,090	3.3
	1981	3,705	6,807	2,570	60	13,142	3.5
	1982	3,600	9,682	1,106	173	14,561	3.1

TABLE AQ-6 THE AREA OF BRACKISH WATER POND BY TYPE OF CULTURE

Unit : Ha

Regency	Year	Type of Culture				
		Mono Milk Fish	Combined Milk Fish - Shrimp	Mono Shrimp	Others	Total
Surabaya	1978	-	-	-	-	-
	1979	5,318	300	300	6	5,984
	1980	5,000	520	400	64	5,984
	1981	4,688	600	620	76	5,984
	1982	4,688	600	620	76	5,984
Sidoarjo	1978	9,239	3,150	584	174	13,153
	1979	10,935	1,620	-	598	13,153
	1980	10,935	1,620	-	598	13,153
	1981	9,630	2,230	-	1,293	13,153
	1982	10,800	1,700	-	653	13,153
Pasuruan	1978	3,033	310	-	20	3,363
	1979	2,190	1,101	-	72	3,363
	1980	2,365	635	-	360	3,363
	1981	2,270	503	-	583*	3,363
	1982	559	2,350	-	453	3,363

* The fry of milk fish and shrimp from the sea enter into the pond when the gate opened.

TABLE AQ-7 LABOUR REQUIREMENTS AND FISH FARM INPUT IN TRADITIONAL BRACKISH WATER POND CULTURE PER HA PER YEAR

	mono milk fish culture	mixed milk fish and shrimp culture
A. Labour requirement (man-days)		
1. Pond preparation	60	70
2. nursery preparation	10	15
3. cherishing :		
- protection		
- manuring	60 /1	75 /1
- irrigation		
4. harvesting	10	15
5. Others	10	10
Total	150	190
B. Farm input		
1. manure (kg)	600 - 1,500	1,000 - 1,500
2. urea (kg)	25 - 100	50 - 150
3. TSP / DSP (kg)	25 - 75	25 - 75
4. pesticide :		
- brestan (kg)	0.25 - 0.5	0.25 - 1.0
- thiodan (l)	0.5	0.5
- tea seed (kg)	20 - 50	20 - 50
5. fish food (kg)	-	700
6. fry :		
- milk fish = nener	5,000 -10,000	3,000 - 7,000
- shrimp = benur	-	5,000 -10,000

/1 done by guardian (= pendega); he is paid at the end of season, about 10% - 13% of the production or abour 30% if he pays also the Labour requirement & input

TABLE AQ-8 LABOUR REQUIREMENT AND FISH FARM INPUT IN MONO CULTURE OF MILK FISH, HELD BY UPBAP/1 - BANGIL, PASURUAN, PER HA PER SEASON

	Rainy season December '83 - May '84	Dry season June '84 - September '84	Annual Total
A. Labour requirement (man-days)			
1. pond and gate preparation	40	50	90
2. cherishing :			
- protection			
- manuring	30 /2	30 /2	60
- irrigation			
3. harvesting	10	10	20
Total	80	90	170
B. Farm input			
1. fertilizer			
- organic (l)	-	3,000	3,000
- urea + TSP (kg)	120	-	120
2. pesticide			
- KCN (kg)	4	4	8
3. fish food (kg)	-	-	-
4. fry	5,000	3,150	8,150
5. pump exploitation (Rp.)	50,000	30,000	80,000

/1 UPBAP = Brackish Water Culture Research Station

/2 done by guardian (pendega).

TABLE AQ-9 LABOUR REQUIREMENT AND FISH FARM INPUT IN MIXED CULTURE: MILK FISH AND TIGER PRAWN, HELD BY UPBAP/1 - BANGIL, PASURUAN, PER HA PER SEASON

	Rainy season December - May '84	Dry season June - September'84	Annual Total
A. Labour requirement (man-days):			
1. pond preparation	58	50	108
2. gate preparation	6	5	11
3. cherishing :			
- manuring			
- protection	40 /2	40 /2	80
- irrigation			
4. harvesting	10	10	20
Sub Total	114	105	219
Annual Total		219	
B. Farm Input			
1. fry of milk fish (nener)	2,000	5,000	7,000
2. fry of tiger prawn (benur)	10,000	10,000	20,000
3. manure (kg or l)	1,000	2,500	3,500
4. urea + TSP (kg)	120	-	120
5. pesticide (kg)	3	3	6
6. pump exploitation (Rp.)	125,000	100,000	225,000

1 US$ = Rp. 1,057.-

/1 UPBAP = Brackish Water Culture Research Station

/2 done by guardian; he is paid at the end of the season

TABLE AQ-10 LABOUR REQUIREMENTS AND FISH FARM INPUT, CALCULATED BASED ON INTAM PROGRAMME /1
(INTENSIVE BRACKISH WATER CULTURE PROGRAM) PER HA PER YEAR

	mono culture shrimp	mixed culture of milk fish and shrimp
A. Labour (man-days):		
1. dikes preparation	75	75
2. pond preparation	200	75
3. preparation of gate	15	15
4. guardian:		
- protection		
- manuring	240	240
- irrigation		
5. harvest	20	25
6. others	15	15
Total	565	445
B. Fish farm input:		
1. fry: shrimp: benur	80,000	40,000
milk fish: nener	-	10,000
2. fish food (kg)	3,200	1,600
3. pesticide:		
- bretan (kg)	1	1
- rolenon (l)	6	6
4. manure (kg)	-	2,000
5. urea (kg)	-	200
TSP (kg)	-	100
6. pump exploitation (Rp.)	120,000	-
7. material (for gate etc.) and pump (Rp.)	275,000	150,000

1 US$ = Rp. 1,057.-

/1 this program be held in 1984/1985, planting season begins November 1984, in East Java.

TABLE AQ-11 ANNUAL PRODUCTION BY TYPE OF FISH FARMING AND PRICE BY SPECIES PRODUCED

1 US$ = Rp. 1,057.-

Types of fish farming		Production (kg/ha/yr)	Price (Rp./kg)
1. Type 1 :	Mono culture :		
	milk fish	800	700
	other's	900	500
2. Type 2 : - 1st	Mixed culture :		
	milk fish	600	700
	shrimp	200	7,000
	other's	700	500
3. Type 2 : - 2nd	Mixed culture :		
	milk fish	700	700
	shrimp	100	7,000
	other's	700	500
4. Type 3 :	Mono culture :		
	shrimp	-	-
5. UPBAP :	Mono culture :		
	milk fish	1,500	750
	other's	-	-
6. UPBAP :	Mixed culture :		
	milk fish	800	700
	shrimp	285	7,600
	other's	-	-
7. INTAM :	Mono culture :		
	shrimp	1,600	7,000
	other's	-	-
8. INTAM :	Mixed culture :		
	milk fish	500	700
	shrimp	800	7,000
	other's	-	-

TABLE AQ-12 ANNUAL NET PROFIT PER HA
IN BRACKISH WATER CULTURE

In Rp. 1,000.- ; US$ = Rp. 1,057.-

	Traditional			Projection of INTAM Program		
	Mono Milk Fish Culture	Mixed Culture Milk Fish	Shrimp	Mixed Culture Milk Fish	Shrimp	Mono Culture Shrimp
I. Fish Farm Output						
1. Yield kg	800 900 /1	600	200 900 /1	500	800	1,600
2. Price Rp.	0.7 0.5/2	0.7	7.0 0.5/2	0.7	7.0	7.0
3. Gross income (1) x (2)	560.0 450.0	420	1,400.0 450.0	350.0	5,600.0	11,200.0
	1,100.0	2,270.0		5,950.0		
II. Fish Farm Input						
4. Fry	150.0	1,000.0	225.0	250.0	1,200.0	2,400.0
5. Fertilizer	37.0	44.0		60.0		-
6. Pestiside	15.0	20.0		85.0		85.0
7. Fish food	-	50.0		1,920.0		3,840.0
8. Hired labour	180.0	220.0		905.0		1,145.0
9. Auction	44.7	68.6		146.2		280.0
10. Guardian 10 % (3 - 9)	104.5	218.1		-		-
11. Pump	-	-		-		125.0
12. Material (gate etc.)	-			150.0		150.0
13. Interest rate (12 % x (4 - 12))	63.7	113.5		399.7		758.4
14. (4 - 13)	595.0	1,059.2		5,116.0		8,783.4
Net Profit	504.9 (US$477.7)	1,210.7 (US$1,145.4)		834.0 (US$789.0)		2,416.5 (US$2,286.0)

/1 Wild shrimp and fish which enter into the pond when high tide

/2 Price of the wild shrimp + fish

TABLE AQ-13 ANNUAL NET PROFIT PER HA IN EXPERIMENTAL BRACKISH WATER CULTURE HELD BY UPBAP /1 BANGIL IN 1984

In Rp. 1,000.- : US$ = Rp. 1,057.-

	Mono culture of milk fish		Mixed culture : milk fish tiger prawn (shrimp)			
	Rainy Season Dec.83 - May 84	Dry Season June 84 - Sept.84	Rainy Season Oct.83 - May 84		Dry Season June 84 - Sept. 84	
			Milk fish	Shrimp	Milk fish	Shrimp
I. Fish farm output						
1. Yield (kg)	938	638	360	160	3,500	125
2. Price Rp. /2	0.7	0.850	0.7	6.5	0.125	7.6
3. Gross income	656.6	542.3	252	1,040.0	437.5	950.0
			1,292.0		1,387.5	
II. Fish farm input (Rp.)						
4. Fry	125.0	78.7	50.0	250.0	125.0	250.0
5. Fertilizer	25.8	60.0	25.8		50.0	
6. Pesticide	7.0	7.0	5,2		5.2	
7. Hired labour	160.0	180.0	148.0		130.0	
8. Auction & Tax	36.1	29.8	42.0		46.0	
9. Guardian	61.0	50.2	125.3		134.1	
10. Pump expl.	50.0	30.0	125.0		100.0	
11. Interest rate 12 % / year	18.4	17.8	30.0		33.0	
Total input	483.3	453.6	801.6		840.4	
Net profit	173.2	88.7	490.4		547.1	
Annual profit	261.9 (US$247.7)		1,037.5 (US$981.5)			

/1 UPBAP : Brackish Water Research Station, Bangil

/2 Being sold in price, not in bulk (kg). The price of fish and shrimp is higher in dry season than in rainy season.

TABLE AQ-14 TYPICAL FISH FARM BUDGET IN BRANTAS DELTA, UPBAP /1 BANGIL, AND INTAM /2 PROJECTION

Rp. 1,000.- 1 US$ = Rp. 1,057.-

	Brantas delta							UPBAP Bangil		Projection of INTAM	
	Sidoarjo			Surabaya		Pasuruan					
	type 1	type 2	type 2a	type 1	type 2	type 1	type 2	type 1	type 2	type 2	type 3
A. Income average cultivated area (ha)	5.4	5.4	5.4	2.0	2.0	3.4	3.4	3.4	3.4	2.0	2.0
Net profit /ha	504.9	1210.7	857.8	504.9	1210.7	504.9	1210.7	261.9	1037.5	834.0 (US$789)	2416.5 (US$ 2,286)
Total profit	2726.5	6537.8	4632.1	1009.8	2421.4	1716.6	4116.4	890.4	3527.5	1668.0	4433.0
B. Over head cost	50.0	50.0	50.0	20	20	32	32	32	32	20	20
Taxes											
Living expenses /3	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0
C. Capacity to pay (C = A - B)	1476.5	5287.8	3382.1	0	1201.4	484.6	3004.4	0	2295.5	448	3213.0

/1 UPBAP = Brackish Water Research Station, Bangil

/2 INTAM = Tambak Intensification, like BIMAS in agriculture

/3 According to "Result of the Social - Economics Survey of rackish Water Fish Farmers in Pasuruan, East Java, 1983", Directorate General of Fisheries, Dept. of Agriculture, Jakarta.

ANNEX WM

WATER MANAGEMENT STUDY

ANNEX WM

LIST OF TABLES

LIST OF FIGURES

Table WM-1 (1) LIST OF EXISTING COMMUNICATION NETWORK IN BRANTAS OFFICE

Name of Station	Elevation (m)	Antenna Mast Type	Antenna Mast Height (m)	Destination of Communication	Transmitting Power (W)	Frequency Transmitting (Receiving) (MHz)	Type of Antenna	Type of Radio Equipment	Licensed Date	Marker	Power Source (V)	Remarks
1. Malang	450	Tower	25	Sengguruh	3	151.8 (152.25)	3EL(V)	TAC-200	Nov.'82	RCA	110	DUP
				Karangkates	5	49.9 (47.0)	3EL(H)	MBA 15 WA	Mar.'75	RCA		DUP
				Jakarta	100	10,938 7,308 3,785	DOUBLET (H)	RF-2,200	Jul.'73	RFC		SIP
	FB, ML			Station 2,3,4,5	1-10	143,975	WHIP(V)	TR-9,000	Jul.'82	Kenwood		SIP
2. Sengguruh	299	Pole	30	Malang	3	152.25 (151.8)	3EL(V)	TAC-200	Nov.'82	RCA	220	DUP
				Karangkates	3	159.95 (152.95)	3EL(V)	TAC-200	Nov.'82	RCA		DUP
	FB, ML			Station 1,3,4,5	1-10	143.975		TR-7,800		Kenwood		SIP
3. Tulungagung	85	Tower Pole	30 30	Wlingi	20	47.3 (38.8)	3EL(H)	MBA 15 WA	Mar.'75	RCA	110	DUP
				Kediri	5	47.2 (47.7)	3EL(H)	MBA 15 WA	May '77	RCA		DUP
				Neyama	25	151.75 (140.70)	5EL			RFC		DUP
				Wonorejo ML	30	152.25 (151.8)	5EL	TAC-200	Nov.'82	RFC		SIP
	FB, ML			Station 1,2,4,5	25	143,975	WHIP(V)	TR-7,800		Kenwood		SIP
4. Kediri	80	Tower	32	Tulungagung	5	47.7 (47.2)	3EL(H)	MBA 15 WA	May '77	RCA	110 220	DUP
				Ploso	30	47.0 (38.8)	3EL(H)	MBA 15 WA	Jan.'78	RCA		DUP
				Widas	25	49.9 (47.1)	3EL(H)	MBA 15 WA	Jan.'78	RCA		DUP
				Ploso Widas	100/25	155.05	5EL(V)	V 600 H	Mar.'83	UTS		SIP
	FB, ML			Station 1,2,3,5	40	143,975	WHIP(V)	TR-7,950		Kenwood		SIP
5. Surabaya	5	Pole	30	Porong	25	47.2 (40.1)	3EL(H)	CMFM7A MMA	May '77	RCA	110	DUP
				Kernung Perning Mojokerto Porong	25	71.2	BROWN(V)	VF-25N MK-II	Nov.'78	Furuno		SIP
	FB, ML			Station 1,2,3,4	1-10	143,975		TR-7,850		Kenwood		SIP
6. Selorejo	637	Pole	20	FB, ML	15	143,975	WHIP(V)	TR-9,000		Kenwood	110 220	SIP

Note: FB : Fixed Base
ML : Mobile Land
DUP : Duplex Line
SIP : Simplex Line

(Source : Ref. No. WM 06)

-- to be continued --

Table WM-1 (2) LIST OF EXISTING COMMUNICATION NETWORK IN BRANTAS OFFICE

Name of Station	Elevation (m)	Antenna Mast Type	Antenna Mast Height (m)	Destination of Communication	Transmitting Power (W)	Frequency Transmitting (Receiving) (MHz)	Type of Antenna	Type of Radio Equipment	Licensed Date	Marker	Power Source (V)	Remarks
7. Karang-Kates	285	Tower	35	Malang	5	47.0 (49.9)	3EL(H)	CMFM7A MNA	Mar.'75	RCA	110 220	DUP
				Wlingi	10	47.1 (40.1)	3EL(H)	CMFM7A MNA	Mar.'75	RCA		DUP
				Sengguruh	5		3EL(V)	TAC-200	Nov.'82	RCA		DUP
8. Wlingi		Tower	32.75	Karang-kates	15	40.1 (47.1)	3EL(H)	CMFM7A MNA	Mar.'75	RCA	110	DUP
				Tulunga-gung	15	38.8 (47.3)	3EL(H)	CMFM7A MNA	Mar.'75	RCA		DUP
9. Porong	6	Pole	25	Surabaya	25	40.1 (47.2)	3EL	CMFM7A MNA	May '77	RCA	110	DUP
				Mojokerto	5	40.1 (47.3)	3EL(H)	CMFM7A MAN	Mar.'75	RCA		DUP
				Surabaya	25	71.2	BROWN(V)	VF-25N MK-II	Nov.'78	Furuno		SIP
10. Wonorejo		Pole	40	Tulunga-gung	10	151.8 (152.25)	3EL(V)	MCA33AA 11A	Nov.'82	RCA	220	DUP
				Tulunga-gung		151.25	5 EL	FM150/ 1-AT550		RFC		SIP
11. Ploso	31.6	Tower	32	Mojokerto	5	40.1 (47.3)	3EL(H)	MBA 15WA11	Jan.'78	RCA		DUP
				Kediri	25	38.8 (47.0)	3EL(H)	MBA 15WA11	Jan.'78	RCA		DUP
						155.05	3EL(V)	V600M	Mar.'83	UTS		SIP
12. Widas	93	Pole	35	Kediri	30	47.1 (49.9)	3EL(H)	CMFM7A MMA DOUBLET (H)	Jan.'78	RCA	110 220	DUP
				Malang	15							
				Kediri	25	155.05	3EL(V)	V6M		UTS		SIP
13. Mojokerto (Lengkong Baru)	20	Pole	30	Porong	5	47.3 (40.1)	3EL(H)	CMFM7A MMA	Mar.'75	RCA	110	DUP
				Ploso	5	(47.3) (40.1)	3EL(H)	MBA 15WA11	Jan.'78	RCA		DUP
				Surabaya	25	71.2	3EL(V)	VH-25N MK-II	Nov.'78	Furuno		SIP
14. Neyama	152	Pole	20	Tulunga-gung	25	140.70 (151.75)	5EL			RFC	220	DUP
					20	151.75	5EL			RFC		SIP

(Source: Ref. No. WM 06)

Table WM-2 LOCATION OF RADIO TELECOMMUNICATION EQUIPMENT FOR FLOOD FIGHTING

No.	TYPE OF INSTRUMENTS	FQ	CALL SIGN	LOCATION OF INSTRUMENTS	OPERATOR	REMARKS
1.	SBB	7308 KHz	HP. 21	Gunung Kelud Project Office	Hery Susanto	
2.	RIG / VHF	143.700 KHz	PK. 01	Gunung Kelud Project Office	Hery Susanto	
3.	HT / VHF	143.700 KHz	PK. 07	Damarwulan (Konto River)	Sudarso	
4.	RIG / VHF	143.700 KHz	PK. 05	Pucangsimo (Konto River)	Suhartomo	
5.	RIG / VHF	143.700 KHz	PK. 02/H	Margo Mulyo (Supervisor Station)	Supriyadi	
6.	HT / VHF	143.700 KHz	PK. 2/B	Badak (Supervisor Station)	Maryoko	
7.	HT / VHF	143.700 KHz	PK. 06	Sumbersari (Badak River)	-	
8.	RIG / VHF	143.700 KHz	PK. 03	Blitar Unit Office	Sukardjono BE	
9.	RIG / VHF	143.700 KHz	PK. 04/M	Car AG. 114	Imam Supardi	
10.	HT / VHF	143.700 KHz	PK. 04/I	Project Leader House	KS. Djasmani BE.	
11.	HT / VHF	143.700 KHz	PK. 01/I	Flood Picket Supervisor	-	
12.	RIG / VHF	143.700 KHz	-	Flood Fighting Station	-	The location is to be conformity with damage

(Source; Ref. No. WM-03)

TABLE MW-3 LIST OF RAINFALL GAUGING STATION

No.	Name of station	Basin	Remarks
1	Karangkates	Brantas	
2	Kesamben	Brantas	
3	Doko	Brantas	
4	Tunggorono	Brantas	
5	Babadan	Brantas	
6	Sumberagung	Brantas	
7	Semen	Brantas	
8	Nyunyur	Brantas	
9	Wates	Brantas	
10	Birowo	Brantas	
11	Wlingi dam	Brantas	With water level gauge
12	Jeli	Brantas	With water level gauge
13	Kediri	Brantas	With water level gauge
14	Kertosono	Brantas	With water level gauge
15	Ploso	Brantas	With water level gauge
16	Jombok	Selorejo	
17	Sekar	Selorejo	
18	Bendosari	Selorejo	
19	Tawangsari	Selorejo	

(Source; Ref. No. WM 06)

TABLE WM-4 LIST OF WATER LEVEL GAUGING STATION

No.	Name of Station	River	Remarks
1.	Pohgajih	Brantas	Left bank
2.	Wlingi dam	Brantas	Near gate
3.	Lodoyo	Brantas	Right bank
4.	Jeli	Brantas	Left bank
5.	Kediri	Brantas	Left bank
6.	Kertosono	Brantas	Right bank
7.	Ploso	Brantas	Right bank
8.	Lengkong Widas	Widas	Left bank
9.	Terusan	Brantas	Right bank
10.	New Lengkong	Porong	Left bank
11.	Porong	Porong	Left bank
12.	Perning	Surabaya	Right bank
13.	Selorejo dam	Konto	Near gate

(Source ; Ref. No. WM 06)

Table WM-5(1) COST ESTIMATE ON EACH STATION OF TELECOMMUNICATION SYSTEM

Item	Unit	MALANG	SENGGU-RUH	KARANG-KATES	WLINGI	LODOYO	TULUNG-AGUNG	WONO-REJO	KEDIRI
1. Multiplex radio transmitter/ receiver									
1) 7-7.5 GHz, 60-120 cH dual type FM	set	1	2	2	2		2		1
2) 400-800 MHz, 24-60 cH dual type FM	set								1
3) 6-12 cH, dual type FM	set	1			1	1	1	1	
2. Multiplex carrier terminal with E-M signalling									
1) End terminal	set	2			1	1		1	
2) Branch terminal	set		1	1	1		1		2
3) 4 way branching equipment	set						1		
3. Supervisory control equipment	set	1	1	1	2	1	2	1	1
4. Test equipment		1							
5. Antenna equipment									
1) Parabolic antenna	Nos	2	2	2	3	1	3	1	2
2) Wave guide	unit	1	2	2	2		2		1
3) Dehydrater	set	1	1	1	1		1		
4) Coaxial cable	unit	1			1	1	1	1	1
5) Cable connector	Nos	2			2	2	2	2	2
6. Reflector					2				
7. Radio tower									
1) Tower	Nos	1	1	1	1	1	1	1	1
2) Lightning arrester	unit	1	1	1	1	1	1	1	1
8. Telephone equipment									
1) Exclusive telephone equipment	unit	1							
2) Private automatic branch exchange PCM type	unit	1							1
3) Key telephone equipment	unit		1	1	1	1	1	1	
9. Power supply equipment									
1) UPS equipment 0.5-1.0 hour	set	1	1	1	1	1	1	1	1
2) UPS equipment 5 hours	set								
3) Engine generator continual time 10-48 hours	set	1					1		1
4) AVR with isolation trans.		1							1
10. Building floor area	m^2	176	25	25	25	21	41	22	40
1) Equipment cost	$x10^3$(¥)	103,100	49,000	51,500	65,500	14,100	63,200	15,200	59,000
2) Spare parts and accessories	$x10^3$(¥)	18,100	8,700	9,000	10,900	2,600	12,600	2,800	10,500
3) Construction cost	$x10^3$(¥)	23,700	15,000	16,400	34,400	3,900	20,000	4,300	18,300
Sub total	$x10^3$(¥)	144,900	72,700	76,900	110,800	20,600	95,800	22,300	87,800
4) Building	$x10^3$(¥)	52,800	7,500	7,500	7,500	6,300	12,300	6,600	12,000

Table NM-5(2) COST ESTIMATE ON EACH STATION OF TELECOMMUNICATION SYSTEM

Item	Unit	PLOSO	NEW LENGKONG	PORONG	SURABAYA	PENGAIPAN SURABAYA	PUJON	SELOREJO	TOTAL COST
1. Multiplex radio transmitter/ receiver									
1) 7-7.5 GHz, 60-120 cH dual type FM	set								
2) 400-800 MHz, 24-60 cH dual type FM	set	2	2		1				
3) 6-12 cH, dual type FM	set		1	1	1	1	2	1	
2. Multiplex carrier terminal with E-M signalling									
1) End terminal	set		1	1	2	1		1	
2) Branch terminal	set	2	2				1		
3) 4 way branching equipment	set								
3. Supervisory control equipment	set	1	2	1	2	1	1	1	
4. Test equipment									
5. Antenna equipment									
1) Parabolic antenna	Nos	2	3	1	2	1	2	1	
2) Wave guide	unit						1	1	
3) Dehydrater	set						1	1	
4) Coaxial cable	unit	2	3	1	2	1	1		
5) Cable connector	Nos	4	6	2	4	2	2		
6. Reflector								2	
7. Radio tower									
1) Tower	Nos	1	1	1	1	1	1	1	
2) Lightning arrester	unit	1	1	1	1	1	1	1	
8. Telephone equipment									
1) Exclusive telephone equipment	unit								
2) Private automatic branch exchange PCM type	unit				1				
3) Key telephone equipment	unit	1	1	1				1	
9. Power supply equipment									
1) UPS equipment 0.5-1.0 hour	set	1	1	1	1		1	1	
2) UPS equipment 5 hours	set								
3) Engine generator continual time 10-48 hours	set	1		1	1		1		
4) AVR with isolation trans.		1	1	1					
10. Building floor area	m^2	40	10	36	40	21	31	23	576
1) Equipment cost	$x10^3$(¥)	46,000	50,200	22,300	46,700	13,400	33,200	38,600	671,000
2) Spare parts and accessories	$x10^3$(¥)	8,100	8,800	3,900	8,600	2,600	6,100	6,000	119,300
3) Construction cost	$x10^3$(¥)	13,900	14,300	6,500	13,700	3,000	8,400	25,600	221,400
Sub total	$x10^3$(¥)	68,000	73,300	32,700	69,000	19,000	47,700	70,200	1,011,700
4) Building	$x10^3$(¥)	12,000	3,000	10,800	12,000	6,300	9,300	6,900	172,800

Table WM-6 (1) COST ESTIMATE TABLE ON EACH PLACE FOR COMPUTER SYSTEM

No.	Item	Unit	MALANG WCC	SENGGURUH dam	KARANGKATES dam	WLINGI dam	LODOYO dam	WONOREJO dam	TULUNGACUNG Office	KEDIRI Office
1.	CPU word length 32 bit	set	1							
	Main memory 2 MB									
	Winchester disk 120 MB	set	1							
	Cartridge disk 10 MB	set	2							
	Magnetic tape 40 MB	set	1							
	System console with CRT, printer	unit	1							
	Operating system	lot	1							
2.	Communication control unit for 14 RTU	unit	1							
3.	MODEM	Nos	14							
4.	Line printer 300 line/min	set	1							
5.	Copier colour	set	1							
6.	Mimic board 5 - 6 m x 2.5 m	unit	1							
7.	Colour graphic 20 inch	set	2							
8.	Operator console	unit	2							
9.	Dam data display unit	unit	6							
10.	Software System planning, data base draw up etc. But except application program such as flood forecasting	lot	1							
11.	Cooling equipment	unit	1							
12.	Facsimile	set	1	1	1	1		1		1
13.	Microfilm processor	unit	1							
14.	RTU A type 1,200 bit/sec with MODEM	set		1	1	1	1	1		1
15.	Interface equipment	unit		1	1	1	1	1		1
16.	Digital data display panel wall mounting type	unit		1	1	1	1	1	1	1
17.	Typewriter	set		1	1	1	1	1	1	1
18.	RTU B type 1,200 bit/sec, with MODEM	set							1	
19.	Building floor area	m^2								
	Equipment cost	$x10^3$(¥)	378,800	34,600	34,600	34,600	32,500	34,600	20,500	34,600
	Spare parts and accessories	$x10^3$(¥)	21,500	5,000	5,000	5,000	4,800	5,000	2,600	5,000
	Construction cost	$x10^3$(¥)	27,200	5,200	5,200	5,200	4,800	5,200	2,600	5,200
	Sub total	$x10^3$(¥)	427,500	44,800	44,800	44,800	42,100	44,800	25,700	44,800
	Building	$x10^3$(¥)								

Table WM-6(2) COST ESTIMATE TABLE ON EACH PLACE FOR COMPUTER SYSTEM

No.	Item	Unit	PLOSO Office	NEW LENGKONG dam	POLONG Office	SURABAYA Office	PENGAIRAN SURABAYA	CIPTA KARYA	SELO-REJO dam	TOTAL COST
1.	CPU word length 32 bit	set								
	Main memory 2 MB									
	Winchester disk 120 MB	set								
	Cartridge disk 10 MB	set								
	Magnetic tape 40 MB	set								
	System console with CRT, printer	unit								
	Operating system	lot								
2.	Communication control unit for 14 RTU	unit								
3.	MODEM	Nos								
4.	Line printer 300 line/min	set								
5.	Copier colour	set								
6.	Mimic board 5 - 6 m x 2.5 m	unit								
7.	Colour graphic 20 inch	set								
8.	Operator console	unit								
9.	Dam data display unit	unit								
10.	Software System planning, data base draw up etc. But except application program such as flood forecasting	lot								
11.	Cooling equipment	unit								
12.	Facsimile	set		1		1			1	
13.	Microfilm processor	unit								
14.	RTU A type 1,200 bit/sec with MODEM	set		1		1			1	
15.	Interface equipment	unit		1		1			1	
16.	Digital data display panel wall mounting type	unit	1	1	1	1	1	1	1	
17.	Typewriter	set	1	1	1	1	1	1	1	
18.	RTU B type 1,200 bit/sec, with MODEM	set	1		1		1	1		
19.	Building floor area	m^2						14		
	Equipment cost	$x10^3$(¥)	20,500	34,600	20,500	34,600	20,500	20,500	34,600	790,600
	Spare parts and accessories	$x10^3$(¥)	2,600	5,000	2,600	5,000	2,600	2,600	5,200	79,300
	Construction cost	$x10^3$(¥)	2,600	5,200	2,600	5,200	2,600	2,600	5,200	86,600
	Sub total	$x10^3$(¥)	25,700	44,800	25,700	44,800	25,700	25,700	44,800	956,500
	Building	$x10^3$(¥)						4,200		4,200

TABLE WM-7 LIST OF RAINFALL GAUGING STATION

No.	Name of Station	Basin	Remarks
1.	Besuki	Brantas	No.1 - No.10 Stations belong to the TJONDROGENI repeater station.
2.	Sumber Pandan	Ngrowo	
3.	Bagong	Ngrowo	
4.	Tugu	Ngrowo	With WL gauge
5.	Bendo	Ngrowo	With WL gauge
6.	Kampak	Ngrowo	With WL gauge
7.	Campurdarat	Ngrowo	
8.	Kalidawir	Ngrowo	
9.	Unidentified 1	Ngrowo	Situation is not fixed
10.	Unidentified 2	Ngrowo	
11.	Batu	Upstream of K'Kates	No.11 - No.22 station belong to
12.	Singosari	Upstream of K'Kates	KATOE repeater station
13.	Jabung	Upstream of K'Kates	
14.	Tumpang	Upstream of K'Kates	
15.	Poncokusumo	Upstream of K'Kates	
16.	Tangkil	Upstream of K'Kates	
17.	Wagir	Upstream of K'Kates	
18.	Kepanjen	Upstream of K'Kates	
19.	Gondanglegi	Upstream of K'Kates	
20.	Dampit	Upstream of K'Kates	
21.	Unidentified 1	Upstream of K'Kates	Situation is not fixed
22.	Unidentified	Upstream of K'Kates	Situation is not fixed
23.	Bening	Widas	With WL gauge
24.	Semantok	Widas	No.22 - No.30, No.34 - No.35 Stations belong to SOBTADI repeater station
25.	Ngluyu	Widas	No.31- No.33 stations belong to WILIS (under implementation Project) repeater station
26.	Bulakmojo	Widas	
27.	Pace	Widas	
28.	Kabuh	Widas	
29.	Jombang	Brantas	
30.	Blimbing	Brantas	
31.	Mojoagung	Brantas	
32.	Tampung	Brantas	
33.	Unidentified 1	Brantas	Situation is not fixed
34.	Unidentified 2	Widas	Situation is not fixed
35.	Unidentified 3	Widas	Situation is not fixed

TABLE WM-8 LIST OF WATER LEVEL GAUGING STATION

No.	Name of Station	Basin	Remarks
1.	Pakel	Brantas	No.1-No.11 stations belong to the TJONDROGENI repeater station
2.	Pakuncen	Ngrowo	
3.	Segawe dam	Ngrowo	
4.	Tugu dam	Ngrowo	
5.	Bendo	Ngrowo	
6.	Kampak dam	Ngrowo	
7.	Kendal	Ngrowo	
8.	Unidentified 1	Ngrowo	Situation is not fixed
9.	Unidentified 2	Ngrowo	Situation is not fixed
10.	Unidentified 3	Ngrowo	Situation is not fixed
11.	Blobo	Upstream of K'Kates	No.11-No.16 stations belong to the KATOE repeater station
12.	Netro	Upstream of K'Kates	
13.	Sumberejo	Upstream of K'Kates	
14.	Unidentified 1	Upstream of K'Kates	
15.	Unidentified 2	Upstream of K'kates	
16.	Unidentified 3	Upstream of K'kates	
17.	Kedungwarak Dam	Widas	No.17-22, No.25,26, No.29-31 stations belong to SOBTADI repeater stations
18.	Bening Dam	Widas	
19.	Kuncir Dam	Widas	No.23-24, 27, 28 stations belong
20.	Kedungpedet	Widas	to WILIS (under implementation
21.	Malangsari	Widas	project) repeater station
22.	Unidentified 1	Konto river	
23.	Gunungsari Dam	Surabaya river	
24.	Jagir Dam	Surabaya river	By the WL of jagir dam, the Surabaya city water inflow is calculated.
25.	Mrican		WL gauge 2 sets. For irrigation inflow calculation
26.	Paras		--- do ---
27.	Porong canal		For irrigation inflow calculation
28.	Mangetan canal		For irrigation inflow calaculation
29.	Unidentified 1	Widas	Situation is not fixed
30.	Unidentified 2	Widas	Situation is not fixed
31.	Unidentified 3	Widas	Situation is not fixed

Table WM-9 COST ESTIMATE TABLE ON EACH STATION FOR TELEMETER SYSTEM

Item \ Kind of station	Unit	Base station	Repeater Station	RF gauging station	WL gauging station	RF.WL gauging station	WL2 gauging station	Master station
1. Telemeter supervisory control equipment (T S/C)	set							1
2. Operation console (for 30 stations)	set							1
3. Typewriter	set							1
4. Radio equipment dual type 150 MHz band, output 10 W	set	1	1					
5. Antenna								
(1) YAGI 5 element	Nos	1		1	1	1	1	
(2) Omnidirectional 6 stage	Nos		2					
(3) Coaxial Cable	lot	1	1	1	1	1	1	
(4) Connector	set	2	2	1	1	1	1	
(5) Pole 20 m	unit		2	1	1	1	1	
(6) Lightning arrester	lot		2	1	1	1	1	
6. Repeater equipment	set		1					
7. Solar cell including power distribution board and Alkaline battery	unit		1	1	1	1	1	
8. Engine generator less than 1 KVA, portable type	set		1	1	1	1	1	
9. Telemeter equipment	set			1	1	1	1	
10. Radio equipment 150 MHz band, output 10 W	set			1	1	1	1	
11. WL gauging equipment	unit				1	1	2	
12. RF gauging equipment	unit			1		1		
13. Test equipment	lot							1
14. Building floor area	m^2		4	4	5	5	5	
Equipment cost	$x10^3$(¥)	2,000	12,600	5,600	5,700	7,200	7,300	45,100
Spare parts and accessories	$x10^3$(¥)	400	3,000	1,000	1,100	1,400	1,500	2,900
Construction cost	$x10^3$(¥)	500	5,400	1,800	1,800	2,300	2,300	9,500
Sub total		2,900	16,000	8,400	8,600	10,900	11,000	57,500
Building	$x10^3$(¥)		1,200	1,200	1,500	1,500	1,500	

Table WM-10 TOTAL COST ON EACH BASIN FOR TELEMETER SYSTEM

Main Basin			Ngrowo	Upstream of Karangkates	Widas	Brantas	
Name of Station	Master station		Malang	Malang	Malang	Malang	Total Cost
	Base station		Tulungagung	Malang	Selorejo	-	
	Repeater station		Tjondrogeni	Katoe	Soetadi	Wilis*	
Master station		Nos	1	1	1	-	
Base station		Nos	1	1	1	-	
Repeater station		Nos	1	1	1	-	
RF gauging station		Nos	7	12	9	3	
WL gauging station		Nos	7	6	10	2	
RF.WL gauging station		Nos	3	-	1	-	
WL x 2 gauging station		Nos	-	-	-	2	
Building floor area		m^2	82	82	95	32	
Equipment cost		$x10^3$(¥)	165,400	166,100	179,300	42,800	553,600
Spare parts and accessories		$x10^3$(¥)	25,200	24,900	27,700	8,000	85,800
Construction cost		$x10^3$(¥)	47,600	47,900	52,000	13,600	161,100
Total		$x10^3$(¥)	238,200	238,900	259,000	64,400	800,500
Building		$x10^3$(¥)	24,600	24,600	28,500	9,600	87,300

* Under implementation project

Table WM-11 ALLOCATION OF THE COST FOR 10 YEARS

Construction stage	Item	Total 10^3(¥)	The Year 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1st	Electric work	1,599,080		150,000	-	500,000	949,080	-	-	-	-	-
	Training cost	120,555			22,325	44,650	53,580	-	-	-	-	-
	Engineering service	651,890	156,275	116,090	75,905	196,460	107,160	-	-	-	-	-
	Freight and insurance	270,632			150,000	120,632	-	-	-	-	-	-
	Sub-total	2,642,157	156,275	266,090	248,230	861,742	1,109,820	-	-	-	-	-
	Civil work	126,000/1			25,000	101,000	-	-	-	-	-	-
2nd	Electric work	944,420					94,000	300,000	300,000	250,420	-	-
	Engineering service	361,665					40,185	84,835	200,925	35,720	-	-
	Freight and insurance	153,808						80,000	73,808	-	-	-
	Sub-total	1,459,893					134,185	464,835	574,733	286,140	-	-
	Civil work	103,800/2						30,000	73,800	-	-	-
3rd	Electric work	225,200								22,000	150,000	53,200
	Engineering service	285,760							13,395	58,045	133,950	80,370
	Freight & insurance	35,480									30,000	5,480
	Sub-total	546,440							13,395	80,045	313,950	139,050
	Civil work	34,500/3								6,000	28,500	-
Total (All stages)	Electric work	2,768,700		150,000	-	500,000	1,034,080	300,000	300,000	272,420	150,000	53,200
	Training cost	120,555			22,325	44,650	53,580	-	-	-	-	-
	Engineering service	1,299,315	156,275	116,090	75,905	196,460	147,345	84,835	214,320	93,765	133,950	80,370
	Freight and insurance	459,920			150,000	120,632	-	80,000	73,808	-	30,000	5,480
	TOTAL	4,648,490	156,275	266,090	248,230	861,742	1,244,005	464,835	588,128	366,185	313,950	139,050
	Civil work	264,300/4			25,000	101,000	-	30,000	73,800	6,000	28,500	-

Note: /1, /2, /3, /4 = Unit: 10^3(Rp)

Fig. WM-1 STAGEWISE IMPLEMENTATION PLAN OF WMS