2.2 Fishery Activities in the Study Area

The fishing activities in the study area are reflected from general fisheries of the country. They contain industrial scale fishing, middle scale fishing and small scale fishing, and aquaculture.

For industrial fishing, seventy two lots has been proclaimed. They cover the area as large as 450,356 ha. The breakdown area is shown on Table F 2.2.1 below.

Table F 2.2.1 Fishing Lots by Province

Province	No. of fishing lot	Area (ha)	No. of Colmatage
Kandal	19	178,907	194
Prey Veng	20	161,700	66
Kampong Cham	13	63,368	n.a.
Takeo	20	46,381	n.a.
Total	**72**	**450,356**	**458***

Source : Cambodian Department of Fisheries

* interpolated

The lots' areas vary from 260 ha (lot no.5, Takeo) to 20,900 ha (lot no.10, Prey Veng). In Kandal and Prey Veng Provinces, 260 comatages were included in the fishing lots. Taking the average number of colmatages at 6 per lot Takeo and Kampong Cham Provinces may add another 198 colmatages into the fishing lots to make total number around 458.

As has been described earlier that fishing in the fishing lot area is mainly through a colmatage during receding flood. The colmatages and natural canals are therefore vital for the licensee in bringing fishes in and catching when fishes migrate out. Physical rehabilitation of the colmatages in the fishing lots, other than deepening may not be practical and sensible.

Locations of fishing lots in the study area is shown on Figure F 2.2.1.

2.3 Fish Capture in The Study Area

Average fish production from the fishing lots is about 18.8 kg/ha with 4.6 kg minimum and 66.9 maximum. However the productions do not correlate with the sizes of the lot area. For example, production from lot no.8 which has an area of only 2,346 ha is as high as 157 MT while from lot no.2 which has an area of 16,731 ha is only 77 MT. In the case of high production it is always associated with inundating forest. Figure F 2.3.1 shows the fishing lots and inundated forest.

Fish production in the study area is on a steady constant in the part 5 years. Data of fish catch in 4 provinces, Kandal, Prey Veng, Kampong Cham and Takeo illustrate the fish catch according to grades. Fish of the First Grade were on a downfall trend from 3,378 MT in 1991 to 1,841 MT in 1995. The Second Grade fishes catch has been also in steady decline stage from 4,781 MT (1992) to 4,027 MT (1995) during the same period. The Third Grade catch during the same period has however been increased from 17,413 MT to 19,422 MT. This indicates that the efficiency of exploitation on small size fishes has been developed quite well in the last 5 years since the large size fish was more and more scarce. Table F 2.3.1 shows fish catch by province and grade in the study area.

For fish production from the fishing lots alone in Kandal Province in 1995, shown on Table F 2.3.2, the records show that it can produce as much as 3,371 MT from the total area of 178,907 ha or average at 18.84 MT/ha. The government has obtained a fee from auction as much as 1,316.9 million riels or 391,000 riels per MT. Comparing with average market price of fish at 2,000,000 riels/MT a considerable margin is left for employment and investment.

2.4 Aquaculture

Aquaculture in the study area is also quite stagnant from 1990 to 1994, from 1,500 MT to 1,586 MT or only 86 MT has been increased, which exhibits slow expansion in the area. Table F 2.4.1 shows the aquaculture production in five provinces. Again the cage/pen culture of high market value predominates in the activities. The shortcomings in using third grade fishes for feed as mentioned above is still there. The cultured species are as described in country's sector review.

Table F 2.4.1 Aquaculture Production in the Study Area

Unit : MT

Province	1990	1991	1992	1993	1994
Kandal	899	937	n.a.	750	1,136
Prey Veng	50	102	n.a.	98	110
Takeo	215	298	n.a.	150	90
Kampong Cham	336	400	n.a.	357	250
Total	**1,500**	**3,237**	-	**1,355**	**1,586**

Source : Annual Report, Cambodian department of Fisheries

3. Proposed Development Plan

Proposed development plan comprise two parts, institutional plan and physical development plan. The general institutional approach to strengthening the DOF and supporting services has been described earlier in the section of country's sector reviews. In this part it will therefore deal with only fishery development that in harmony with agricultural development of this study.

3.1 Institutional Approach

For the institutional setting up that is relevant to the over all development from this study, namely water resource development for agriculture, it is to establish a Swamp Fisheries Unit (SFU), affiliated to the being planned FFRI (or FRRI by MRC/DANIDA). The proposed SFU shall have a task as followings:

- to regulate fishing in a swamp area at sustainability,
- to create body of knowledge in swamp fish ecology,
- to conduct a stock assessment in term of species diversity and biomass,
- to regulate frequent, quantity and species of stocking,
- to promote aquaculture in the swamp's adjacent area.

The facilities for the planned SFU shall compose of a Fish Seed Production Center for produce fish seed for stocking in the swamp and aquaculture promotion and shall be provided with sufficient equipment, laboratory and library for water quality management, swamp fisheries management and control. Conceptual prototype of fish seed center is shown on Figure F 3.1.1.

The planned SFU's staff should comprise 1 Ph.D., 3 M.Sc., holders (one for fish breeding, one for fish production ecology, and one for aquaculture development), whom shall be supported by a number of B.Sc. holders and technicians.

3.2 Physical Measures

Most of the physical measures for swamp fisheries development will go along with the other agricultural development. In securing water for irrigation in the dry season rehabilitation of the swamp seems to be inevitable, either directly or indirectly by controlling of water through colmatages (which not be belonging to fishing lots). In that case for fisheries it requires the depth of more than 3 m in some part of the swamp, one mater for evaporation-transpiration, 1 m for irrigation and 1 m for fish pool during the dry season.

Three sites have been selected for development of the master plan. They are Srok Ponhea Leu, Srok Lovea Em in Kandal Province and Srok Koh Sotin and Srok Srey Santhor in Kampong Cham Province.

The swamp in the Srok Ponhea Leu (south of fishing lot no.14) seems to be very good alternative since it is totally in a public fishing area, (Figure 3.2.1). The conflict of resource exploitation as described earlier can be avoided from the beginning. The main objective of modification of swamp configuration is to protect flooding in agricultural area during the flood season as well as assurance of water and fish availability during the dry season.

The modification of this swamp can be done by embankment of the west side in parallel and same elevation with the Road No.5 in a distance of about 3-5 km, depending upon the extent of the flood. Thus, together with other minor modifications, flooding over the

hinterland can be protected and water in the swamp can be retained all year round. This will enable the operation of agriculture as well as swamp fishing in every season.

Since aquaculture in this area (along the Road No.5) has already developed to some extent, seventy ponds under operation with current production of 178.7 MT (DOF), the planned swamp can therefore strengthening the aquaculture expansion in the area as well.

From geographical and environmental considerations, *the swamp at the Srok Lovea Em* is suitable for swamp fisheries development and may be considered as a second alternative. It can be rehabilitated by embankment with water control building at the Srok Kampong Leave and other minor modifications.

After completion it will be a huge standing water bodies covering an area of about 455 sq. km. However the area about 250 km or 55% is still a fishing lots no.17 & 18 of Kandal Province and part of lot no.2 & 3 of Prey Veng Province, allowing only 161 sq.km. (35%) for public fishing and 44 sq.km. (10%) for sanctuaries (Figure 3.2.2).

From this kind of development annual fish yield of 5,700 MT may be obtained, or even more provided it is well manage. Furthermore during the dry season substantial amount of water can be provided for irrigation both dried and recession farming on a drawndown zone.

For the third alternative *the swamps in the Srok Koh Sotin and Srok Srey Santhor* in Kampong Cham province can be also rehabilitated for the same purposes. But again, the area is occupied by fishing lot no.1,7 & 9 covering the about 60% of the area (Figure 3.2.3).

3.3 Aquaculture

Aquaculture proposed to be developed in harmony with agriculture is in three models, pond culture, rice cum fish culture, and rice-chicken cum fish culture. Integrated farming system is not recommended here since at the early step farmers must be familiar with animal husbandry and catch crop production which are lacked in most of the paddy farmers except only some few innovated one.

3.3.1 Pond Culture

Pond culture is quite simple practice but site selection must be very careful regarding drainage system. Pond construction should be properly done. Culture method should based on multi-species culture. The species recommended is mainly hardy fish such as nile tilapia, common silver carp or common carp. Feed can be derived from agriculture by product such as rice bran, broken rice, waste part of vegetable, or some available water plant such as duck weed, water crest, and etc.

3.3.2 Rice cum Fish Culture

Rice cum fish culture is practiced by stocking fish in the paddy field. But modification of the field is needed by digging ditch around the field, (Figure 3.3.1). Spoil can be used for embankment.

Fishes can be stocked in the ditch from the time of soil preparation. After transplanting water level will be raised to irrigate the paddy, the fishes can take refuge on the inundated paddy land and, at the same time, they can eradicate many kind of pests for paddy. No feeding is required. However application of pesticides must be taken much precaution. When the paddy is ripe the water level will subside, fish can be collected from the ditch. Production of 20-30 kg/ha may be obtained.

Ideally rice farming for subsistent level requires 4 ha per family of 6 people. In addition rice cum fish culture will provide about 100 kg/plot of 4 ha/year which will contribute to fish consumption per capita as much as 16.6 kg.

3.3.3 Rice-Chicken cum Fish Culture

This method can be done in the same way as rice cum fish culture. However if the farmers residence is next to the paddy field chicken house may be constructed over the ditch so that chicken drop may be artificial fish feed and at the same time nourish the field. Fish production by this method may be as much as 30-40 kg/ha/year.

4. Feasibility of Proposed Pilot Project

4.1 Fishing Ground and Fish Capture

The study area, particularly for fishery study purpose, covers the Boeng Phtea, Boeng Krapeu and their vicinity which are comprising of lowland capable of retaining water after flooding period. The area of the Boengs' vicinity at the water level of 5 m elevation and below, is about 500 ha. Together with the area of 600 outside the Boengs' vicinity but with the same elevation, the total area at 5 m elevation and below is about 1,100 ha or about 18 % of the study area (6,130 ha). At the flood high to 9 m elevation during the month of September almost 90 % of the study area is submerged.

Flood depths range from 0.3 m to more than 3 m. Flood period, depending on the topography of the area, is ranging from few weeks to permanent swamps, wetland and reservoirs. However as the area is quite flat (3 - 10 m) flooding time from place to place does not vary much, except the area below 4 m elevation where the water can be retained for a longer period. In the area of 6 - 4 meter elevation flood time of 4 - 5 months can be expected. Figure F 4.1.1, redrawn from imagery of LANSAT (December, 1994), shows the flood areas and depth during the end of flood season.

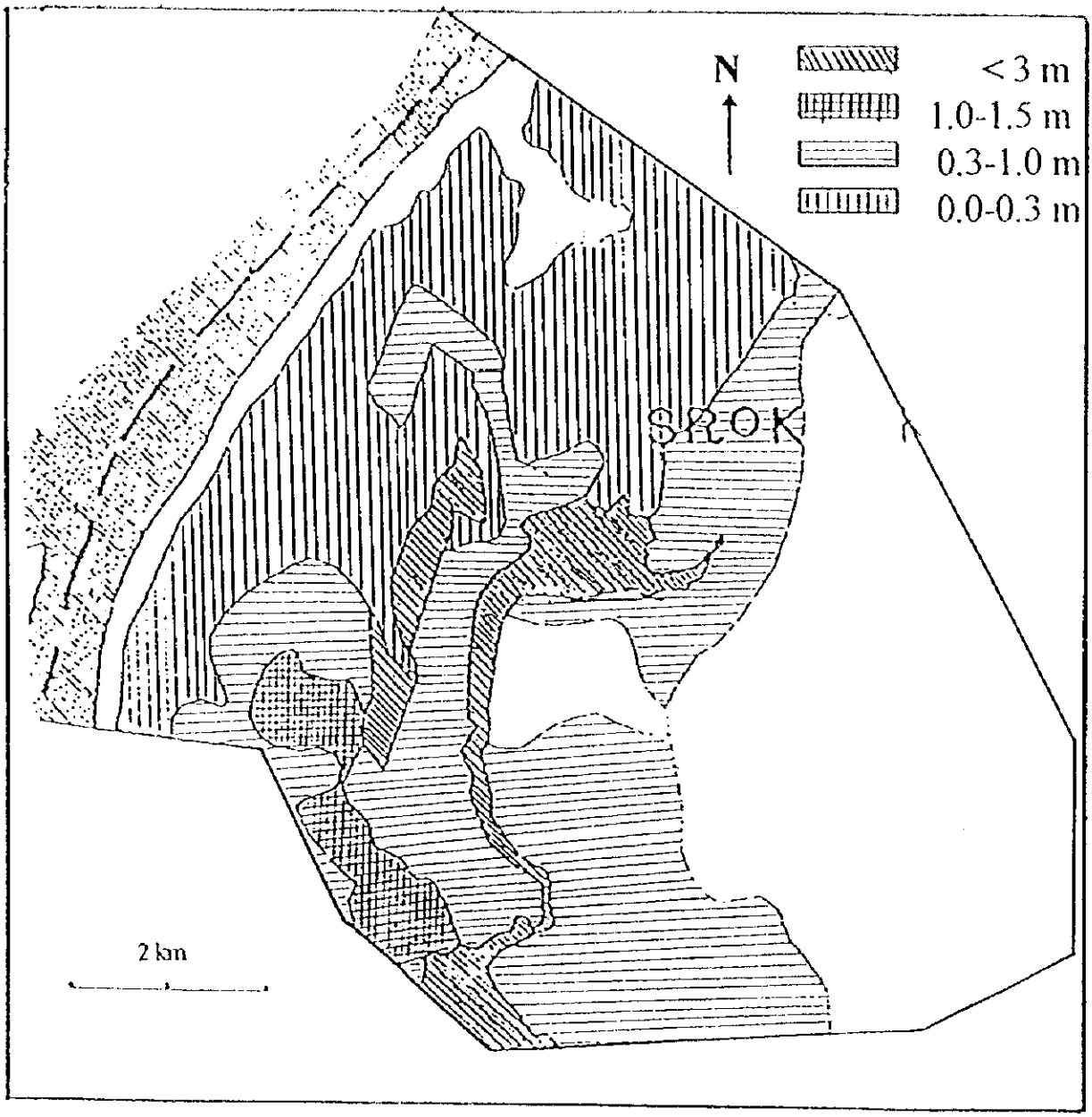


Figure F 4.1.1 Flood Areas and Flood Depth in the Study Area (Dec., 1994)
(Redrawn from LANSAT imagery -December 1994)

At the water level of 4 m, the total area of the Boeng Phtea is about 312 ha. Together with it outlet in the south about 120 ha and Boeng Krapeu 17 ha it forms a great role during the dry season. However at the late of dry season when the water surface is at 3.4 m (June 19, 1997) the water surface of the Boeng Phtea has been remained about 50 % of the area at 4 m water level.

Boeng Phtea and its outlet has a mean depth when the water level at 4 m. about 0.5 m. Therefore, with surface area of 312 ha the Boeng, together with its outlet of 120 ha, retains water about 21,600,000 cu. m. There is no previous limnological and/or fish population studies of the Boeng Phtea.

Preliminary data from *in situ* measurement during our field survey show that the water quality in the Boeng Phtea and its outlet are acceptable for fishes. Table F 4.1.1 shows some parameters of water quality from 3 stations, in the Boeng, at the mouth and the end of the outlet.

Table F 4.1.1 Indicative *in situ* Water Quality in the Boeng Phtea and its Outlet (June 4, 1997)

Parameters* Stations	pH	EC (ms/cm)	SS (NTU)	DO (mg/l)	Temp. (C)	NaCl (%)
In the Boeng	7.94	0.145	941	8.76	29.9	0.00
	7.91	0.145	941	8.76	29.9	0.00
Mouth Outlet	7.46	0.169	785	8.84	29.5	0.00
	7.21	0.168	794	8.13	29.4	0.00
End Outlet	7.51	0.121	527	8.66	32.5	0.00
	7.49	0.120	557	8.53	32.6	0.00
Average	7.58	0.145	755	8.59	30.6	0.00

*13:30, at the surface layer.

Fishing ground in this area is varied, depending on the hydrological seasons. As mentioned earlier that during the rainy season most of the area are flooded. Consequently fishing ground enlarge 9 times of the dry season. While after flood receded the fishing is concentrated in the area of below 5 m elevation at least 6 more months until the water availability is only in the Boeng Phtea, its outlet, Boeng Krapeu and other few swamps.

During the dry season the fishing ground confines mainly on the Boeng Phtea together with its outlet in the south, Boeng Krapeu in the north and other few small swamps. Those swamps may not contribute to fishing activities as significant as Boeng Phtea and its vicinity.

It should be noted that part of the study area and part of the Fishing Lot No. 17 of Kandal Province overlap each other. Total Fishing Lot area is 8,828 ha while its part belonging to the study area is about 1,100 ha or about 18 % of the study area. Figure F 4.1.2 shows the part of the Fishing Lot that is in the study area.

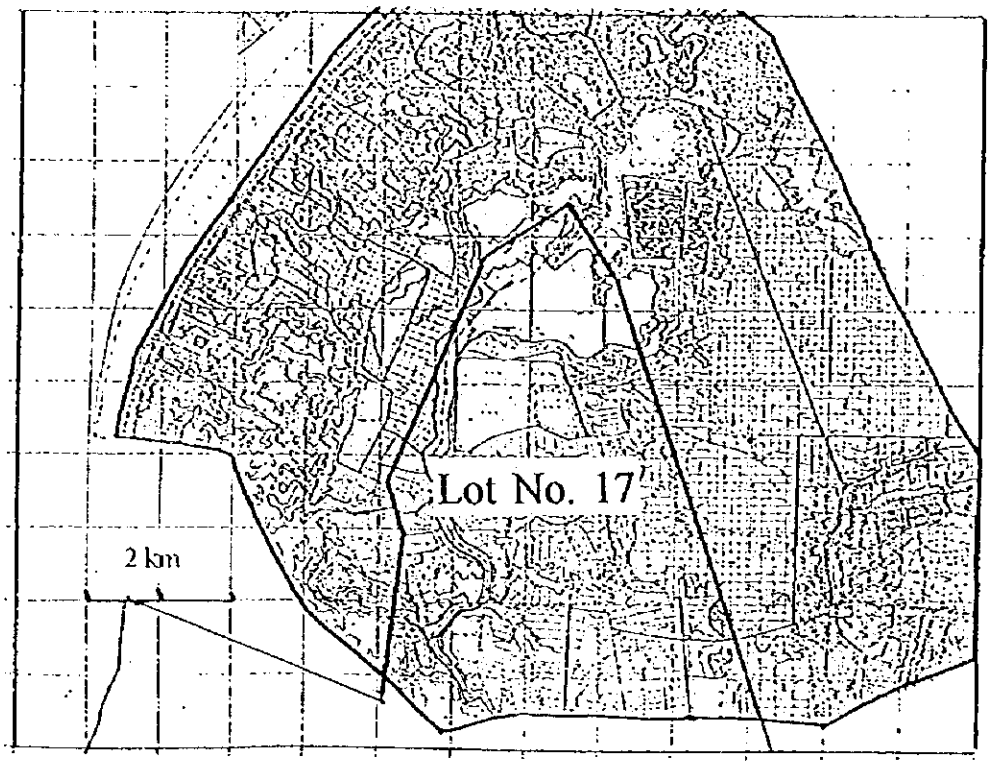


Figure F 4.1.2 Part of Fishing Lot in the Study Area.

Fishing operation in the Lot has been arranged in 8 different fishing points of which 3 points are in the study area and being operated by the licensee himself. They are in the Boeng Ptea, its outlet and Boeng Krapeu. The rest of the fishing point have been subleased to other fishermen. Compartment fishing in the outlet is shown on Photo F 4.1.1.

Apart from large scale fishing in the Lot there are medium and small scale fishing being operated in the study area. From field observation during June, 1997, a number of fishermen operating fish capture is found and the fishing gears such as seine, oblong trap, brush park (Photo F 4.1.2), bamboo fence trap (Photo F 4.1.3-4), gill net (Photo F 4.1.5-6), cast net, and hook and line are commonly seen.

From interviewing the 67 fisherman households from 6 communes in the study area it is found that the most frequent fishing gears used by the fishermen are gill net (79 %), bamboo trap (49 %), hook and line (27 %) and seine net (7.5 %), (Table F 4.1.2). Many of them indicate that they have more than one type of gears.

Table F 4.1.2 Main Fishing Gear used by Fishermen in Different Commune

Fishing Gears Communes	No. of Sample	Seine Net	Bamboo Trap	Hook and Line	Gill Net	Others
Prek Tamerk	22	--	86.36	--	77.27	--
Puk Reusei	18	11.11	11.11	11.11	72.20	--
Sanlung	3	33.33	33.33	--	66.67	--
Vihearsour	20	10.00	50.00	60.00	90.00	15.00
Prek Ampil	4	--	25.00	100.00	75.00	--

From the same field interviews, it reveals that the average household size composes of 5 - 7 members. Dominant age group is found to be 10 - 20 years old. More than 50 % are schooled, but mainly not beyond primary level. Mostly the labors are used for both fishing and farming. Table F 4.1.3 shows the status of the fishermen in the study area.

Table F 4.1.3 Present Status of the Fishermen in the Study Area.

Household Communes	No. of Sample	Size	Male (%)	Female (%)	Dominant Age group	Schooling (%)	Labor Status
Prek Tamerk	22	6.5	43.22	56.78	15-20	82	Fa/Fi
Puk Reusei	18	6.0	49.56	50.44	11-15	78	Fa/Fi
Sanlung	3	6.0	30.96	69.04	5-10	56	Fa/Fi
Vihearsoour	20	7.0	42.85	52.15	15-20	69	Fa/Fi
Prek Ampril	4	5.5	63.63	36.36	11-15	17	Fa/Fi

No aquaculture practice is found among them. However during the field reconnaissance it was observed that temporary stocking of live fish in a pen and a cage when the time of surplus catch is commonly practice. Few cases in stocking of sand goby in the Boeng Phtea have been observed.

Surprisingly, despite unfound aquaculture practice in the samples, from our field survey it reveals that 70 % of fishermen are interested in aquaculture, but they indicate their constrains about lacking of capital, technical skill, water availability throughout a growing season and, last but not least, they have seen satisfied results from the neighbors who have ever tried.

4.2 Fishery Production and Utility

When referring to fish production there are few words to be clarified for their definitions. The term production means that the increment of biomass in particular time while productivity means the rate of biomass increment according to area and time. On the contrary the catch by fishermen is equivalent to a yield and standing crop means the existing of fish biomass at particular area and time. In this report the biomass, production and yield of fish in the Boeng Phtea will be elaborated.

According to the field observation during June 19, 1997 the standing crop of fishes in the Boeng Phtea can be estimated from the sampling by encircling purse seine of 100 m length. This encircling purse seine, when surround the water area, will cover the area of 795 sq. m. Each haul has yielded 50 - 60 kg of fishes. Photo F 4.2.1 - F 4.2.3 exhibit the procedure of encircling purse seine operation. Thus, the standing crop of this particular date is about 690 kg/ha. However this figure can not be considered as a standing crop in its real term since the fishes therein are trapped and concentrated from larger area at the end of flood season.

Since the water surface of this particular date is about 50 % of the area when the water level is at 4 m, and if taken water surface area of 312 ha as mentioned above into consideration the standing crop would be about 345 kg/ha which is in the range of most of the swamps in Southeast Asia.

Most of the fishes comprising in the catch are Sheatfish (*Kryptopterus sp.*), Catfish (*Mystus sp.*), Silver Barb (*Puntius sp.*), Smith Barb (*Puntioplites sp.*), Soldier River Barb (*Cyclocheilichthys sp.*) and Glassfish (*Chanda sp.*). Most of the fish lengths are about 10 - 20 cm. Photo 4.2.4 shows the miscellaneous fishes caught by the encircling purse seine.

Fishery yield from the Lot No. 17 during the last two years (1995 - 1996) was reported to be annually about 157 MT (Table F 2.3.2). If taking earlier estimated ratio of yields from large scale fishing and family fishing of 7 : 2.5, the yield family fishing may be about 41 MT/year. From this point of view the yield from this Lot may vary between 190 - 200 MT/year for the last two years. This indicates that the yield per unit area (ha) of surface water is about 23 kg/ha for 5 months which is unusually low.

In order to get a rough idea of fish production from the Lot another point of view must be therefore taken into consideration. Assuming that average fish price is at 0.1016 million Riels/MT and with the sublease fee and investment cost for fishing gear of 65,000,000 Riels, (Section 2.8.3 will described about fishing costs), the sub-licensee(s) have to catch fishes not less than 639.8 MT (or 318.9 MT/year) just to cover investment of 65,000,000 Riels of which the costs of labor, transportation, and marketing are not included.

Furthermore the fish caught by the licensee himself has not yet taken into account. If the analysis above shows something near to the reality the report of fish yield in the Burden Book of DOFi (157 MT/year) should be considered as under declared. The figure of fish yield from the Lot of 318.9 MT/year (4-5 months) will therefore used as a reference throughout this study.

There are three indirect approaches to measure fish production from a standing water body. The first is to sampling fish standing crop as described above; the second is by comparison with the fish production of a reservoir in the same region; while the third is to estimate a yield by using data on morphology and water chemistry of the swamp or in other word known as morhpo-edaphic index (MEI).

As any record from the Lot is always under value and at the moment it is difficult to estimate how much is the fish production from the area out of part of the Lot in the study areas. Indirect estimation as below will be applied to get an idea of fish production in the study area. The estimation based on various assumptions that:

Area of more than 3 month- flood period (9 m and below)	: 5,330 ha,
Fish yield from the Lot No. 17	:318 MT/year,
or	:0.036 MT/ha/year,
Plus family fishing 35 % of large scale fishing	:0.049 MT/ha/year,
Plus fishes remained uncaught 30 %	:0.06 MT/ha/year,
Total production from flooded area 5,330 ha	:320 MT/year.

In other words total fish production from inside and outside the Lot in the study area, from all, large scale, medium scale and small scale fishing, may be around 320 MT/year or 640 MT for equivalent one leasing period of the Lot.

Another attempt is to estimate a yield in the Boeng Phtea and its vicinity by MEI method. The formula of MEI is:

$$\text{MEI} = \text{conductivity (uS/cm)/ mean depth (m)}$$

For a swamps that its fish reached their maximum level of exploitation, the relationship is shown below:

$$\text{Catch (kg/ha)} = 14.3136 \times (\text{MEI})^{0.4681}$$

The mean depth of the Boeng Phtea is 0.5 m, the conductivity in the dry season is about 145 uMos/cm. The MEI for Boeng Phtea is thus 290 and accounting for the above formula a yield of 204 kg/ha/year can be achieved. Present fish yield in the Boeng Phtea and its vicinity during the dry season should be around 127 MT/year.

Based on the result from our previous study on fish grade composition, the ratio of First Grade : Second Grade : Third Grade is 1:2.2:13.3, the catch of the three grades, first, second and third will be19.3, 42.7 and 258.3 MT/year, respectively.

Provided the fishes of first grade and second grade are sold elsewhere and third grade of 258.3 MT is for local consumption, a net contribution of fish to the local diet of the local population of 26,715 (Table F 4.2.1) would be about 9.7 kg/person/year. This is equivalent to about 69 % of national average, 13-15 kg/person/year. However please note that these people also catch fish outside the study area.

Table F 4.2.1 Population in the Study Area

Communes	No. of Village	Population		
		Male	Female	Total
Prek Tamerk	8	3,834	4,265	8,099
Puk Reusei	6	4,710	5,066	9,776
Sanlung	1	454	484	938
Vihearsour	4	3,130	3,357	6,487
Prek Ampril	1	628	787	1,415
Total	20	12,756	13,959	26,715

The catch is not only sold in fresh or trash. It is also preserved in various kind of products for family consumption. However fish processing for commercial purpose is mostly in the hand of fish wholesalers. They process into fish paste, salt-dried fish, smoked fish and fish sauce. Most of them are in the scale of cottage industry.

No official record is available that how much the catch in the study area has been converted into processed products. But based on the countrywide percentage of fresh fish having been processed into various kind of fishery product of about 40 %, the processed fish in the study area can be therefore estimated to be about 128 MT/year.

4.3 Control and Management of Fishery Activities

DOFi is not the only one institution involving in control of fishing activities in the study area. On the contrary fishing activities are controlled by the Kandal Provicial Fishery Inspection Unit which is under the authority of Kandal Province. The function of the DOFi is mainly confined to technical guidance. In turn the Provincial Fishery Inspection Unit has designated its authority to a sub-ordinate authority, Muk Kampul Sub-Unit for day to day and routine operation in the Lot No. 12, 13, 16 and 17. The organization chart involving the control and management of fishing activities is shown on the Figure 4.3.1.

Fishery management in the area is involved in informing people about fishery law, arranging a meeting for fishery resources conservation, and operation in a Fishing Lot - opening bidding and let the licensee run a show.

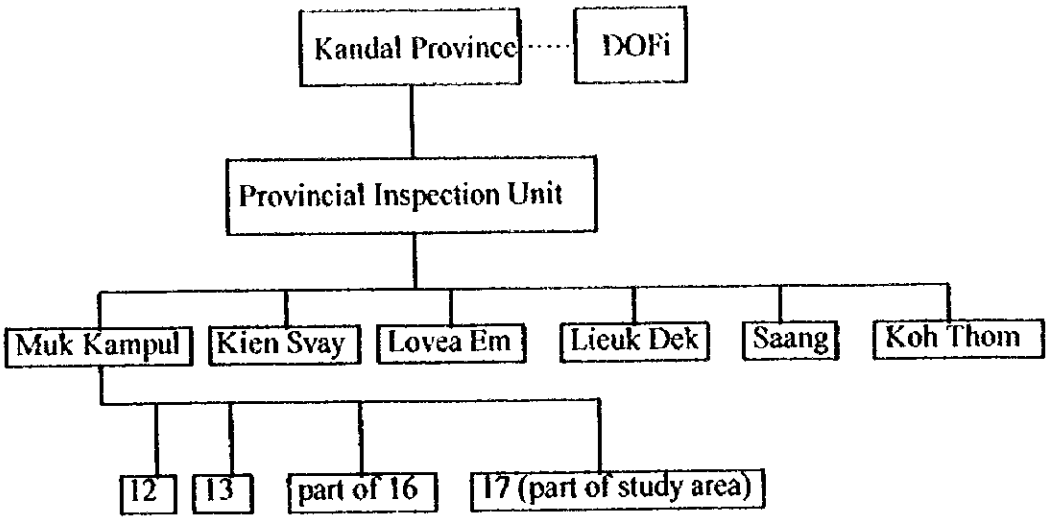


Figure 4.3.1 Organization Chart of Fishery Authority in The Study Area

During 1996-1997 the standard auction price was 30,000,000 Riels, may be as well as the new auction price to come. The bidder tendered for 33,400,000 Riels. He afterward has arranged 8 fishing points in the Lot, three operated by himself while other 5 having been subleased to other fishermen from whom he received 35,000,000 Riels return in cash. The fishing gears that may cost about 30,000,000 Riels more are a responsibility of the sub-licensee(s). The total cost for initial investment of the sub-licensee(s) may be around 65,000,000 Riels

Apart from a lot management, visiting of fishery officers from the Inspection Unit has been irregularly conducted. The purposes of a visit is chiefly for patrol of illegal fishing, keeping people informed about fishery law and to inspect that the fishing gears of the Lot licensee(s) have been removed at the end of fishing season.

It is not therefore surprisingly that quite a number of fishermen has ever been in contact with fishery officer regarding fishery law. As much as 48 % of fishermen has responded that they have ever been informed by the fishery officers, except in Sanlung where the people show no such a response.

The people in the study area receive knowledge of conservation from mass communication (33 %) and in Prek Tamerk they also receive from other source, fishing lot licensee (14 %). However in receiving direct information through any meeting arranged by the government officers majority (55 %) indicates that they have never been to such a meeting while 42 % say that they used to be in such a meeting.

For means of receiving a fishery information other than fishery law fishermen receive from the government in quite limit, (13 %) while they mostly receive from mass communication. Among these they receive from radio and television in a high

percentage, 94 % and 78 % respectively. No other sources more have been indicated, particularly from a reading material, (Table F 4.3.1).

Table F 4.3.1 Means of Receiving Fishery Information by Fishermen

Means Commune	No. of Sample	Government Officers	Television	Radio	News-paper	Periodicals
Prek Tamerk	22	--	100.00	100.0	--	--
Puk Reusei	18	27.70	72.00	100.0	--	--
Sanlung	3	--	66.00	100.0	--	--
Vihearsour	20	--	60.00	80.0	--	--
Prek Ampril	4	100.00	75.00	100.0	--	--

For fish marketing there is no restriction about landing, fish price and buyers. Most of the fishermen can sell their fish according to their choice and commitment, mostly compulsory from loan which has been taken. The market shares of the middlemen, wholesaler, and others are 39 %, 34 %, and 19 %, respectively. Table F 4.3.2 shows the fish marketing pattern in the study area.

Table F 4.3.2 Fish Marketing Pattern in Different Commune

Buyers Commune	No. of Sample	Middlemen	Wholesalers	Merchant	Others
Prek Tamerk	22	13.63	72.72	--	--
Puk Reusei	18	55.50	33.30	--	27.70
Sanlung	3	--	--	--	100.00
Vihearsoour	20	50.00	5.00	5.00	20.00
Prek Ampil	4	75.00	--	--	25.00

There is no institutional credit available in and/or for the study area. Most of the fishermen either obtained their loan from a money lender (63 %), often with high interest rate. Payment may be made in cash or fishes. Very few (3 %) received loan from their relatives and neighbors. Table F 4.3.3 illustrates the credit pattern in the study area.

Table F 4.3.3 Loan Sources of the Fishermen in The Study Area

Loan Sources Commune	No. of Sample	Money Lender	Relatives	Rice Bank	NGO	Neighbors
Prek Tamerk	22	81.81	--	--	--	--
Puk Reusei	18	11.00	5.50	--	--	--
Sanlung	3	--	33.33	--	--	--
Vihearour	20	90.00	--	--	--	5.00
Prek Ampil	4	100.00	--	--	--	--

In forming or joining a fishermen association of any kind, the fishermen has no experience in such as organization. Most of them operate on an individual basis in fishing, marketing and taking loan. 100 % do not know whether any association exist at all.

For external assistance, the SAO (Southeast Asian Outreach) has conducted a small scale aquaculture extension in the study area since 1994. Pilot scale has been set up in Sanlung, Vihearsour and Prey Chas to cultivate few species of fishes such as carp (*Cyprinus carpio*), Nile tilapia (*Oreochromis niloticus*) and common silver barb (*Puntius gonionotus*) . 13 ponds of average 241 sq. m has been constructed in those communes. Few harvests have been already operated. The results of production are 2.8 - 3.6 MT/ha/year which are consideringly satisfied. Furthermore, construction of seed production center covering 8 ha to produce fish seed of 4,000,000 fries/year has been completed and now under operation. Nineteen fishermen families have already turned to aquaculture operation while a number of them have shown their interest.

4.4 Relation between Farming and Fishing Activities

Farming and fishing activities in the study area, as normally practicing in the Country, are coinciding each other. Most of the farmers are opportunistic fishermen, or in another word, the farmers catch fishes at any available opportunities and occasional need. From socio-economic survey of this study it reveals that only 13 households out of 500 are full time fishermen, i.e. their main household income is derived from fishing. Also very few farmers do not have side income from fishing. Most of the fishing are for both selling and family consumption.

From recent field survey, even though in a well selected population of fishermen, 100 % of the fishermen response that they also have a side income from fishing activities. What attention can be paid here is the degree of intensity in fishing and farming. Normally it goes around a hydrological cycle. However the fishermen and farmer are similar in division of their household labors. Some family member are fishing while the other do cropping.

However it is common to all that during the flood season when most of the area can not be used for cropping they operate fishing or being employed as a fishing labor in a fishing lot. On the contrary, during the dry season when the water availability is scarce, they, if can not get employment elsewhere or being self-employed such as mat making or being employed, also confine themselves on fishing operation or fired wood gathering.

Apart from cropping and fishing, they share all the social functions such as funeral, ordination, marriage and religious ceremonies.

4.5 Feasibility of Proposed development Plan

4.5.1 Institutional Approach

Institutional approach should be in conjunction with the being proposed Operation and Maintenance Supporting Office, managed by inter-departmental committee, in the section of agriculture described elsewhere in this report. In this center fishery section should be incorporated and integrated in a way of multi-utilization of resources and facilities.

Two functions of fishery operation, seed production together with aquaculture extension and supervision of swamp fisheries, are crucial to the success of the project.

In connection to these functions four fisheries officers, two for seed production and two for swamp fishery supervision, exclusive of technicians and labors, should be assigned to the being proposed center. However at the beginning these officers must be trained abroad or being trained at site by expatriate expert in their particular fields for 9 months. In the latter case two expatriate experts of relevant fields should be assigned along with post project operation and management.

However legal approach should be also incorporated into fishery management. As proven in our interim report that high fish production is always obtained in coincide with inundated forest. The inundated forest is existing in our study area. It must be protected in the formed of proclaimed fishery sanctuary with clear demarcation.

The area around the Boeng Phtea is strongly recommended, namely, the wetland in the northeast of the Boeng Phtea till Som Say Reservoir, Tanon Reservoir, Pleuv Tuk Reservoir and Promok Reservoir. Figure F 4.5.1 exhibits the proposed sanctuaries. Fishing inside these sanctuaries should be exclusively prohibited and forest should be preserved at its natural conditions, exception for dead branches which may be taken for fired wood.

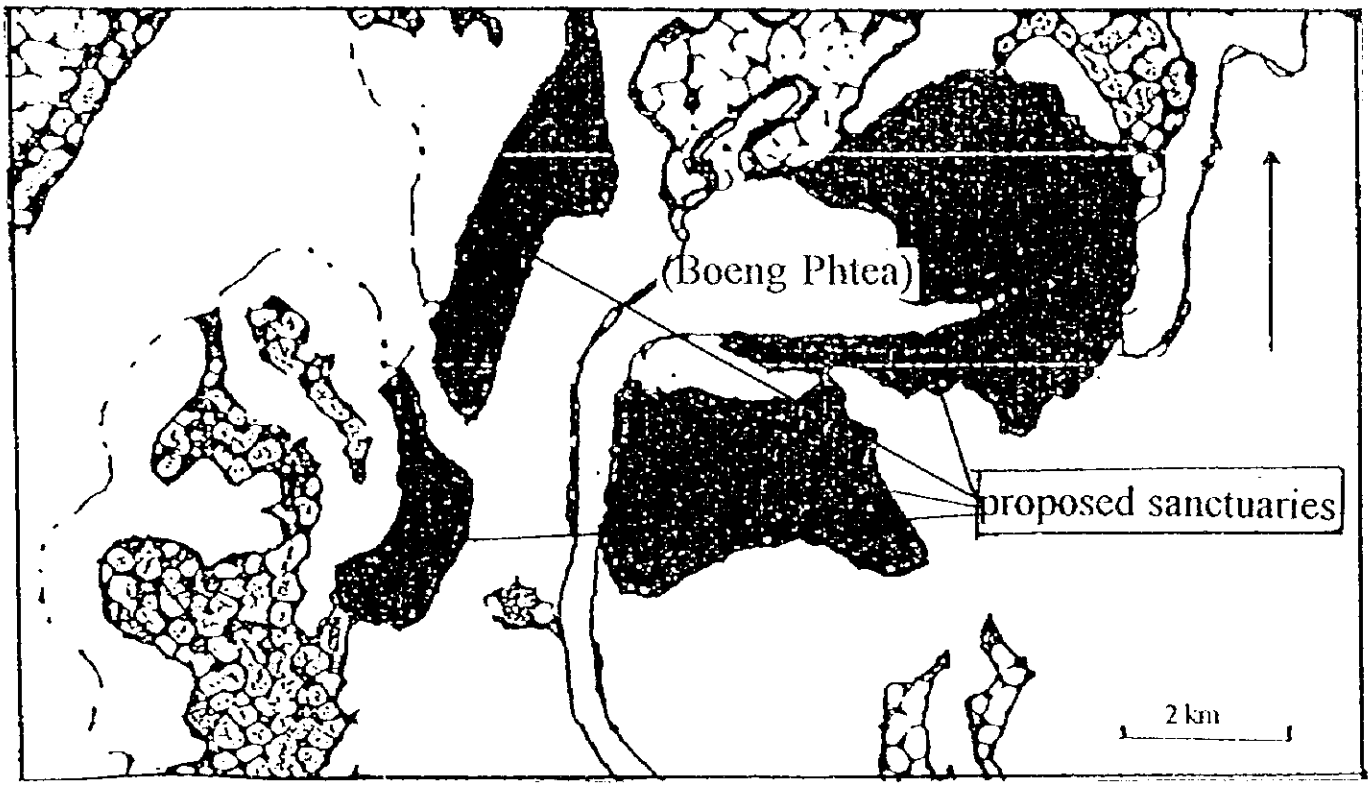


Figure F 4.5.1 Proposed Fish Sanctuaries in The Study Area.

As our findings that the fishermen depend chiefly on the money lender with high interest rate, often compulsory to sell their produce in a low price, it is therefore recommended to establish a small credit organization with paid members. Loan accruing can be operated by group guarantee. Selected fishermen, after passing through a training program in integrated aquaculture at the being proposed Agriculture Development Center, can be accredited to a loan, particularly for aquaculture development not for fish capture. This credit organization may be integrated with other agricultural credits.

4.5.2 Physical Measures Harmonized with Agriculture

a) Swamp (Boeng Phtea) Rehabilitation.

In physical measures harmonized with agriculture it is recommended that Boeng Phtea should be rehabilitated by constructing a weir at about 6 km down stream of the outlet. The retention level should be at 5 m elevation. That will, as the swamp bottom now is at 3 m, have a water depth in the Boeng about 2 m. This weir will be submerged during the flood season. Proposed location of the weir is shown on Figure F 4.5.2.

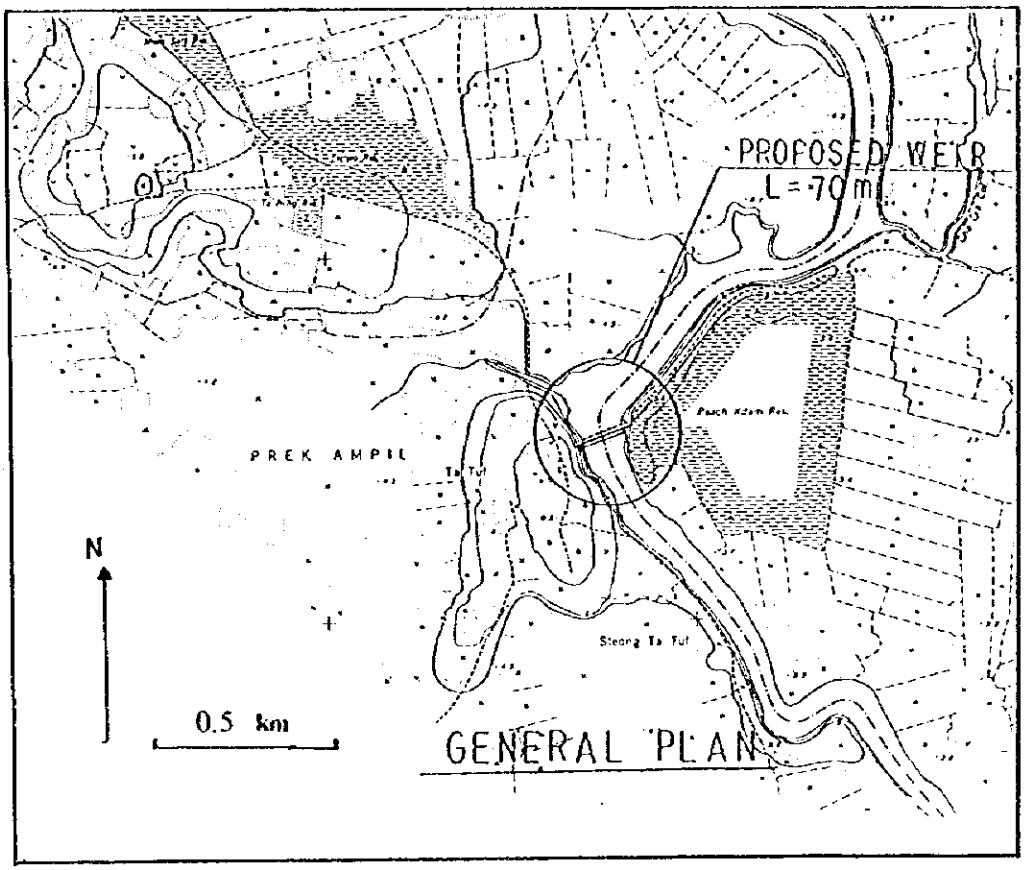


Figure F 4.5.2 Proposed Weir Location in the Outlet of the Boeng Phtea

However since this proposed development is in the Fishing Lot there will be some controversial issue. Fishing Lot operation has been a long tradition and deep in the thought of entrepreneurs, government official as well as the government. The main question is concerning whether the proposed weir will obstruct a fish catching of the lot licensee(s). If the answer is negative the lot licensee may bargain for lowering an auction fee which in turn may affect a government revenue.

In this regard the area to retain a water is very small comparing with the total Fishing

Lot area of 8,828 ha. The area to be rehabilitated is about 500 ha of which 188 ha is being expanded from present condition or only about 2 % of the Lot area. Fishes are still allowed to be caught until the water in the Boeng lower down to 5 m elevation.

Provided the peak flood of 9 m the water head that the licensee can catch fish is 4 m which is much more than the water head retained on the Boeng of which only 2 m. This mean that the licensee can use water for fishing as much as 20,000,000 cu. m. from the Boeng area plus 176,000,000 cu. m from the flooded area inside the Lot while flooded area outside where the lot licensee(s) can have benefit has not yet included. The water retained in the Boeng is only 9,900,000 cu. m. or 5 % of the water that the lot licensee can utilized. This can be considered as negligible.

Suspicious may be also arisen from the people side. Since the proposed development project as we have mentioned in our Interim Report that one criteria to be considered is socially acceptable. From our interviews it reveals that majority of people agree with various points being proposed. Table F 4.5.1 illustrates the responses from the people in the study area.

Table F 4.5.1 Attitude of The People in The Study Area towards Project Development

Projects Commune	People's in a Fish	Fishing Right ing Lot	Swamp tion &	Rehabilita- Stocking	Water Develop	Resource ment
	Yes	No	Yes	No	Yes	No
Prek Tamerk	100	--	54.54	45.46	100	--
Puk Reusei	100	--	100	--	100	--
Sanlung	100	--	100	--	100	--
Vihearsour	95	--	50	50	55	45
Prek Ampril	100	--	75	25	100	

The other minor point which should be considered is that the construction of dike or weir in the fishery domain is prohibited by law but with also a provision in the law that if to construct it should seek a permission from the DOFi and the Ministry of Agriculture before construction taken place.

Those who oppose a swamp rehabilitation because their misunderstanding that after stocking they may not be allowed to catch fish any longer and those who oppose a water resource development because they afraid that their farmland will be flooded in a longer term. In fact the stocking of fingerling is for their benefit and in the area around Boeng Phtea below 5 m elevation farmland is very scarce.

b) Seed Production Station

Seed production is aimed for two purposes, stocking in the being rehabilitated swamp (Boeng Phtea) and distribution to fish farmers with low price, either for stocking in a rice cum fish culture or in an integrated fish farm.

Assuming swamp stocking at 1 fingerling per 2 sq. m, in the rehabilitated swamp of total area of 620 ha (500 ha in the Boeng and 120 ha in the outlet) seed requirement will be 3,100,000 pieces per year.

It is not known about an acceleration of diffusion of aquaculture to the farmers/fishermen, but one when they see the results it can grow exponentially. Despite this difficulty the assumption below is being used to anticipate aquaculture growth in the study area for facilities designed.

Average household member	: 5.4 members/household;
Total population in the study area	: 26,715 persons;
Estimated total household number	: 4,950 households;
Assumed 10 % are innovated	: 495 households
Average farmland holding per household	: 0.95 ha;
Total area for aquaculture development	: 470 ha;
Extensive stocking density	: 5,000 fries/ha;
Total fish seed requirement	: 2,350,000 fries/year.

In total the seed production station must be designed to produce, in order to support a swamp rehabilitation program and extensive aquaculture, at least 5,000,000 seeds per year.

To facilitate the production of 5,000,000 fries, the following assumptions are set up:

One brood fish can yield	: 2,000 fries/year;
5 million fries require	: 2,500 brood fish;
Stocking density of brood fish	: 1 per 8 m^2;
Pond's water surface area for brood fish	: 20,000 m^2;
Fry productivity	: 100 pieces/m^2;
Rotation of pond	: 3 crops/year;
Pond's water surface area for fries	: 16,000 m^2;
Total pond's water surface requirement	: 36,000 m^2.

In connection to this context, preliminary estimation indicates that a land requirement of 50,000 sq. m. is compulsory and be considered as a minimum. In hatchery, maturation tanks, hatching thanks, fry acclimation tanks, water filter and storage system, wet lab and dry labs must be provided. General layout of fish seed station is shown on Figure F 4.5.3.

4.5.3 Aquaculture with Farming Practice

Aquaculture and farming to be developed must be a kind of integrated and sustainable type, not one on the expense of the others. Maximum efficiency of water utilization is taken into consideration to propose aquacultural-agriculture system being described below. Whenever possible all the agricultural by-products will be considered to be incorporated into aquacultural benefit.

Three types of aquaculture are proposed to be developed, namely rice cum fish culture. Livestock cum fish/cash crop culture and semi-intensive fish pond culture. Rice cum fish culture model has already been explained in the Interim Report.

However location for rice cum fish culture should be selected in the area where irrigation is proposed in this and/or other project. With 0.9 farmland holding it will contribute about 800 kg of fish per six months, provided stocking rate is 5,000 fingerlings/ha, 50 % survival rate and fish grow up to 3 pieces/kg.

Livestock cum fish/cash crop culture is to maximize land and water utilization in a sustainable way. Several research have already been conducted and confirmed the results. This model provided a self-sustainable yield for a long years. Land and water have been rotated by using half of a year for aquaculture while the other half for cash crop growing. For both operation, the fish feed and manure are derived from agricultural waste such as chicken drop and pig dung. Necessary input is only animal feed which may be obtained from agricultural by-product such as broken rice, brand, vegetable both from growing and natural. Figure F 4.5.4 exhibits one ha model of such an integrated farming.

Location for this type of integrated aqua farming should be easily accessible, preferably in a farmer's residence area where more intensive care of plants and animals can be conducted. All year round availability of wastes should be provided.

However the farmers must be trained at the proposed O & M Supporting Office, where the integrated aqua farming is exhibited and operation process is demonstrated. Only after this training then they will be promoted through providing incentives to run a farm like this since it needs some general knowledge in growing cash crop, looking after the animals and up keeping of fish.

4.5.4 Expected Project Benefit

Benefit expected from this kind of rehabilitation is resulted from two sources. These are the water surface area expansion from 312 ha to 500 ha during the dry season, i.e. area increment of 188 ha, and additional water volume retaining of about 8 million cu. m. more than the present time.

Together with 1.9 million cu. m. of water in its outlet, total volume of water in magnitude of 9.9 million cu. m. will be available during the dry season. This excess water, apart from natural fishery benefit being described below, can be also used for aquaculture development promotion as well as irrigation of cash crop during the dry

season, provided the facilities such as irrigation canal and aquaculture supporting system are available.

Resulting from this enlargement of water surface area and increment of water volume fish production will be enhanced by two dimensions, horizontally and vertically.

Horizontally, in expanding water surface area of 188 ha, with average production 0.06 MT/ha/3 months (Section 2.8.2) or 0.24 MT/ha/year; or 0.204 MT/ha/yea (by MEI Method) it is expect that fish production will increase in a magnitude of 38-45 MT/year. Vertically, in addition to above production, fish production increment can be estimated by using following assumptions:

Average water volume during flood season (0.3 m depth)	: 3,000 m^3/ha;
Fish production 0.24 MT/ha/year	: 0.08 Kg/m^3;
Total water volume increase (620 x 1.5 m)	: 9.9 m^3;
Expected fish production increment	: 792 MT/year.

In total, benefit from the proposed rehabilitation of the Boeng Phtea in term of fish production it may be expected as much as 837 MT/year without any doubt.

In fact this level of production seems to be very high comparing with estimated present production elsewhere in this Report. However if taken average value per ha into consideration it is still reasonable because the production is only 1.35 MT/ha which is an average production from most of the extensive growout ponds. Furthermore this figure may be confirmed from estimation by using production/biomass ratio. In most of the standing waters in Southeast Asia the P/B ratio is **"3"**, i.e. one gram of existing fish biomass will be increased to three grams in one year or three times turnover in one year. When actual standing crop of fish biomass was found to be 345 kg/ha (Section 4.2), three times of this figure would give rise to 1.035 MT/ha which is very closed to above production forecast. To reach this level or not it is mainly depending on the operation and management.

However the more significant benefit is that it will bring about the increasing of per capita consumption of fish and employment. For per capita consumption, it will add up another 50 kg/person/year which is much excess international standard requirement, 20 kg/person/year. Together with the existing consumption of 9.7 kg/person/year it makes up to 59.7 kg of which about 30 kg/person/year or in total 800 MT can be expected to give monetary return.

Based on the following assumption, gross monetary return can be estimated:

Dry season average farm gate fish price of all Grades	: 1.7 mill. Riels/MT;
Fish production increment	: 790 MT/year;
Total gross monetary return	: 1,343 mill. Riels/year.

Furthermore, employment benefit is that it can absorb an additional self-employment of 12 man-day per ha or 2,256 person/day until the time of fish exhausted. Provided one person catch fish of 0.005 MT/day, the duration of employment may last for 70 days or i.e. it can absorb total employment of 158,000 man-day.

For benefit from aquaculture system, it taken direct benefit from fry production of which 2,000,000 fries will be sold to the farmer at 35-40 Riels/piece, gross monetary return can be expected as much as 80 million Riels/year. This will in turn lead to multiplied benefit in the growout system.

For integrated growout system described below, assuming stocking rate of 5,000 fries/ha, survival rate 50%, fish grow up to 3 pieces/kg for 3-4 month of growing period, the production of 330 MT can be achieved. Gross monetary return will be around 560 million Riels. Since the integrated culture does not need high input in term of feeding and after substracting fry cost of 80 million Riels, value added of 480 million Riels per year can be generated.

Furthermore, in supporting swamp rehabilitation from 3,000,000 fries stocking in the rehabilitated Boeng Phtea, the benefit, assuming 20% survival rate, fish grow up to 3 pieces/kg, additional 200 MT can be expected from such kind of stocking other than natural fish. However in this operation value added from the fry cost 220 million Riels, otherwise making higher survival rate by nursing fry to fingerling in a captivity before stocking.

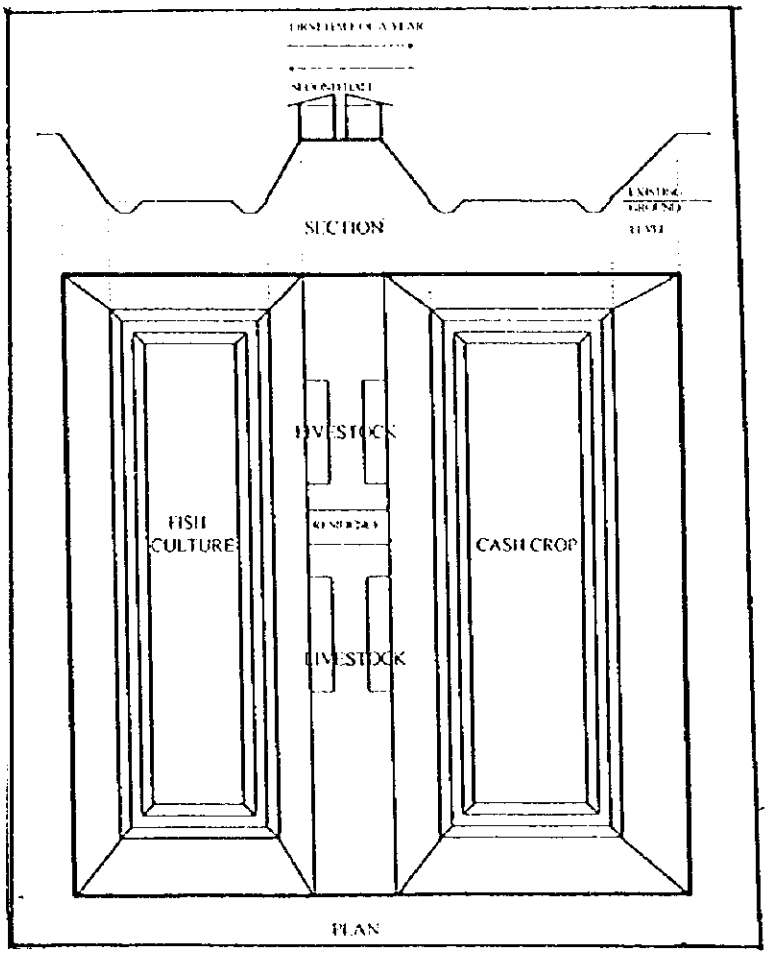


Figure F 4.5.4 Proposed Model for 1 Ha of Livestock cum Fish/Cash Crop Culture

Table F 1.1.1 STATISTIC OF FISHERIES PRODUCTS OF CAMBODIA FROM 1980-1995

Unit : Ton, Crocodile : Head

No.	Year	Fisheries product	Freshwater Fish	Marine Fish	Aquaculture	Shrimp Product	Crocodile (head)
1	1980	19,600	18,400	1,200	-	-	-
2	1981	51,594	50,780	814	-	-	-
3	1982	68,715	65,700	3,015	-	-	-
4	1983	68,161	58,717	9,444	-	-	-
5	1984	64,424	55,093	7,721	1,610	-	-
6	1985	70,578	56,400	11,178	3,000	-	-
7	1986	73,628	64,184	7,247	2,200	-	-
8	1987	82,001	62,154	17,417	2,500	-	1,400
9	1988	86,800	61,200	21,000	4,600	-	2,910
10	1989	82,088	50,500	26,050	5,538	-	4,372
11	1990	111,400	65,100	39,900	6,400	-	5,654
12	1991	117,800	74,700	36,400	6,700	-	6,100
13	1992	111,150	68,900	33,700	8,500	-	3,664
14	1993	108,900	67,900	33,100	7,400	500	4,816
15	1994	103,200	65,000	30,000	7,640	560	6,194
16	1995	112,510	72,500	30,500	8,779	731	14,691

Source : Department of Fisheries, Cambodia

Table F 1.1.2 STATISTIC OF FISHING GEAR IN 1995

No.	Province	Type of Fishing Gear															
		Large scale				Middle scale					Small scale (Family)						
		Brarrage trap	Fishing da'y	Shrimp da'y	D	Gill net	Uorn Hum	Neam	Chuorn	Chayra	Cast net	Tru	Lop	Saydeum	Chaneang da'y	Thnang	Hooked net
1	Phnom Penh	-	25	-	-	4,800	6	130	8	22	56	-	-	-	-	-	20,000
2	Kandal	121	49	-	-	46,210	25	73	3	25	22	1,850	4,050	180	391	586	43,850
3	Prey Veng	101	7	13	-	1,530	2	10	5	21	53	7,000	4,000	1,200	250	600	12,000
4	Takeo	5	10	-	-	1,600	36	-	-	-	650	1,320	287	-	-	-	520
5	Kampong Cham	40	-	-	-	31,150	33	18	-	18	10,000	3,500	500	250	500	1,400	21,000
6	Kratie	8	-	-	-	8,000	60	-	1	1	245	450	1,000	180	120	-	-
SUBTOTAL (1-6)		**275**	**91**	**13**	**-**	**93,290**	**162**	**231**	**17**	**87**	**11,026**	**14,120**	**9,837**	**1,810**	**1,261**	**2,586**	**97,370**
TOTAL 13 Provinces		**427**	**91**	**13**	**27**	**813,610**	**3,894**	**317**	**54**	**118**	**26,846**	**17,970**	**17,302**	**3,510**	**3,486**	**7,300**	**297,924**

Source : Annual Report, Department of fisheries, Cambodia

Table 1.4.1 Dominant Fish Species in the Phnom Penh Market (September - October, 1995)

Common Name	Scientific Name	Remark
Giant snake-head	*Channa Micropeltes*	Maj. From cage culture.
Striped catfish	*Pangasius sutchi*	Maj. from pond & cage
Striped snake-head	*Channa Striatus*	culture.
Soldier river barb	*Cyclocheilichthys enoplos*	
Black ear catfish	*Pangasius larnaudi*	
Common silver barb	*Puntius gonionotus*	
Climbing perch	*Anabus testudineus*	
Iridescent mystus	*Mystus vittatus*	
Grey feather back	*Notopterus notopterus*	
Indian river barb	*Cyclocheilichthys apogon*	
Mud carp	*Cirrhina microlepis*	
Tiger nandid	*Pristolepis fasciatus*	
Whisker sheatfish	*Kryptopterus bleekeri*	
Twisted-jaw sheatfish	*Belodontichthys dinema*	
Bonny lipped barb	*Osteocheilus melanopleura*	
Eye-spot barb	*Hampala dispar*	
Swamp eel	*Fluta alba*	
Giant freshwater prawn	*Macrobrachium rosenbergii*	
Lanchester's fresh prawn	*M. lanchesterii*	

Table F 1.5.1 STATISTIC OF FISHING LOTS AND FISH SANCTUARIES FROM 1980-1995

No.	Year	Fishing lots for exploitation							Fish sanctuaries	Remarks
		Fishing lots	Fishing da'y	Fishing da'y for White lady carp seed	Shrimp da'y	Fishing da'y for Pungasius seed	Peoch fishing lots	TOTAL		
1	1980	143	96	-	13	-	55	307	11	
2	1981	143	96	-	13	-	55	307	11	Trend to increase
3	1982	143	96	-	13	-	55	307	11	
4	1983	143	96	-	13	-	55	307	11	
5	1984	143	96	-	13	-	55	307	11	
6	1985	143	96	-	13	-	55	307	11	
7	1986	143	96	-	13	-	55	307	11	
8	1987	143	96	-	13	-	55	307	11	
9	1988	143	96	-	13	-	55	307	11	
10	1989	141	76	7	13	31	34	302	13	After Aqua-development
11	1990	141	76	7	13	31	34	302	13	
12	1991	141	76	8	13	31	32	301	15	
13	1992	141	76	8	13	31	32	301	15	
14	1993	141	76	8	13	31	31	300	15	
15	1994	141	76	8	13	31	31	300	15	
16	1995	141	63	8	13	31	23	279	15	

Source : Annual Report, Department of Fisheries, Cambodia

Table F 1.5.2 Freshwater Fish Capture in Cambodia

	Family fishing	Middle scale	Large scale
Fishing period	Year-round	October-May	October-May
Major gear	harpoon/spear; castnet (< 5 m) ; small gillnet (< 10 m); single hooked lines; and bamboo traps	seine net; gillnet; castnet; hooked line; and bamboo traps	bagnet; bamboo/wooden barrage; and bamboo fence and traps
Fishing rights allocation	Free within areas outside fish reserves and fishing lots	Annual license fee according to gear type and size	Leasing of designated fishing grounds every two years through competitive bidding
Background of fishers/operators	Artisanal fishers; subsistence farmers and landless	Artisanal fishers from river-and lakeside communes	Financially and politically powerful people and their agents
Source of fishing labor and terms of employment	Family members	Family members and covillagers as partners, and occasional hired workers; income sharing	Hired workers from nonfishing communes; fixed wages (cash and food) according to skills
Average size of crew	1-3	3-6	50-80

After Ahmed, M. and T. S. Tana, (1996) Fifth Common Property Conference, Bodoc, Norway.

Table F 1.7.1 Rehabilitation Projects and Fishery Development in 5 Year Plan (1996-2000)

Projects	Duration	Descriptions
People organization In fishery demarcation prevention and fishery development.	1996-2000	Preservation and reservation of natural resources, explaining to population about fish & fish stocking in fishery domain. Recognition of the importance of fishery resource.
Improving fishery legislation	1996-1997	Amendment of fishery law for social development
Strengthening fishery inspect. inspecting facilities and construction of four fishery units.	1996-2000	Post-control in all fishery sanctuaries, -to control all illegal fishing gears, -to control fishing exploitation according to the technical fishing -to prohibit all foreign boat.
Demarcation of inundated forest, mangrove forest, fishing lots and fish sanctuaries.	1996-2000	To promote people and manager of fishing lots, replanting inundated forest, improving by dredging all colmatages and streams for fish migration to lakes and flood plain.
Preservation and prevention of fishery domain	1996-2000	Elimination of silting at the intersection, e.g. silting at Chatomuk.
Freshwater and marine aquaculture development; strengthening and expansion of aqua research station.	1996-1997	Freshwater aquaculture: - to improve area of the station, - to construct 20 fishponds more, - to construct one administrative building, - to set up water pumping system from the Tonle Sap River to the station, - to prepare inlet-outlet water system, - to acquire more equipment & instrument.
Establishment of marine research station.	1996-1998	Set up shrimp hatchery.
Development research and extension: establishment of oceanography in Sihanouk Ville	1996-1998	Before Cambodia has oceanography institute in Sihanouk Ville but during the war the institute has lost all every things. Now the DOF is preparing to establish the institute in this City again for conduction research on marine stock and aquaculture development.
Construction of freshwater research institute	1997-2000	The objectives of this institute are for: ■ - research on biodiversity, ■ - fish stock assessment, ■ - biochemistry research, ■ - fresh water exploitation.

Table F 1.7.1 (Continued)

Projects	Duration	Descriptions
Construction of inundated forest research institute	1996-1997	The objectives of this institute are: - research on biodiversity in the wetland, inland and marine fishes, - to improve water flow system like in colmatages, streams etc.
Establishment of fisheries research centers and extension offices in the provinces	1996-2000	For local extension
Documentation and extension	1996-2000	Improving of library
Collecting fish products and processing: - Construction marine fishing port in Sihanouk Ville, - Construction of freshwater fish port in Phnom Penh.	 1996-1998 1997-2000	 To make facility for fishing boats and to make easy for people for collecting fish. To make convenience for fishermen in selling fish and keep fish quality.
Human resource development	1996-2000	

Table F 2.3.1 Fish Capture (MT) in the Study Area

Grades	Province	1989-90*	1990-91	1992-93*	1993-94	1994-95
First						
	Kandal	1,686	1,888	968	830	694
	Prey Veng	264	400	219	328	363
	Takeo	448	470	405	416	344
	Kampong Cham	510	620	590	560	440
	sub-total	**2,908**	**3,378**	**2,182**	**2,134**	**1,841**
second	Kandal	1,893	2,120	1,628	1,414	920
	Prey Veng	419	636	750	430	523
	Takeo	749	785	868	890	836
	Kampong Cham	**1,020**	**1,240**	**1,580**	**148**	**1,748**
	sub-total	**4,081**	**4,781**	**4,385**	**7,234**	**4,027**
Third	Kandal	8,921	9,990	7,882	6,756	11,965
	Prey Veng	1,547	2,346	2,494	3,732	2,216
	Takeo	703	727	527	541	579
	Kampong Cham	**3,570**	**4,340**	**3,730**	**3,540**	**4,662**
	sub-total	**14,741**	**17,413**	**14,633**	**14,569**	**19,413**
	Grand Total	**21,730**	**25,572**	**21,200**	**23,937**	**25,281**

Source : Provincial Fishery Units of Kandal, Prey Veng, Takeo and Kampong Cham

Table F 2.3.2 Fishing Lots' areas, productions and auction prices and number of colmatages in Kandal Province

Lot	Lot Area	Production		Auct. Price	M.Ric/MT	No.Colm.
	ha	Mt	kg/ha	Mil.Riels		
1	9,415	75	7.96	30.5	0.203	20
2	16,731	77	4.60	n.a.	-	23
3	12,590	100	7.90	68.0	0.340	22
4	9,722	93	9.56	70.2	0.378	1
5	10,626	120	11.29	n.a.	-	11
6	15,108	423	27.99	133.0	0.157	10
7	7,950	460	57.86	73.0	0.080	2
8	2,346	157	66.90	33.4	0.107	2
9	9,318	116	12.45	172.9	0.742	16
10	3,607	201	55.73	n.a.	-	16
11	6,290	153	24.32	221.0	0.722	20
12	15,612	220	14.09	52.7	0.120	10
13	4,468	111	24.84	26.2	0.118	6
14	8,707	113	12.98	21.7	0.096	4
15	1,616	91	56.31	2.4	0.013	3
16	13,789	150	10.88	94.0	0.314	8
17	8,828	157	17.78	33.4	0.107	3
18	12,944	272	21.01	235.0	0.432	6
19	9,240	282	30.52	80.0	0.142	11
Total	178,907	3,371	18.84	1,316.9	0.391	194

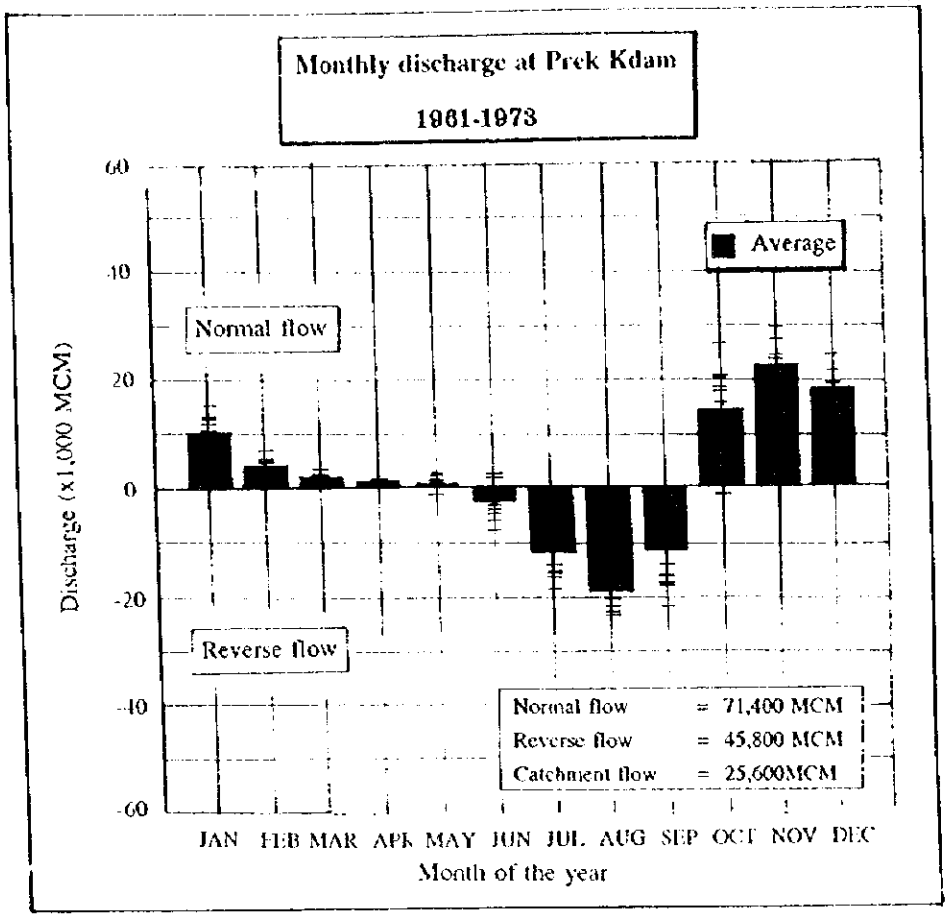


Figure F 1.2.1 Reversal Flow to the Great Lake vin the Tonle Sap

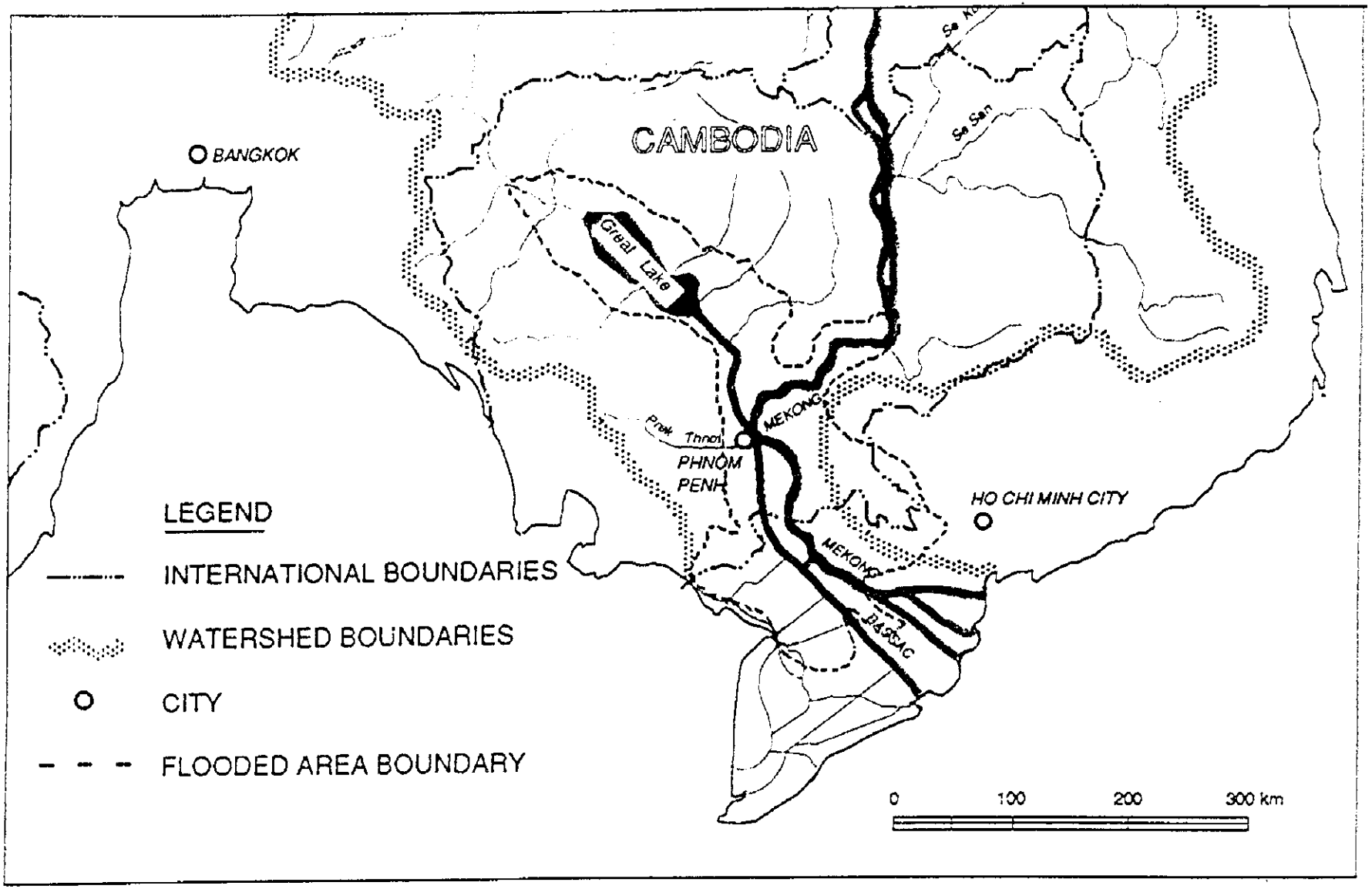


Figure F 1.2.2 Mekong Flooded Area in the Cambodia
(after MRC's Fisheries in the Lower Mekong Basin, 1992)

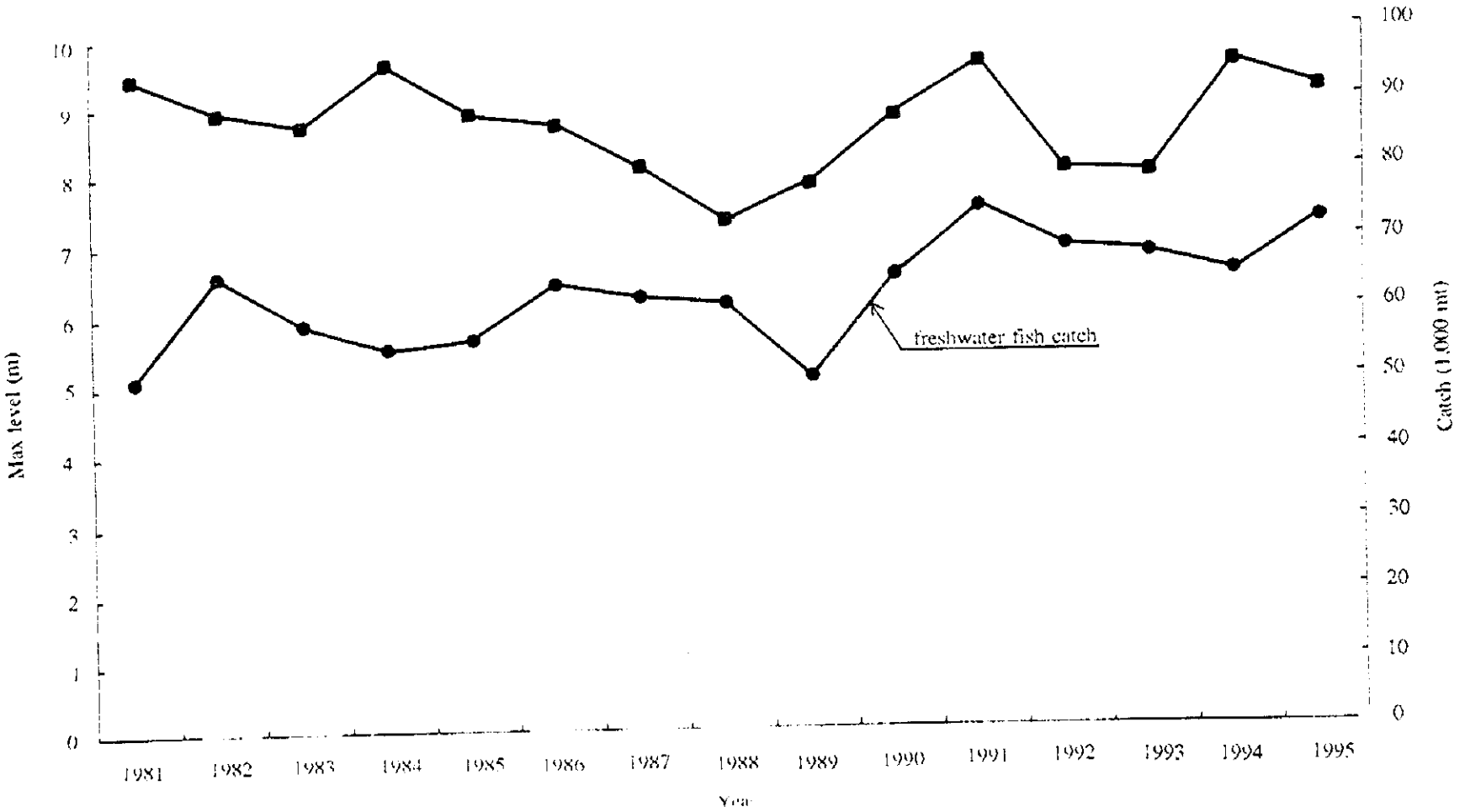


Figure F 1.3.1 Fish Catch and Maximum Floode Level (Chatomuk)

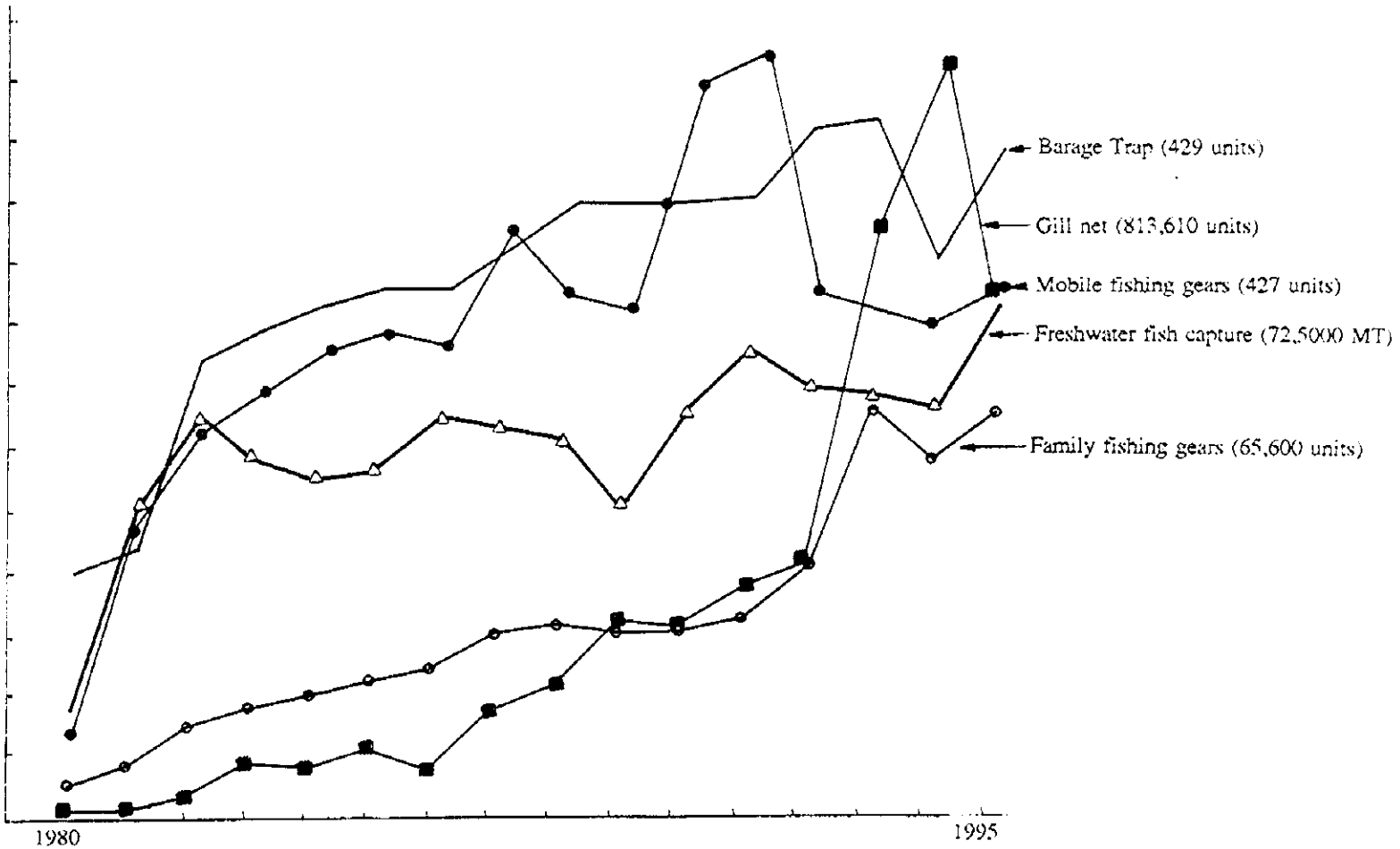


Figure F 1.4.1 Freshwater Fish Catch and Some Fishing Gears

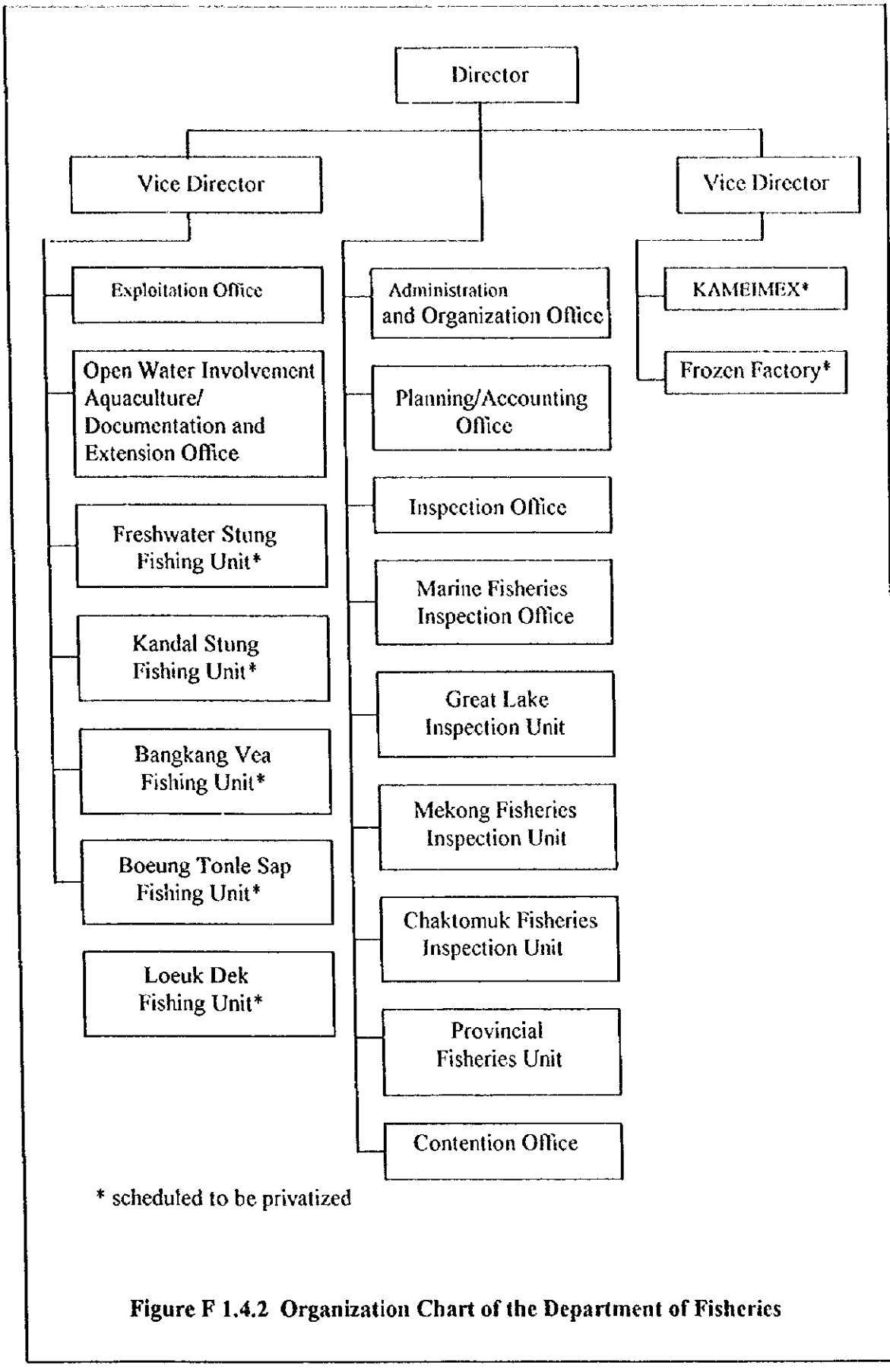


Figure F 1.4.2 Organization Chart of the Department of Fisheries

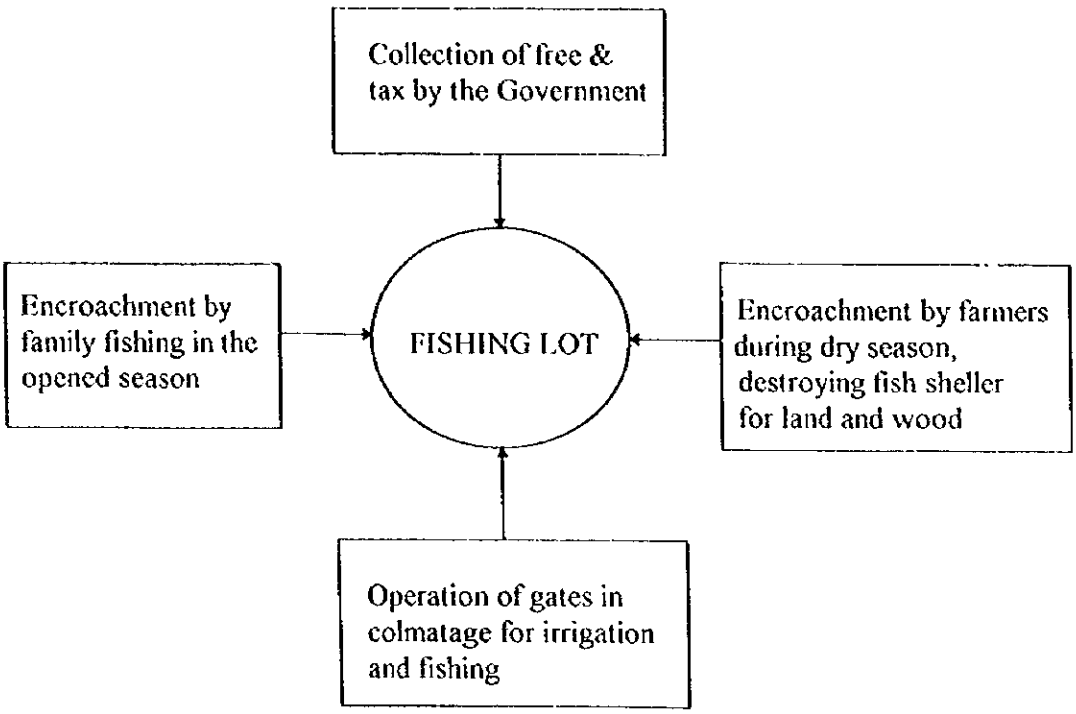


Figure F 1.7.1 Typical Scheme of Conflicts in Flood Plain Uses

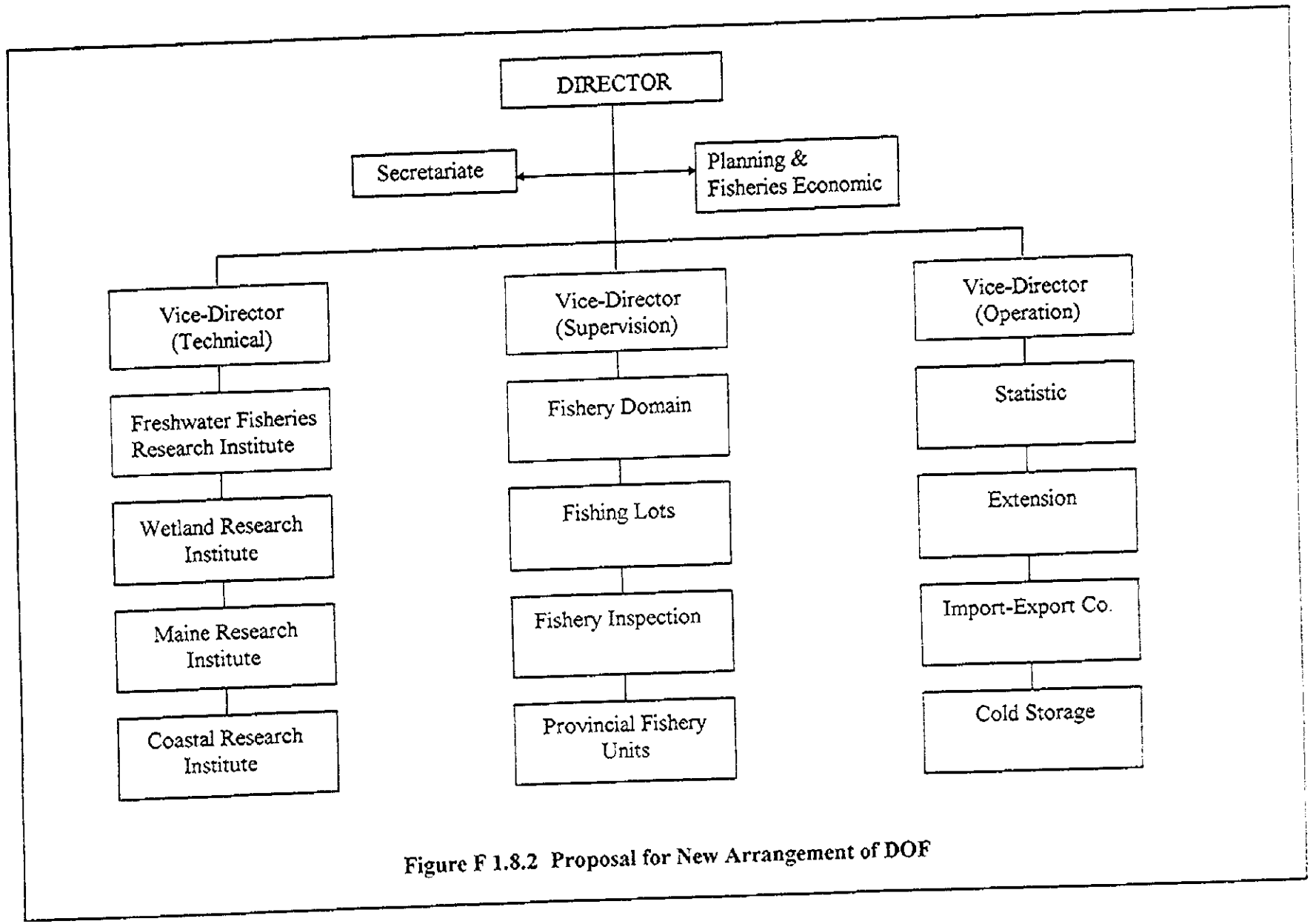


Figure F 1.8.2 Proposal for New Arrangement of DOF

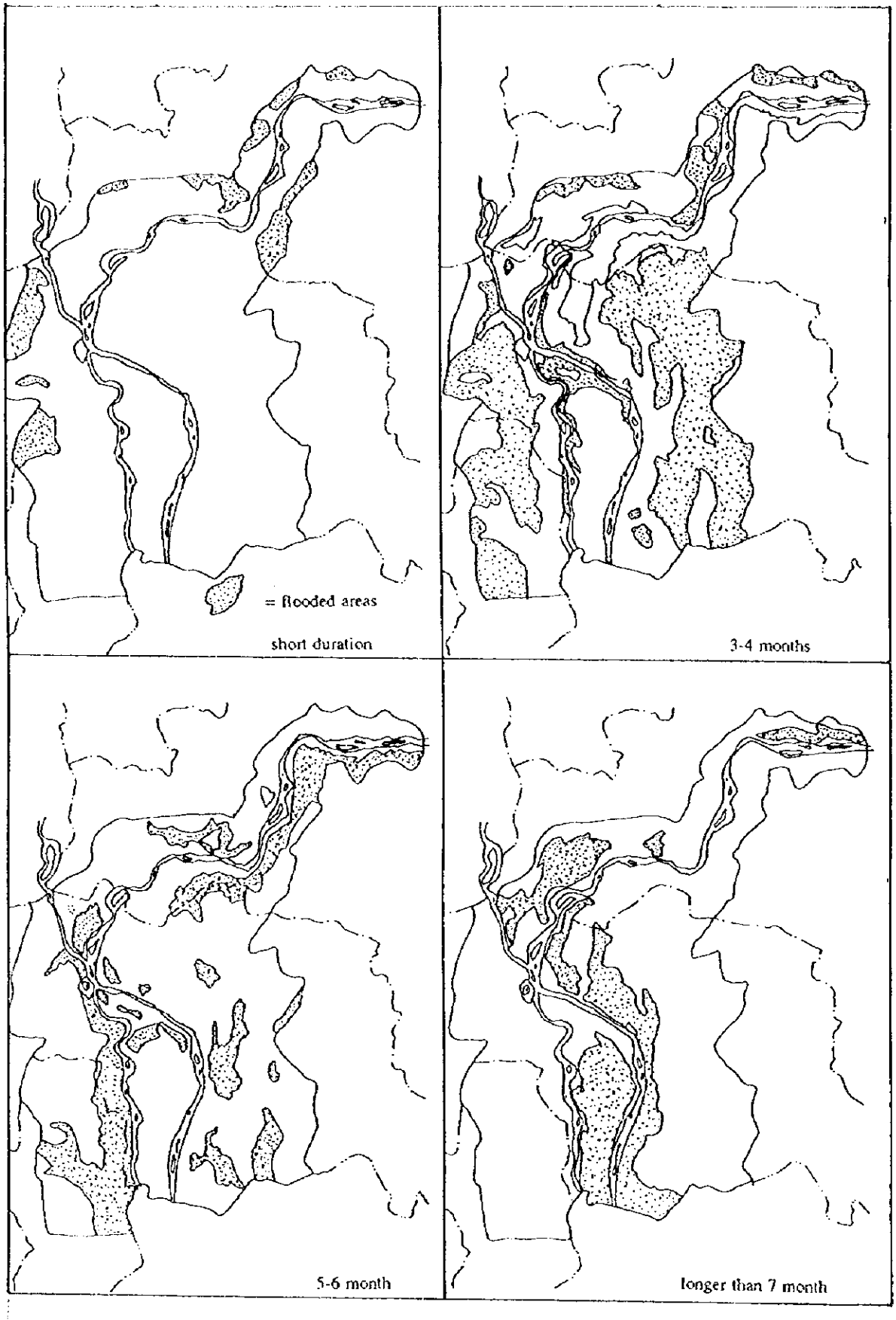


Figure F 2.1.1 Locations of Different Flood Duraion

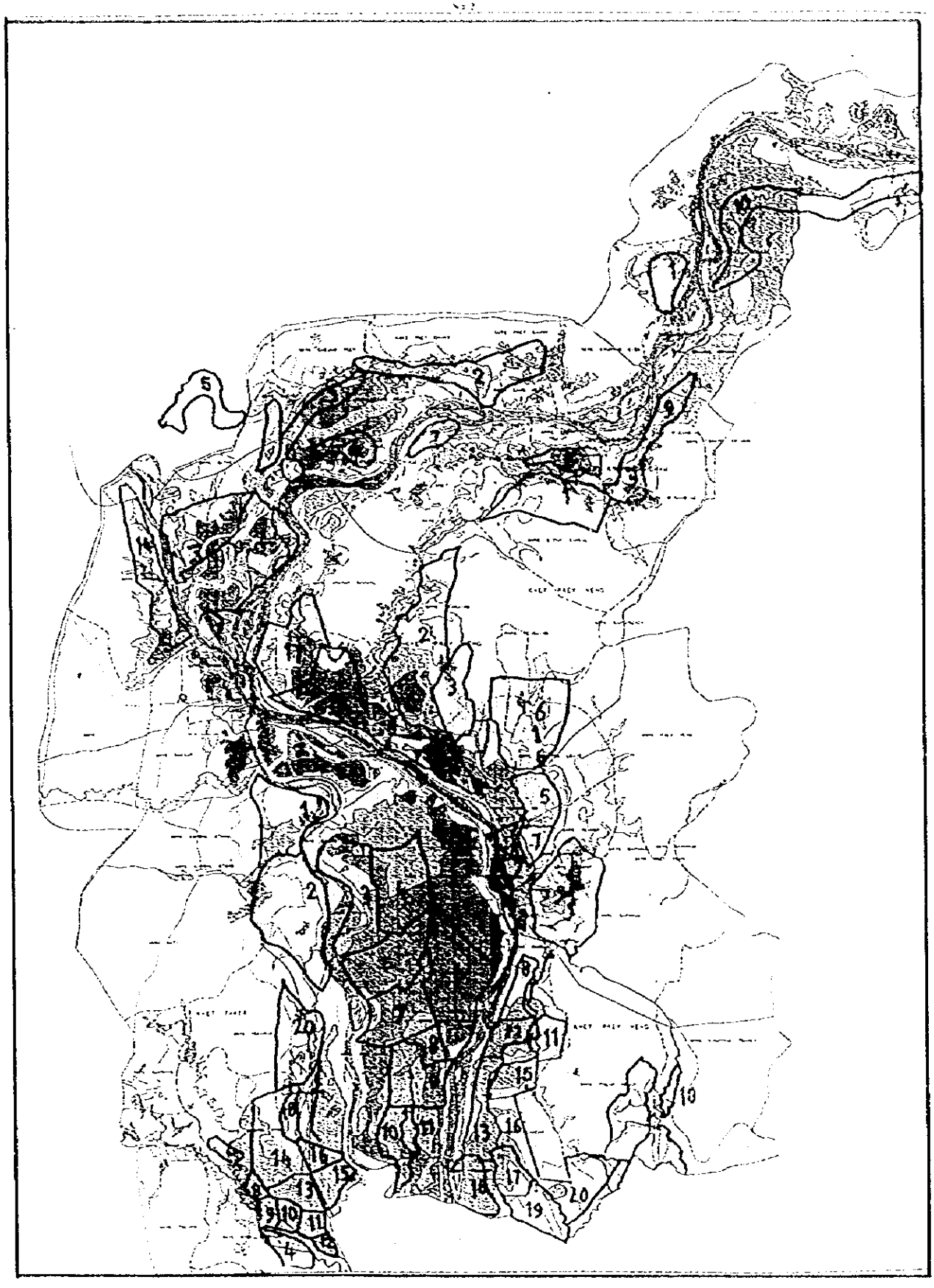


Figure F 2.2.1 Locations of Fishing Lots in the Flooded Area (shaded)

Figure F 2.3.1 Fishing Lots and Inundated Forest (shaded)

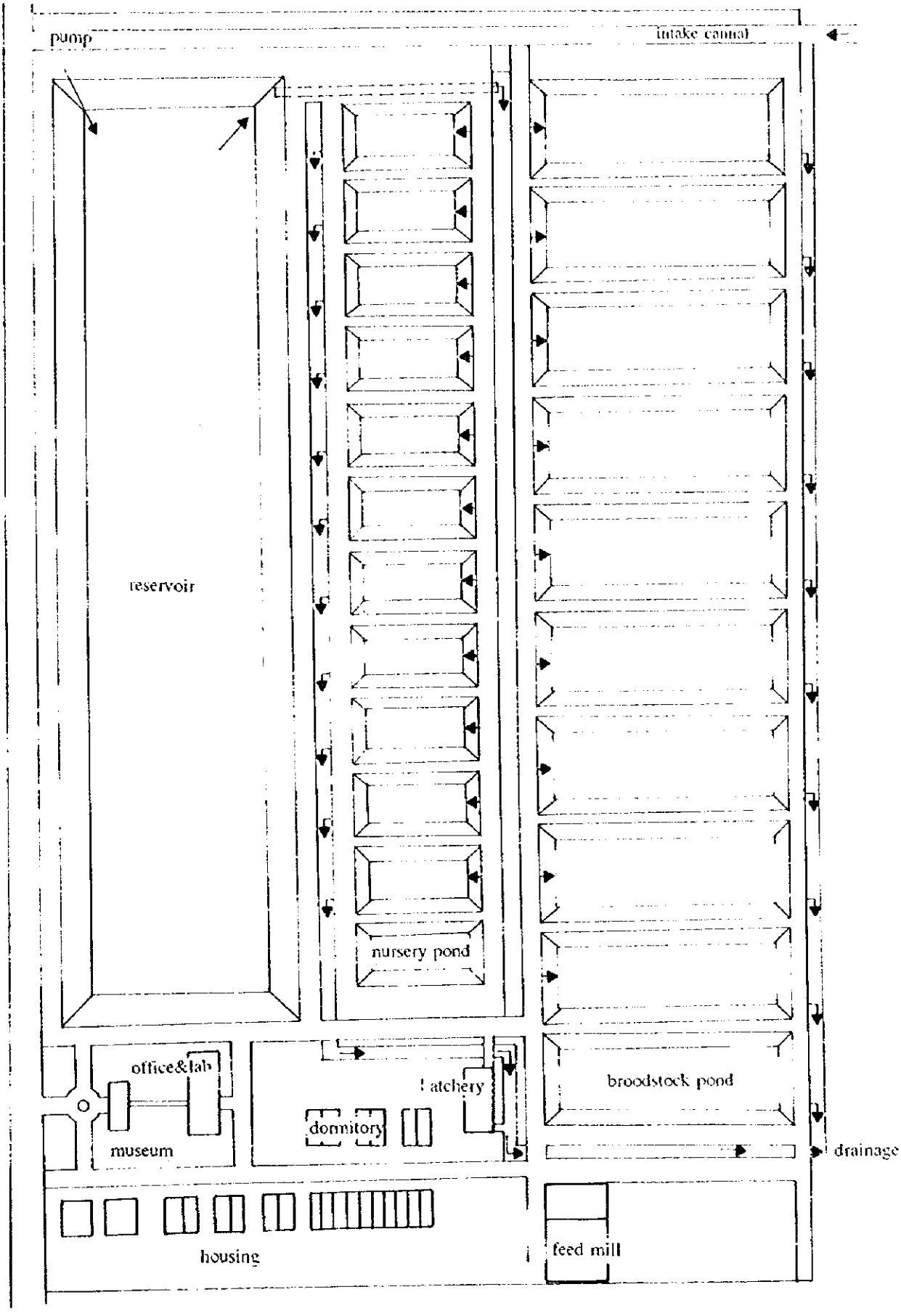


Figure F 3.1.1 Prototype of Fish Seed Center

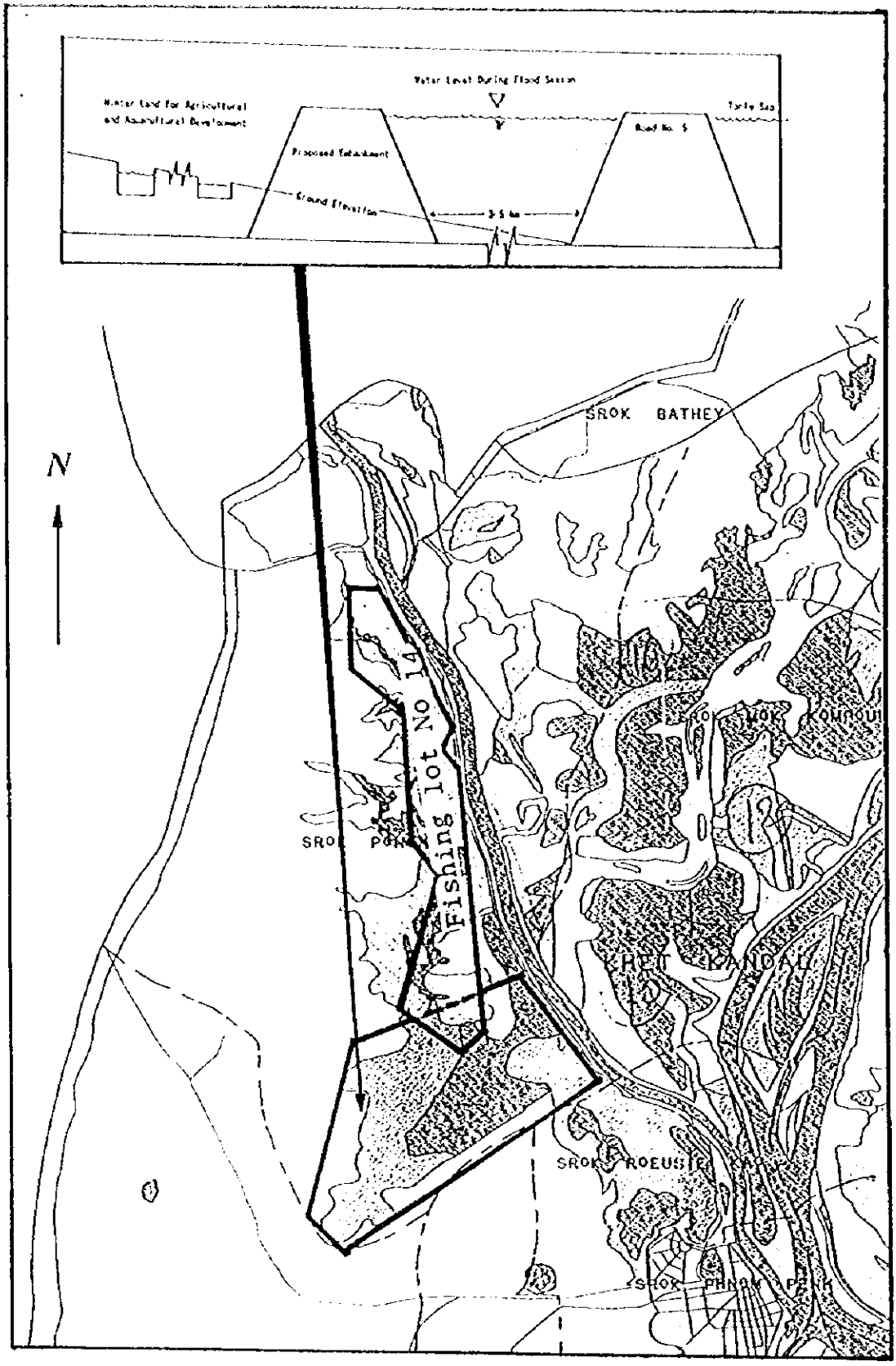


Figure F 3.2.1 Proposed Swamp Rehabilitation at Srok Ponhea Leu

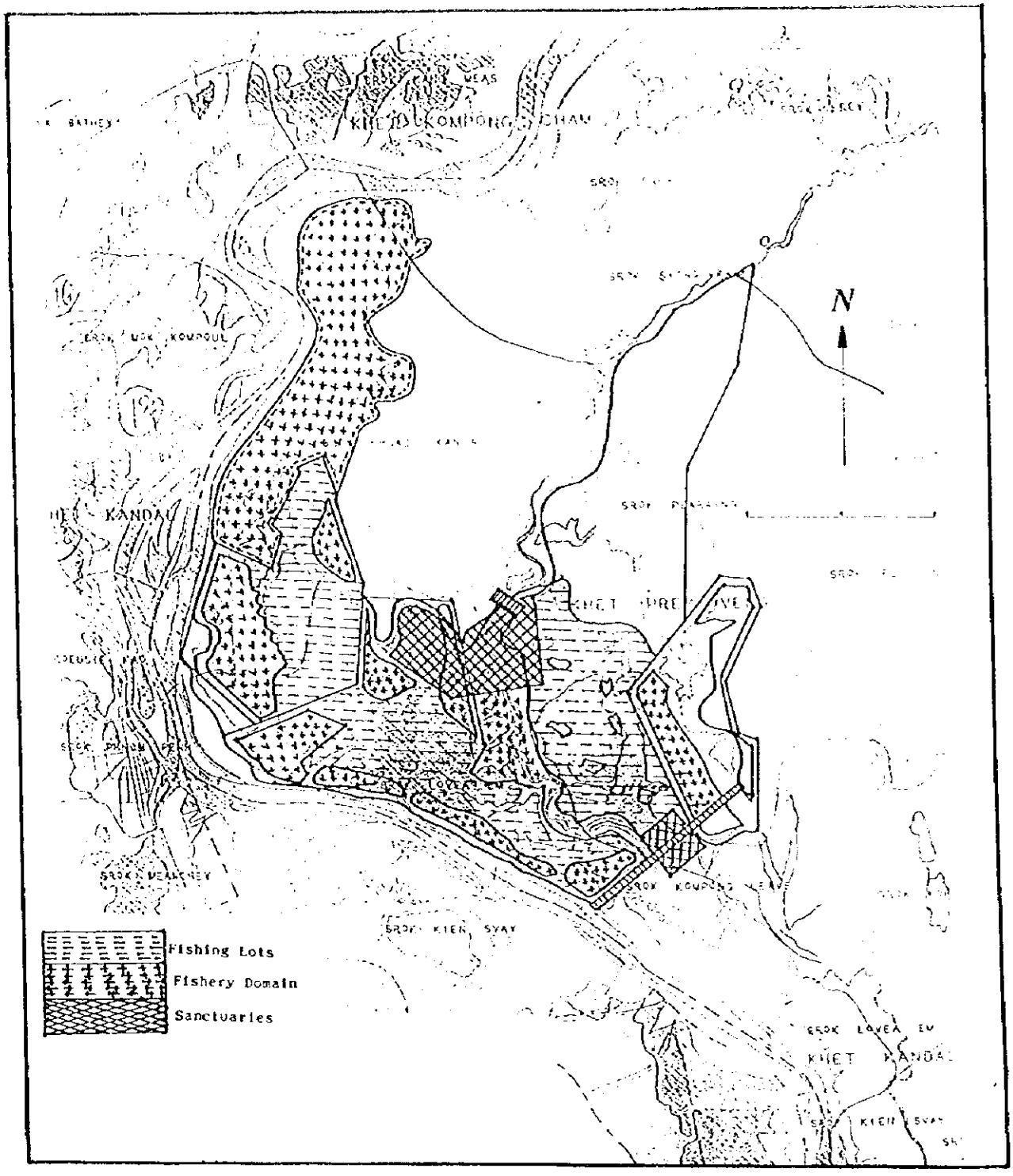


Figure F 3.2.2 Proposed Swamp Rehabilitation at Srok Lovea Em

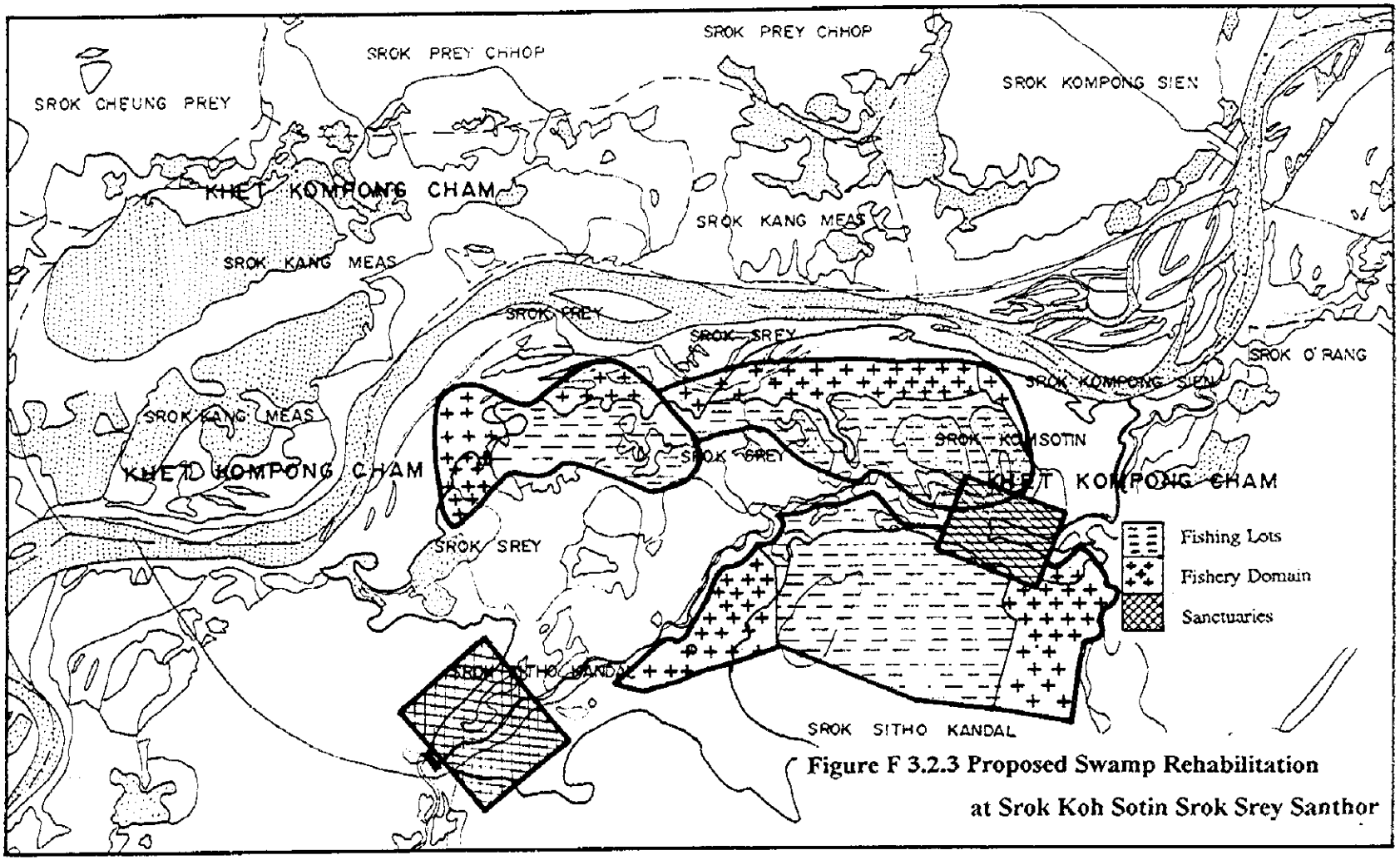


Figure F 3.2.3 Proposed Swamp Rehabilitation at Srok Koh Sotin Srok Srey Santhor

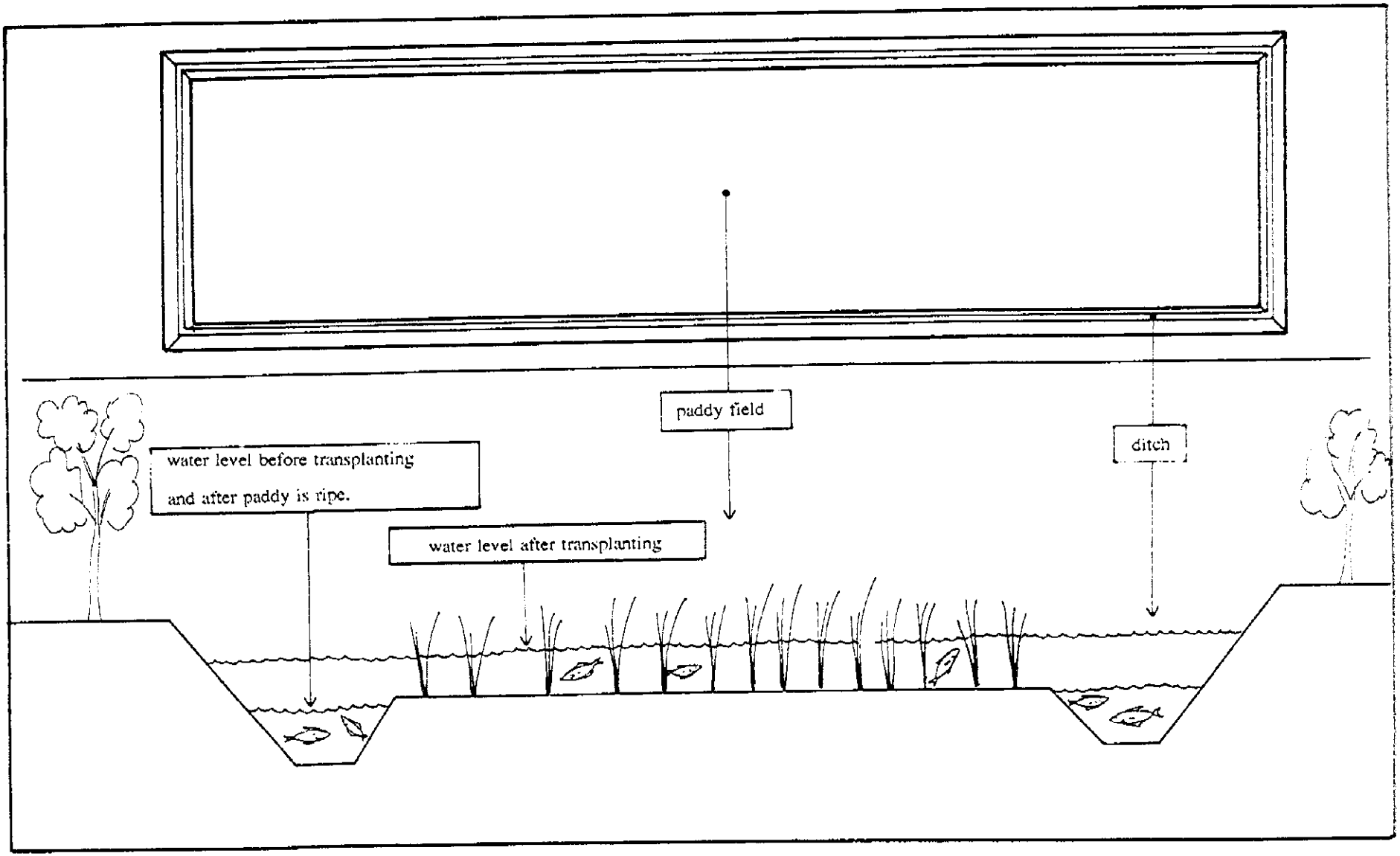
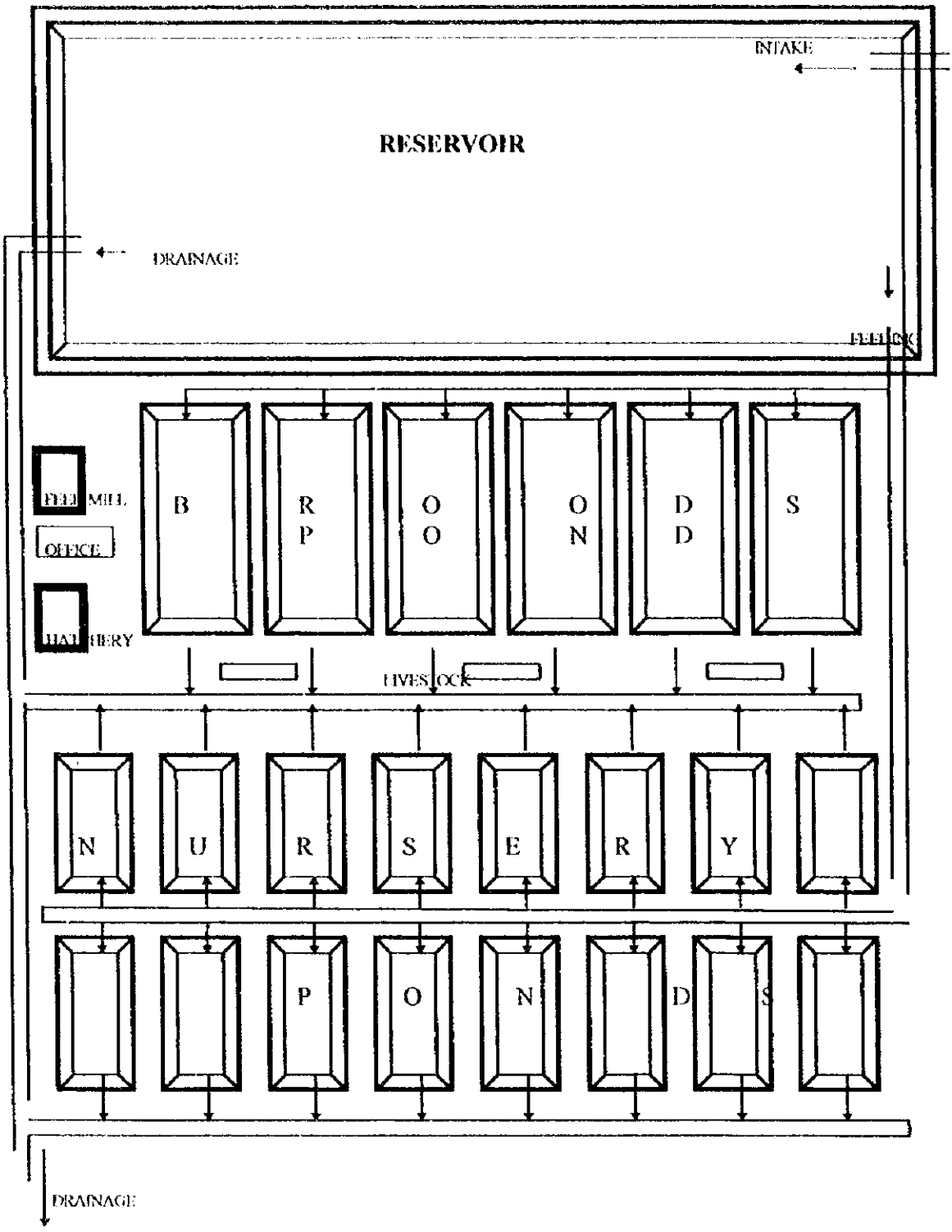


Figure F 3.3.1 Typical Physical Structure of Paddy Field of Rice cum Fish Culture



Reservoir 90 x 240 x 2.5 m (1 Unit)
Brood Stock Pond 30 x 70 x 1.8 m (6 Units)
Nursery Ponds 20 x 50 x 1.2 m (16 Units)
Hatchery 10x 12 m; Feed Mill 8 x 10 m; Office 5 x 8 m

Figure 4.5.3 General Layout of Fish Seed Production Station
(Capacity 5 mill.Seed/year)

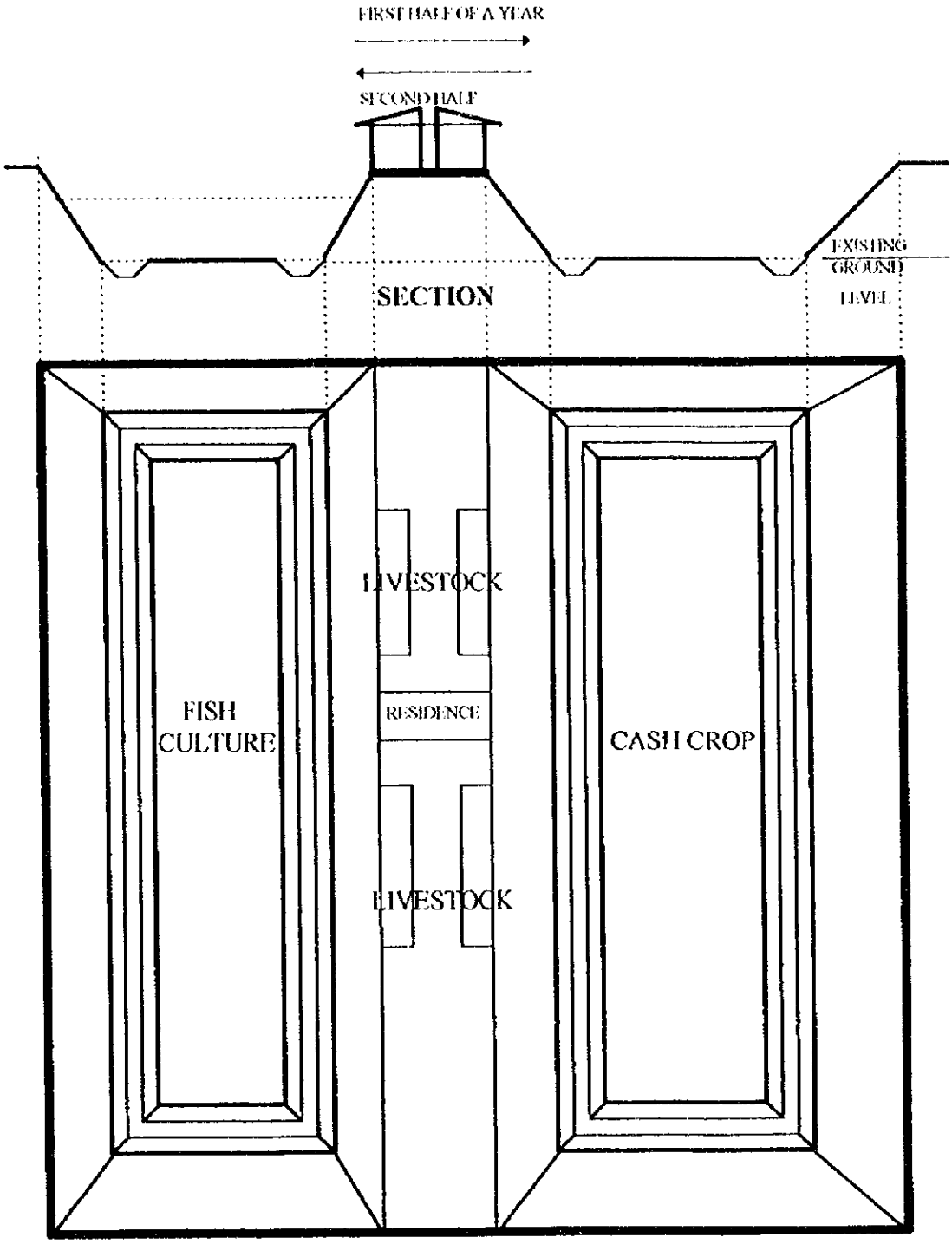


Figure 4.5.4 One Ha Model of Aqua-Agriculture Integrated Farm

APPENDIX G

Agricultural Infrastructure / Cost Estimation

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I. Master Plan Study

G.1 Present Condition of Rural Infrastructure

G.1.1 Institutions Involved in Rural Infrastructure Development

(1) Rural Road Networks

According to the 'Road Basic Design Criteria' prepared by the Public Works Research Centre, Ministry of Public Works and Transport(MPWT), Road is classified into followings.

I. **Road hierarchy (Highway)** - is the basic recognition that one extreme, streets are primary for vehicular movements, while at other extreme they are for pedestrian activity and local access. As general rule, road may join other roads of the same, or immediately above or below their own hierarchical classification.

II. **Arterial Roads (primary - national)** - predominantly carry through traffic from one region to another forming principal avenues of communication for urban traffic, from city to city of province and carry traffic directly from one part of a region to another including development centre.

III. **Collector roads (secondary - provincial)** - connect the arterial/primary roads to the local roads system in developed areas. They link the district centers to the province centers and to the primary roads, or link adjacent provinces, and also connect major industrial centers, tourist centers or other centre with large transport needs to the primary roads.

IV. **Access or Local roads (tertiary - district)** - are the sub-divisional roads within a particular developed area. They are used solely as local access roads. They cater for the inter-district transport, connect rural centers to town, to each other or primary or secondary.

Out of the above classification, roads in the rural areas including farm roads are categorized into the 'IV', of which operation and maintenance had been conducted by the Provincial Public Works in the past. But according to the recent information from the MPWT and the Ministry of Rural Development(MRD), it is supposed to be executed by the Department of Community Development, General Department for Technical Affairs(MRD). (refer to Figure G.1.1)

(2) Rural Water Supply

In the 1980's, rural water supply was operated by UNICEF and the Ministry of Health(MOH). Since December in 1994, the operating body was removed to Department of Rural Water Supply, General Department for Technical Affairs(MRD). The Oxfam, one of NGOs, also promoted the rural water

supply projects in close cooperation with the Ministry of Agriculture's Department of Hydrology(DOH) since 1989, which is proceeded to the PRASAC project under cooperation with Provincial Office of Irrigation, Meteorology and Hydrology at present. (refer to Figure G.1.2)

G.1.2 Rural Infrastructure Facilities

(1) Rural Road Networks

(a) Transportation Systems

Farmers has various means for transportation of farm products from farms to residences, as follows;

- human labor
- ox
- ox-cart
- motorcycle
- motorcycle drawn cart

Most of farmers depend on ox and ox-cart to transport paddy from fields to their farm yards. The transportation of products to market is usually conducted by motorcycle or bicycle. But road condition is generally poor.

(b) Road Length

National and provincial roads are generally under good condition even in wet season due to asphalt pavement. But most of district and farm roads are poor, no pavement, which are unfunctional during flooding season.

Total length of roads provided so far is shown in the following table. (refer to Table G.1.1)

Length of Roads in the Study Area

(unit ; km)

Provincial Name	National Road	Provincial Road	Rural road	Total
Kampong Cham	167.5	243.4	2,369.5	2,780.4
Kandal	246.0	81.1	1,674.5	2,001.6
Prey Veng	107.1	448.0	1,479.0	2,034.1
Takeo	140.5	121.9	590.0	852.4
Total	661.1	894.4	6,113.0	7,668.5

Source : Collected data and information from the Public Works and Transportation Service Office in each Province.

(c) Density of Road

According to the collected data from Public Works and Transport Service Offices of each province, the density of road in each province is shown in the table below. (refer to Table G.1.1 and Figure G.1.3)

Density of Roads in the Study Area

(unit ; km/km^2)

Provincial Name	National Road	Provincial Road	Rural road	Total
Kampong Cham	0.025	0.036	0.354	0.415
Kandal	0.069	0.023	0.471	0.563
Prey Veng	0.025	0.104	0.343	0.471
Takeo	0.051	0.044	0.213	0.308
Whole Area	0.038	0.052	0.353	0.442

Source : Collected data and information from the Public Works and Transportation Service Office in each Province.

The characteristics are summarized as follows.

- The average density of rural roads in the study area is 0.35 km/㎢.
- Takeo province is the lowest density of 0.21 km/㎢ in the study area.
- In Kampong Cham and Prey Veng provinces, the average density of rural roads is 0.35 km/㎢ and 0.34 km/㎢ respectively. These figures are nearly average in the study area.
- Kandal province is the highest density of 0.47 km/㎢ in the study area.

(2) Rural Water Supply

(a) Drinking Water Source

Drinking water source in the rural area is as follows.

- Pond
- River
- Dug-well (shallow well)
- Tube-well
- Rainfall
- Others (lake, stream, pumping machine, buying from the dealer)

People in the rural area have traditionally little use of groundwater, tending to rely on pond/river, dug-well and stream in the dry season, and rainwater, pond/river and shallow well in the rainy season. Groundwater from deep well is rather unpopular for drinking, because its taste is 'flat' and it sometimes contains high concentrations of mineral salts or iron, which also give an

unpleasant taste.

(b) Number of Existing Drilling Wells

Since 1980's, construction works of tube-well have been conducting by the above mentioned institutions involving in NGOs. The numbers of drilling well constructed by UNICEF are as follows. (refer to Table G.1.2)

Numbers of Drilling Well Constructed by UNICEF

Provincial Name	Numbers of Well (Nos.)	Density (person/well)	Depth of Well (m)	Water Level (m)	Yield (m3/H)
Kratie	15	2,949	37.9	12.2	1.20
Kampong Cham	922	1,279	27.7	9.2	2.56
Kandal	1,483	586	31.2	5.9	3.57
Prey Veng	764	1,009	35.6	5.5	2.97
Takeo	961	548	29.5	5.5	2.36
Total	4,145	818	32.4	7.6	2.53

Source ; Department of Rural Water Supply, MRD

(c) Density of Existing Drilling Well (Constructed by UNICEF)

According to the collected data and information from Department of Rural Water Supply (MRD), the density of drilling well constructed by UNICEF is shown in Table G.1.2 and Figure G.1.4. The characteristics are summarized as follows.

- The average density, depth and yield of existing tube-wells in the study area are 818 person/well, 32.4m and 2.53 m3/hr respectively.
- Kratie province has the lowest density (2,949 person/well) of existing tube-wells.
- The average density of existing tube-wells in Kompong Cham and Prey Veng provinces are 1,279 person/well and 1,009 person/well respectively. These figures are a little lower than the average in the study area.
- The average density in Kandal and Takeo provinces are 586 person/well and 548 person/well respectively, which are the highest density in the study area.

G.1.3 Results of Farmers Interview Survey for Rural Infrastructure

(1) Drinking Water Source

According to the farmers interview survey, drinking water sources in the study area are mainly pond, river, dug or tube-wells and rainfall. The condition of drinking water source in the study area is

summarized as follows (see Figure G.1.5).

- In the study area, the number of surface water consists of pond or river is almost same as that of dug or tube-wells. Utilizing ratio between surface water (pond/river) and groundwater (dug or tube-wells) is different in each province.
- Kandal province is depending on pond/river, occupying the highest ratio of 75%, since the access to surface water source site is much better than groundwater source site due to the presence of the Mekong and Bassac rivers.
- In Kratie province, the ratio of pond/river and dug-wells are 53% and 42% respectively. The ratio of tube-well is few.
- In Kampong Cham province, dug-well is used the most of 56%. Pond/river and tube-well are 39% and 5% use respectively.
- In Prey Veng province, the ratio of three water sources are almost equal.
- Takeo province has the highest ratio of tube-well, 38% as compared with the other provinces. However, pond/river is the most useful of 53% and dug-well is used 10%.
- Rainfall is also important source for domestic water. Rainfall is accounted for 420 households or 42% of total. Detail is shown as below;

The Ratio of Rainfall for Drinking Water Source

Description	Kratie	Kampong Cham	Prey Veng	Kandal	Takeo	Total
Rainfall User	14	130	74	185	17	420
Nos. of Survey	38	272	289	362	39	1,000
Proportion (%)	37	48	26	51	44	42

(2) Electricity Power

The electricity condition in the study area is summarized as follows (see Figure G.1.6).

- 67% of whole households in the study area is depending on the lamps.
- Remains 33% has electricity equipment including generator and small battery. Most of them use small battery.
- In Kampong Cham and Prey Veng provinces, the ratio of no electricity households is the highest over 76%.
- In Kandal province, the ratio of households using small battery is the highest of 36%.
- The ratio of using small battery in Takeo province is 47%, but it is doubtful due to few sampling data.

G.1.4 Constraints for Rural Infrastructure Development

(1) Rural Road Networks

- Due to insufficient pavement and drainage facilities, the roads become muddy in the rainy season and it is difficult to travel by cars.
- About 6,100 km of the rural roads are necessary to rehabilitate, but the budget for rehabilitation is not enough.
- Some of the bridges in the study area are poor condition and difficult to pass by cars.
- Due to submerged farm roads in the rainy season, it is difficult to access to the farms.

(2) Rural Water Supply

- Many people in the study area depend on pond or river for domestic water, because of the lack of tube-wells and bad quality of water in tube-well.
- Almost all of the dug-wells are not satisfactorily yields in the dry season.
- The maintenance of the tube-well facility is to be conducted by village people, but it is hardly difficult for them to repair the pump facility, etc., due to lack of funds.

Table G.1.1 Inventory of the Rural Roads in each Province

No.	Province /District	Area (1) (km2)	Commune	Village	Population	Distance (2) (km) National	Provincial	Rural	Total	Density (=(2)/(1)) (km/km2) National	Provincial	Rural	Total
	Kratie												
1	Prek Prasap	1,500.0	8	48	51,931	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
2	Chhlong	1,047.0	8	40	44,233	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
	sub total	2,547.0	16	88	96,164	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
	Kampong Cham												
1	Kroch Chhmar	769.5	12	72	89,464	-	-	501.4	501.4	-	-	0.652	0.652
2	Tbong Khmum	971.3	22	323	202,960	34.0	8.8	177.4	220.2	0.035	0.009	0.183	0.227
3	O Reang Ov	520.7	8	141	86,362	16.5	31.2	132.5	180.2	0.032	0.060	0.254	0.346
4	Koh Sotin	194.3	8	85	74,665	-	-	138.1	138.1	-	-	0.711	0.711
5	Srey Santhel	340.5	14	86	99,965	-	32.7	258.7	291.4	-	0.096	0.760	0.856
6	Stung Trang	988.2	14	74	86,004	-	22.7	217.8	240.5	-	0.023	0.220	0.243
7	Kampong Seim	384.1	15	111	95,438	10.0	25.3	208.5	243.8	0.026	0.066	0.543	0.635
8	Prey Chhor	421.8	15	176	123,294	26.0	15.2	185.0	226.2	0.062	0.036	0.439	0.536
9	Kang Meas	389.8	11	93	88,092	8.6	45.0	141.8	195.4	0.022	0.115	0.364	0.501
10	Cheung Prey	397.8	10	74	71,468	36.4	3.9	150.6	190.9	0.092	0.010	0.379	0.480
11	Batheay	781.5	12	79	84,209	34.8	-	144.2	179.0	0.049	-	0.203	0.252
12	Kampong Cham	3.5	4	31	35,680	1.2	32.1	7.5	40.8	0.343	9.171	2.143	11.657
13	Dambe	602.1	7	63	41,789	-	26.5	106.0	132.5	-	0.044	0.176	0.220
	sub total	6,695.1	152	1,408	1,179,390	167.5	243.4	2,369.5	2,780.4	0.025	0.036	0.354	0.415
	Kandal												
1	Ksach Kandal	353.2	18	95	103,353	-	-	82.0	82.0	-	-	0.232	0.232
2	Muk Kampoul	275.0	9	47	67,075	28.0	9.0	113.0	150.0	0.102	0.033	0.411	0.545
3	Lvea Em	260.9	15	43	59,100	-	-	102.0	102.0	-	-	0.391	0.391
4	Kean Svay	382.1	12	41	115,134	46.0	-	406.3	452.3	0.120	-	1.063	1.184
5	Saang	515.0	16	117	155,052	46.0	-	145.0	191.0	0.089	-	0.282	0.371
6	Leuk Dek	372.2	7	24	44,900	7.5	-	35.3	42.8	0.020	-	0.095	0.115
7	Koh Thom	503.1	11	92	124,786	29.8	-	95.5	125.3	0.059	-	0.190	0.249
8	Ponhea Leu	315.5	14	140	80,863	31.0	17.0	154.7	202.7	0.098	0.054	0.490	0.642
9	Ang Snoul	296.1	16	307	83,135	18.0	26.0	374.1	418.1	0.061	0.088	1.263	1.412
10	Kandal Stung	250.6	23	155	74,415	28.0	16.2	151.3	195.5	0.112	0.065	0.604	0.780
11	Takhmau	31.8	6	19	43,839	11.7	12.9	15.3	39.9	0.368	0.406	0.481	1.255
	sub total	3,555.5	147	1,083	951,652	246.0	81.1	1,674.5	2,001.6	0.069	0.023	0.471	0.563
	Prey Veng												
1	Kamchay Mear	452.1	8	128	73,825	-	46.0	87.0	133.0	-	0.102	0.192	0.294
2	Kanh Chreach	318.7	8	99	59,315	10.9	58.0	122.0	190.9	0.034	0.182	0.383	0.599
3	Sithor Kandal	307.7	11	60	67,636	5.7	45.0	102.0	152.7	0.019	0.146	0.331	0.496
4	Peareang	559.9	11	84	115,836	-	40.0	138.0	178.0	-	0.071	0.246	0.318
5	Prey Veng DC	494.9	11	138	91,388	12.9	15.0	124.0	151.9	0.026	0.030	0.251	0.307
6	Kampong Leav	251.2	8	42	48,808	14.4	3.0	60.0	77.4	0.057	0.012	0.239	0.308
7	Ba Phnom	341.6	9	108	78,364	-	50.0	94.0	144.0	-	0.146	0.275	0.422
8	Peam Ro	186.5	8	41	59,038	25.4	24.0	61.0	110.4	0.136	0.129	0.327	0.592
9	Kampong Trayek	506.3	13	122	115,764	21.2	57.0	387.0	465.2	0.042	0.113	0.764	0.919
10	Prea Sdech	501.5	11	145	115,224	16.6	56.0	226.0	298.6	0.033	0.112	0.451	0.595
11	Peam Chor	396.5	10	51	53,432	-	54.0	78.0	132.0	-	0.136	0.197	0.333
	sub total	4,316.9	108	1,018	878,630	107.1	448.0	1,479.0	2,034.1	0.025	0.104	0.343	0.471
	Takeo												
1	Bati	376.0	15	168	101,094	34.0	22.9	121.3	178.2	0.090	0.061	0.323	0.474
2	Prey Kabass	247.5	13	110	79,545	-	26.1	99.4	125.5	-	0.105	0.402	0.507
3	Angkor Borey	216.0	6	31	41,762	-	10.3	17.0	27.3	-	0.048	0.079	0.126
4	Samrong	330.0	11	147	99,316	33.8	10.2	48.6	92.6	0.102	0.031	0.147	0.281
5	Tram Kak	539.0	14	243	138,452	9.7	-	93.8	103.5	0.018	0.000	0.174	0.192
6	Borey Cholasar	248.0	5	38	21,806	-	-	36.0	36.0	0.000	0.000	0.145	0.145
7	Treang	365.0	14	153	94,558	20.6	20.0	48.5	89.1	0.056	0.055	0.133	0.244
8	Koh Andet	330.0	6	68	44,971	26.7	11.0	83.0	120.7	0.081	0.033	0.252	0.366
9	Takeo PC	113.0	3	40	30,072	15.7	21.4	42.4	79.5	0.139	0.189	0.375	0.704
	sub total	2,764.5	87	1,001	651,576	140.5	121.9	590.0	852.4	0.051	0.044	0.213	0.308
	Total	19,879.0	510	4,598	3,757,412	661.1	894.4	6,113.0	7,668.5	0.033	0.052	0.353	0.442

Note ; Rural Road means minor road and cart road.

Sources ; Public Works and Transport Service Office of each Province

Table G.1.2 -(1) Inventory of Existing Drilling Well (Constructed by UNICEF)

No.	Province /District	Area (km2)	Population (1)	Number of Well (2) 1988~92	1,993	1,994	1,995~	Total	Density (3) = (1) / (2) (person/well)	Depth (m)	W.L (m)	Yield (4) (m3/H)	Remarks
	Kratie												
1	Prek Prasap	1,500.0	51,931	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
2	Chhlong	1,047.0	44,233	-	15	-	-	15	2,949	37.9	12.2	1.20	
	Total	2,547.0	96,164	0	15	0	0	15	2,949	37.9	12.2	1.20	
	Kampong Cham												
1	Kroch Chhmar	769.5	89,464	1	6	3	12	22	4,067	30.3	12.6	2.01	
2	Tbong Khmum	971.3	202,960	68	-	12	18	98	2,071	27.6	8.9	3.42	
3	O Reang Ov	520.7	86,362	2	-	-	83	85	1,016	21.4	5.3	4.97	
4	Koh Sotin	194.3	74,665	47	-	-	3	50	1,493	30.5	8.9	1.93	
5	Srey Santhel	340.5	99,965	60	11	-	-	71	1,408	27.9	9.8	2.49	
6	Stung Trang	988.2	86,004	12	-	-	-	12	7,167	33.7	10.1	1.83	
7	Kampong Seim	384.1	95,438	49	-	49	76	174	548	26.0	9.2	3.06	
8	Prey Chhor	421.8	123,294	91	-	6	40	137	900	28.4	9.7	3.34	
9	Kang Meas	389.8	88,092	47	1	-	1	49	1,798	32.5	11.4	1.65	
10	Cheung Prey	397.8	71,468	44	5	19	1	69	1,036	33.9	9.5	1.93	
11	Batheay	711.5	84,209	47	6	21	3	77	1,094	28.0	8.6	2.57	
12	Kampong Cham	3.5	35,680	42	1	14	18	75	476	22.4	9.8	2.24	
13	Dambe	602.1	41,789	3	-	-	-	3	13,930	17.0	5.3	1.80	
	Total	6,695.1	1,179,390	513	30	124	255	922	1,279	27.7	9.2	2.56	
	Kandal												
1	Ksach Kandal	353.2	103,353	187	25	2	-	214	483	28.1	6.9	3.07	
2	Muk Kampoul	275.0	67,075	12	-	-	15	27	2,484	32.0	7.5	1.56	
3	Lvea Em	260.9	59,100	103	-	-	-	103	574	30.3	7.0	2.78	
4	Kean Svay	382.1	115,134	141	60	23	8	232	496	32.0	5.9	4.40	
5	Saang	515.0	155,052	113	31	38	6	188	825	32.8	5.1	4.98	
6	Leuk Dek	372.2	44,900	57	14	-	10	81	554	32.8	6.5	2.96	
7	Koh Thom	503.1	124,786	160	15	53	19	247	505	30.5	5.3	3.01	
8	Ponhea Leu	315.5	80,863	144	5	2	32	183	442	30.0	5.3	2.67	
9	Ang Snoul	296.1	83,135	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
10	Kandal Stung	250.6	74,415	83	3	3	-	89	836	30.6	4.3	3.83	
11	Takhmau	31.8	43,839	93	8	12	6	119	368	33.3	4.9	6.43	
	Total	3,555.5	951,652	1,093	161	133	96	1,483	586	31.2	5.9	3.57	

Note ; W.L = water level from the ground level
n.a means not available

Sources ; Department of Rural Water Supply , Ministry of Rural Development

Table G.1.2 -(2) Inventory of Existing Drilling Well (Constructed by UNICEF)

No.	Province /District	Area (km2)	Population (1)	Number of Well (2) 1,992	1,993	1,994	1,995	Total	Density (3) = (1) / (2) (person/well)	Depth (m)	W.L (m)	Yield (4) (m3/H)	Remarks
	Prey Veng												
1	Kamchay Mear	452.1	73,825	36	23	10	28	97	761	34.6	4.6	3.47	
2	Kanh Chreach	318.7	59,315	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
3	Sithor Kandal	307.7	67,636	7	1	12	23	43	1,573	36.5	7.6	2.30	
4	Peareang	559.9	115,836	10	48	36	37	131	884	27.5	6.1	3.55	
5	Prey Veng DC	494.9	91,388	24	22	56	18	120	762	35.0	4.9	3.37	
6	Kampong Leav	251.2	48,808	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
7	Ba Phnom	341.6	78,364	8	10	4	84	106	739	41.6	5.1	2.93	
8	Peam Ro	186.5	59,038	24	19	3	24	70	843	37.3	5.5	2.79	
9	Kampong Trayek	506.3	115,764	10	5	38	22	75	1,544	42.1	4.9	2.48	
10	Prea Sdech	501.5	115,224	9	-	73	29	111	1,038	27.9	5.0	3.10	
11	Peam Chor	396.5	53,432	7	2	-	2	11	4,857	37.7	5.7	2.75	
	Total	4,316.9	878,630	135	130	232	267	764	1,009	35.6	5.5	2.97	
	Takeo												
1	Bati	376.0	101,094	170	22	30	12	234	432	30.7	5.3	1.62	
2	Prey Kabass	247.5	79,545	173	27	-	17	217	367	31.2	6.4	2.81	
3	Angkor Borey	216.0	41,762	56	14	-	1	71	588	28.8	6.2	3.00	
4	Samrong	330.0	99,316	152	10	18	10	190	523	29.3	4.7	1.95	
5	Tram Kak	539.0	138,452	96	3	16	24	139	996	31.5	6.2	2.66	
6	Borey Cholasar	248.0	21,806	25	-	3	2	30	727	25.5	4.7	2.08	
7	Treang	365.0	94,558	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
8	Koh Andet	330.0	44,971	51	-	27	2	80	562	29.3	5.0	2.37	
9	Takeo PC	113.0	30,072	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	
	Total	2,764.5	651,576	723	76	94	68	961	548	29.5	5.5	2.36	
	Grand Total	19,879.0	3,757,412	2,464	412	583	686	4,145	818	32.4	7.6	2.53	

Note ; W.L = water level from the ground level
n.a means not available

Sources ; Department of Rural Water Supply , Ministry of Rural Development

Table G.1.3-(1) Existing Drinking Water Source in the Study Area

No.	Province /District	Farmer										Fisherman										Total									
		nos. of survey	Pond	River	Well	Tube -Well	Rain- fall	Others Lake	Others stream	Others other*	n.a	nos. of survey	Pond	River	Well	Tube -Well	Rain- fall	Others Lake	Others stream	Others other*	n.a	nos. of survey	Pond	River	Well	Tube -Well	Rain- fall	Others Lake	Others stream	Others other*	n.a
	Kratie																														
1	Prek Prasap	17		9	7		4				1	2		2			1					19		11	7		5				1
2	Chhlong	17		9	7	1	8					2			2		1					19		9	9	1	9				
	Sub-total	34		18	14	1	12				1	4		2	2		2					38		20	16	1	14				1
	Kompong Cham																														
1	O'Reang Ov	35			35							3		1	2							38		1	37						
2	Koh Sotin	35		18	24	1	17					3		3			3					38		21	24	1	20				
3	Srey Santhel	35		6	32		33					3		3			3					38		9	32		36				
4	Kang Meas	35	2	18	11	1	29	5				3		3	1		3					38	2	21	12	1	32	5			
5	Kroch Chhmar	19		12	10	1	11					3		3	1							22		15	11	1	11				
6	Tbong Khmum	19		15	6		5					3		2	1							22		17	7		5				
7	Stung Trang	19		16	4		16					2		2			2					21		18	4		18				
8	Kompong Seim	19			10	10						3		3			1					22		3	10	10	1				
9	Prey Chhor	11			10	1	1															11			10	1	1				
10	Cheung Prey	11	6		6		2															11	6		6		2				
11	Batheay	11			11		4															11			11		4				
	Sub-total	249	8	85	159	14	118	5				23		20	5		12					272	8	105	164	14	130	5			
	Prey Veng																														
1	Peam Ro	35		22	5	9			3			4		2	2							39		24	7	9				3	
2	Peam Chor	35	10	23	3	5	18					5		5								40	10	28	3	5	18				
3	Kanh Chreach	23			20	3																23			20	3					
4	Sithor Kandal	23		1	21	1						2		2								25		3	21	1					
5	Peareang	24		3	9	13	23					4			2	2	4					28		3	11	15	27				
6	Kompong Leav	24	1	5	3	16						2			1						1	26	1	5	4	16					1
7	Prey Veng	24			7	17	19				1	2			1	1	2					26			8	18	21				1
8	Ba Phnom	24	8		16	2	5					4	3		1							28	11		17	2	5				
9	Kamchay Mear	11		1	10							2			2							13		1	12						
10	Kompong Trayek	11		10			3					2		2								13		12			3				
11	Prea Sdech	24	1	4	5	14						4		2	2	2						28	1	6	7	16					
	Sub-total	258	20	69	99	80	68		3	1		31	3	13	11	5	6				1	289	23	82	110	85	74			3	2

Table G.1.3-(2) Existing Drinking Water Source in the Study Area

No.	Province /District	Farmer nos. of survey	Pond	River	Well	Tube -Well	Rain- fall	Others Lake	Others stream	Others other*	n.a	Fisherman nos. of survey	Pond	River	Well	Tube -Well	Rain- fall	Others Lake	Others stream	Others other*	n.a	Total nos. of survey	Pond	River	Well	Tube -Well	Rain- fall	Others Lake	Others stream	Others other*	n.a
	Kandal																														
1	Ksach Kandal	35	2	16	6	8	35	3				4		4			3					39	2	20	6	8	38	3			
2	Muk Kampoul	35	2	25	1	1	34	1	5		1	5		5			5					40	2	30	1	1	39	1	5		1
3	Lvea Em	35	4	30		4	3	1		1		5		4				4	1			40	4	34		4	3	5	1	1	
4	Kean Svay	35	7	13	1	12	16	4				5		3		2	2					40	7	16	1	14	18	4			
5	Saang	35	1	22	6	1			5			4		1		1		2				39	1	23	6	2		2	5		
6	Leuk Dek	35		33		1					1	5		5								40		38		1					1
7	Koh Thom	35	3	25		4	18		4			4	1	3			1					39	4	28		4	19		4		
8	Ponhea Leu	35	3	30		2	33	1	1			4		4			4					39	3	34		2	37	1	1		
9	Ang Snoul	23	5	11	6	5	8	1	6													23	5	11	6	5	8	1	6		
10	Kandal Stung	23			21	2	23															23			21	2	23				
	Sub-total	326	27	205	41	40	170	11	21	1	2	36	1	29		3	15	6	1			362	28	234	41	43	185	17	22	1	2
	Takeo																														
1	Bati	11	2		3	6	11					2	1			1	2					13	3		3	7	13				
2	Prey Kabas	11	4	1	1	6	1					2	1			1	2					13	5	1	1	7	3				
3	Angkor Borey	11	6	4		1	1					2		2								13	6	6		1	1				
	Sub-total	33	12	5	4	13	13					6	2	2		2	4					39	14	7	4	15	17				
	Total	900	67	382	317	148	381	11	26	4	4	100	6	66	18	10	39	6	1		1	1,000	73	448	335	158	420	17	27	4	5

Notes : (1) Some household use the plural source.
(2) * = pumping machine or buying from the dealer

Source : Rural Socio-Economic Survey by JICA Study team

Table G.1.4-(1) Existing Power Resources in the Study Area

No.	Province /District	Farmer nos. of survey	Power line	Group Gen.	Private Gen.	Battery	None	Others O.L	Others F.O	n.a	Fisherman nos. of survey	Power line	Group Gen.	Private Gen.	Battery	None	Others O.L	Others F.O	n.a	Total nos. of survey	Power line	Group Gen.	Private Gen.	Battery	None	Others O.L	Others F.O	n.a
	Kratie																											
1	Prek Prasap	17			1	10	15		1		2			2						19			3	10	15		1
2	Chhlong	17	8		1	9	7				2			1	1	1				19	8		2	10	8		
	Sub-total	34	8		2	19	22		1		4			3	1	1				38	8		5	20	23		1
	Kompong Cham																											
1	O'Reang Ov	35				35	35				3			1	2	2				38			1	37	37		
2	Koh Sotin	35			1	34	35				3				3	3				38			1	37	38		
3	Srey Santhel	35			1	34	34				3		1		2	2				38		1	1	36	36		
4	Kang Meas	35	1		18	12	35				3	2		2		2				38	3		20	12	37		
5	Kroch Chhmar	19	3	1	4	11	14	2			3	2			1	3				22	5	1	4	12	17	2	
6	Tbong Khmum	19		2	4	13	13				3			2	1	1				22		2	6	14	14		
7	Stung Trang	19	3		5	10	13				2				2	2				21	3		5	12	15		
8	Kompong Seim	19			7	11	13				3		1	2						22		1	9	11	13		
9	Prey Chhor	11				11	11													11				11	11		
10	Cheung Prey	11			2	9	11													11			2	9	11		
11	Batheay	11				9	11													11				9	11		
	Sub-total	249	7	3	42	189	225	2			23	4	2	7	11	15				272	11	5	49	200	240	2	
	Prey Veng																											
1	Peam Ro	35		1	9	24	2				4				4					39		1	9	28	2		
2	Peam Chor	35			12	21	4				5				5					40			12	26	4		
3	Kanh Chreach	23			2	21														23			2	21			
4	Sithor Kandal	23			1	2	23				2			1		1				25			2	2	24		
5	Peareang	24			7	17	2				4		1	1	2					28		1	8	19	2		
6	Kompong Leav	24	1			13	12				2				1				1	26	1			14	12		1
7	Prey Veng	24				23			1		2				2					26				25			1
8	Ba Phnom	24			4		22				4				1	4				28			4	1	26		
9	Kamchay Mear	11				3	9				2					2				13				3	11		
10	Kompong trayek	11				2	11				2					2				13				2	13		
11	Prea Sdech	24					24				4					4				28					28		
	Sub-total	258	1	1	35	126	109		1		31		1	2	15	13			1	289	1	2	37	141	122		2

Table G.1.4-(2) Existing Power Resources in the Study Area

No.	Province /District	Farmer									Fisherman							Total								
		nos. of survey	Power line	Group Gen.	Private Gen.	Battery	None	Others O.L	Others F.O	n.a	nos. of survey	Power line	Group Gen.	Private Gen.	Battery	None	Others O.L	Others F.O	n.a	nos. of survey	Power line	Group Gen.	Private Gen.	Battery	None	Others O.L	Others F.O	n.a
	Kandal																											
1	Ksach Kandal	35	4			12	20				4				3	1				39	4			15	21			
2	Muk Kampoul	35	1		1	16	14		3	1	5		1			4				40	1	1	1	16	18		3	1
3	Lvea Em	35				9	28				5				4	1				40				13	29			
4	Kean Svay	35	2	4		7	22				5					5				40	2	4		7	27			
5	Saang	35	6			10	19				4				2	2				39	6			12	21			
6	Leuk Dek	35				11		24			5				1		4			40				12		28		
7	Koh Thom	35	2	1		15		28			4		1				3			39	2	2		15		31		
8	Ponhea Leu	35	5			13		28	1		4				1		3			39	5			14		31	1	
9	Ang Snourl	23		1		1	21													23		1		1	21			
10	Kandal Stung	23					22													23					22			
	Sub-total	326	20	6	1	94	146	80	4	1	36		2		11	13	10			362	20	8	1	105	159	90	4	1
	Takeo																											
1	Bati	11				2	4	9			2				1		2			13				3	4	11		
2	Prey Kabas	11						11			2				2					13				2		11		
3	Angkor Borey	11				3	5	8			2				2					13				5	5	8		
	Sub-total	33				5	9	28			6				5		2			39				10	9	30		
	Total	900	36	10	1	178	489	464	6	3	100	4	5		28	40	41		1	1,000	40	15	1	206	529	505	6	4

Notes : (1) Some household use the plural power resources.
(2) Gen. = Generator, O.L = Oil lamp, F.O = Fish oil, n.a = not available

Source : Rural Socio-Economic Survey by JICA Study team

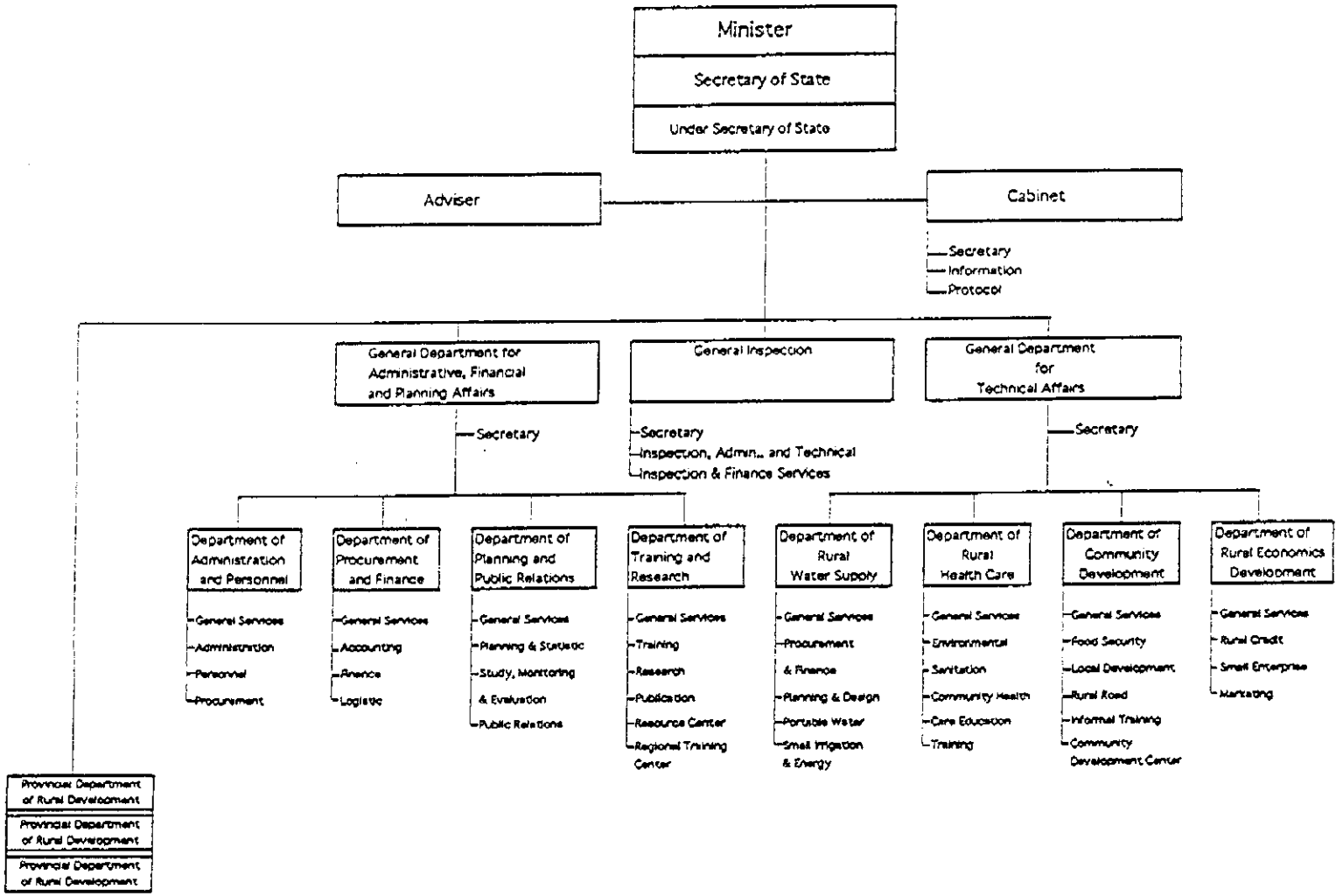
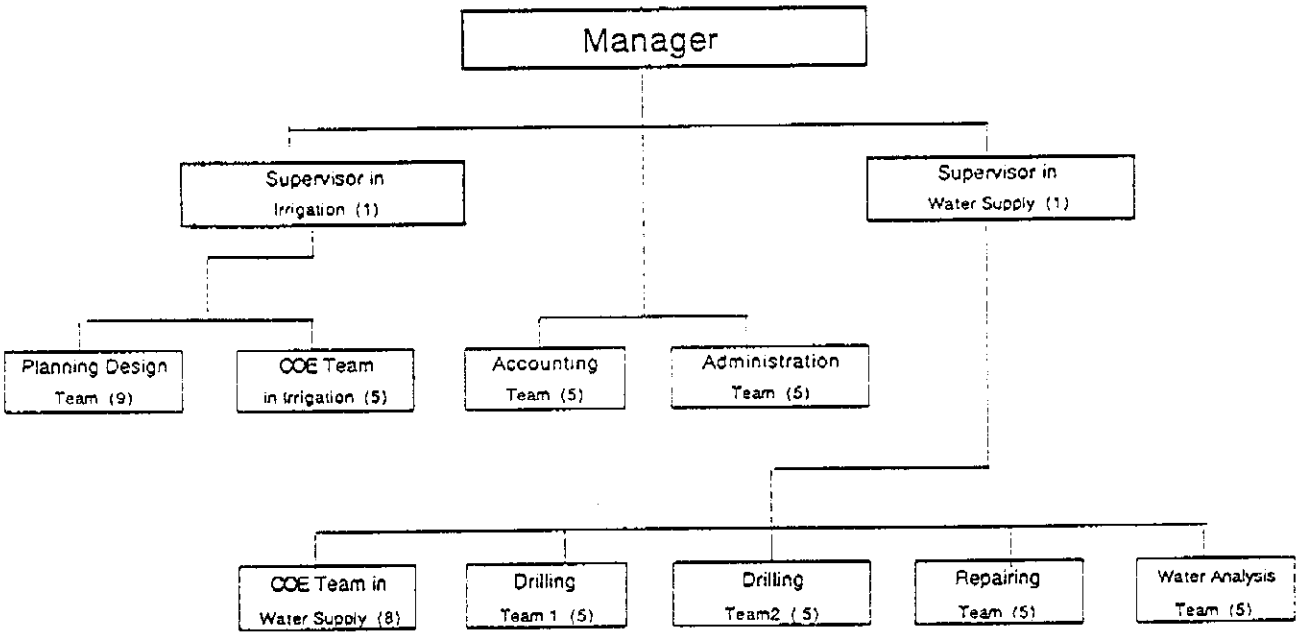
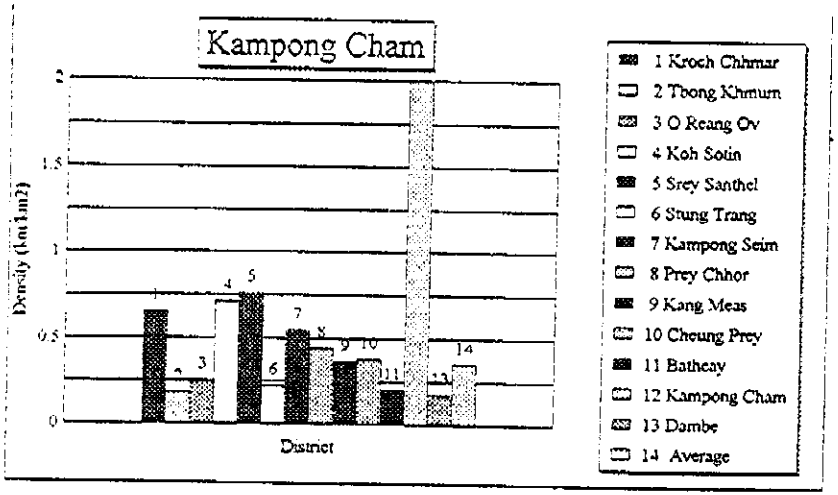


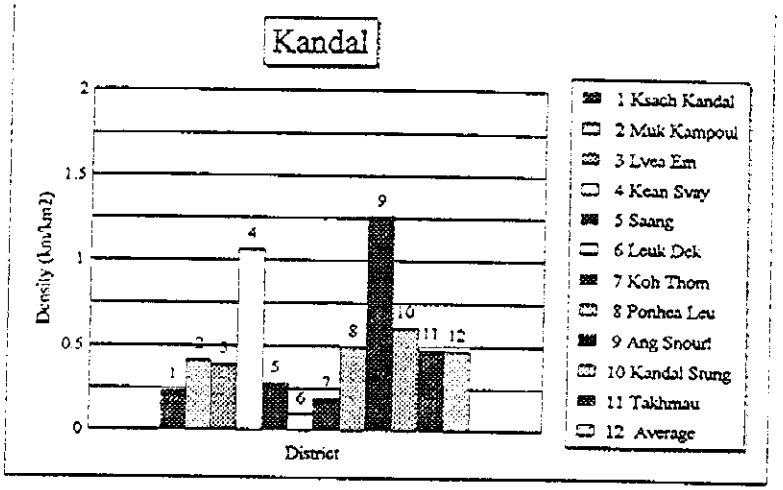
Figure G.1.1 Organization Chart of the Ministry of Rural Development (MRD)

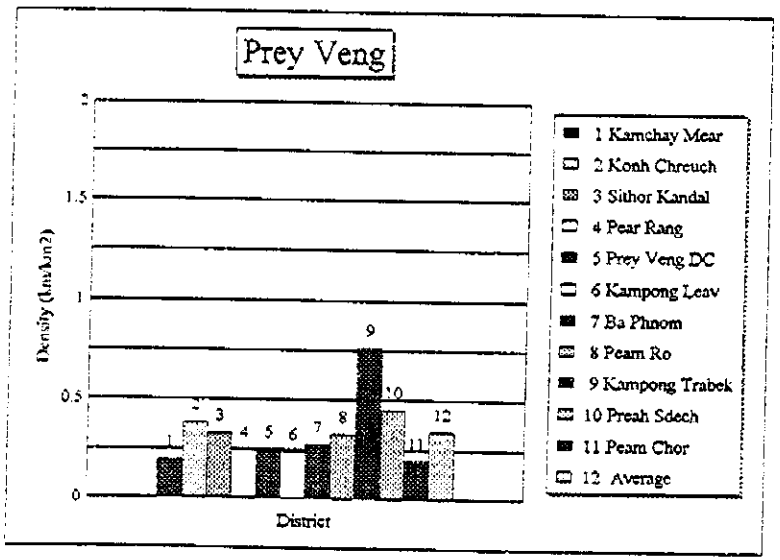


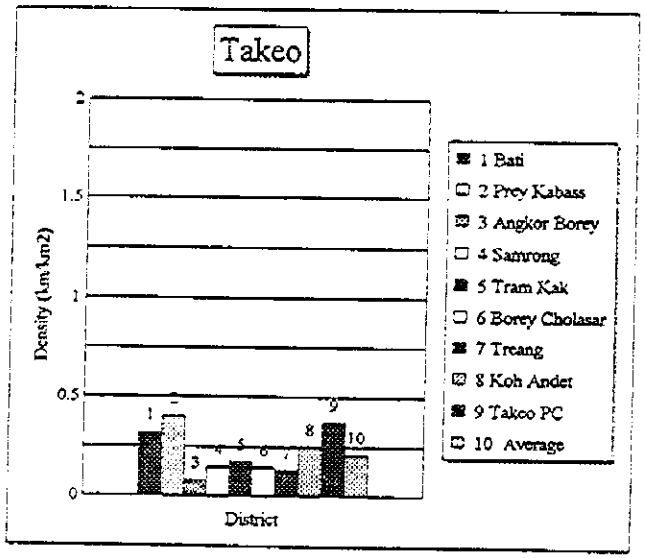
Note:
- Drilling Team (5) shows number of staff and all staff of the Project is 50 persons.
- COE means Organization of Community Education
- The Project has 2 drilling machines.(ϕ 49mm, ϕ 105mm)
- In response to farmer's request, the project constructs wells.
- Oxfam or EU donates the necessary material for construction of well and a beneficiary should pay u$30.0 for well.
- The project constructed 252 wells between July,'95 and Aug. '96(New Hand Pump 216, New Dug Well18and Rehabili. 18).

Figure G.1.2 Infrastructure in the Program of Irrigation and Water Supply (PRASAC 3 Project), Prey Veng Province



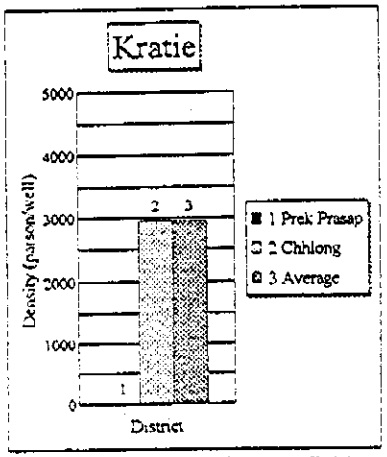




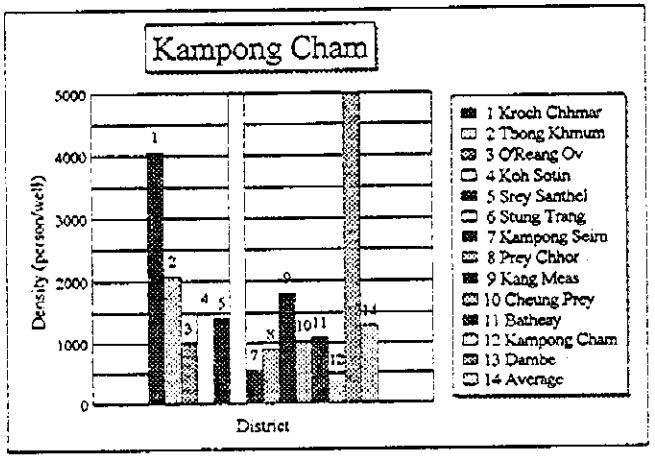


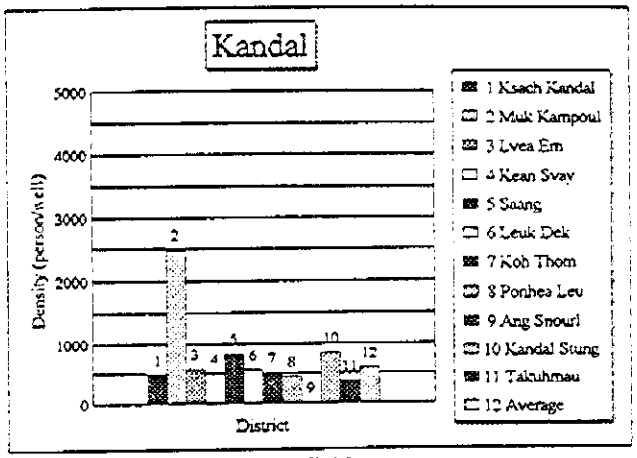
Note ; Kratie province is unavailable.

Figure G.1.3 Density of Rural Road in each District

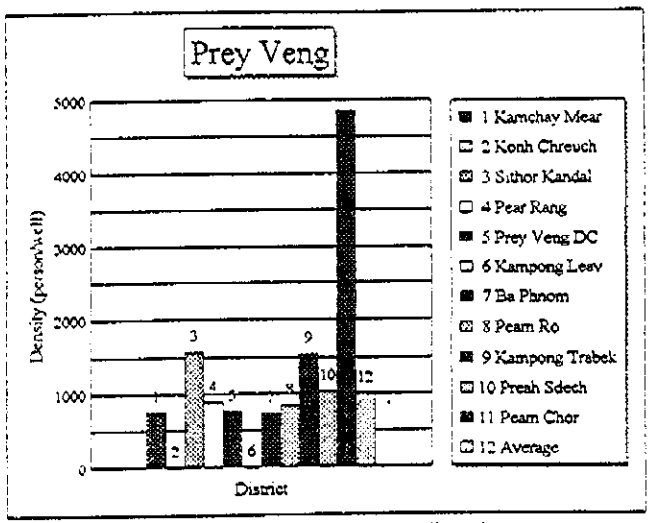


Note;'1 Prek Prasap' is unavailable.

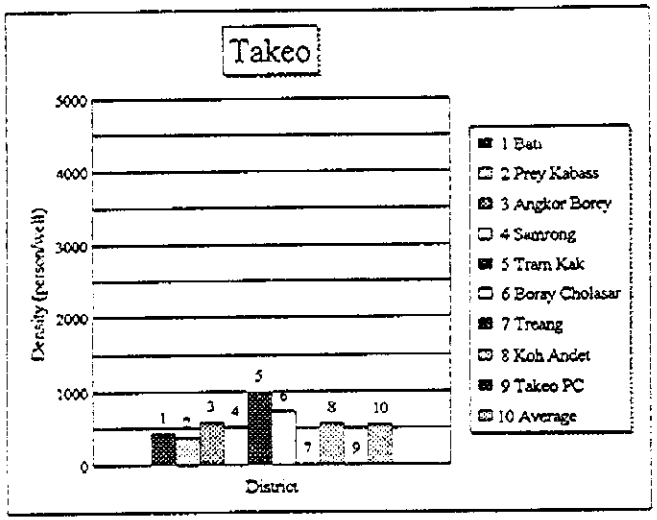




Note;'9 Ang Snourl' is unavailable.

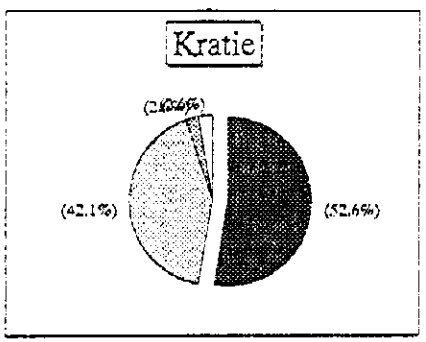


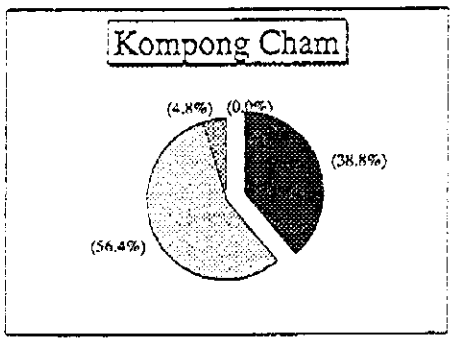
Note;'2 Konh Chreuch' and '6 Kampong Leav' are unavailable.

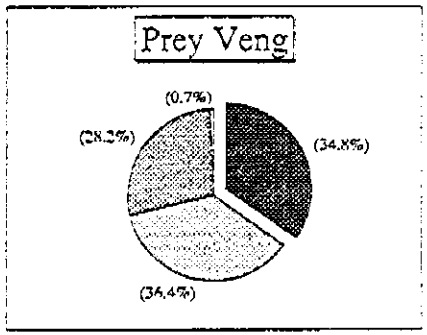


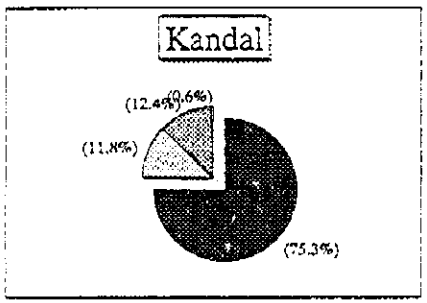
Note;'7 Treang' and '9 Takeo PC' are unavailable.

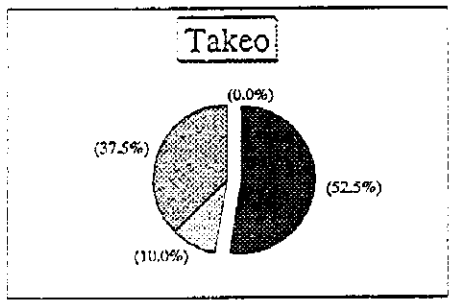
Figure G.1.4 Density of Existing Drilling Well (Constructed by UNICEF) in each District

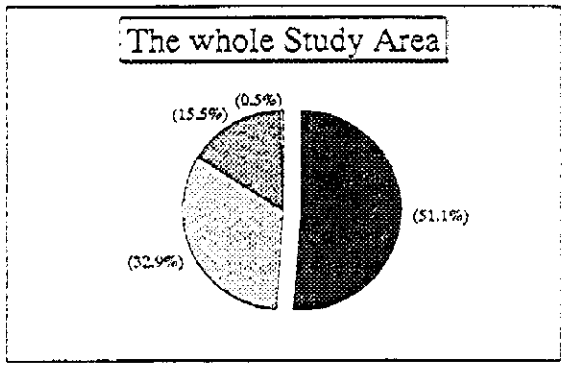












Ratio of Existing Drinking Water Source

Province	Ratio (%)				
	Pond/River (1)	Well (2)	Tube-Well (3)	n.a (4)	Total (5)=(1)~(4)
Kratie	52.6	42.1	2.6	2.6	100.0
Kompong Cham	38.8	56.4	4.8		100.0
Prey Veng	34.8	36.4	28.2	0.7	100.0
Kandal	75.3	11.8	12.4	0.6	100.0
Takeo	52.5	10.0	37.5		100.0
Total	51.1	32.9	15.5	0.5	100.0

Source : Rural Socio-Economic Survey by JICA Study team

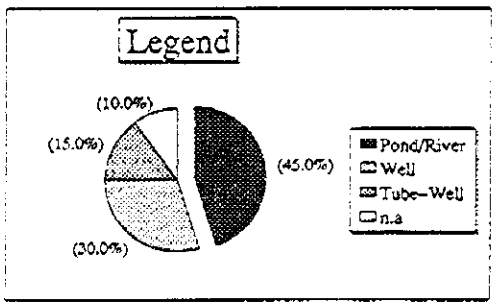
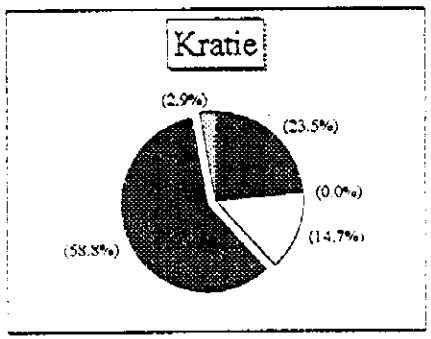
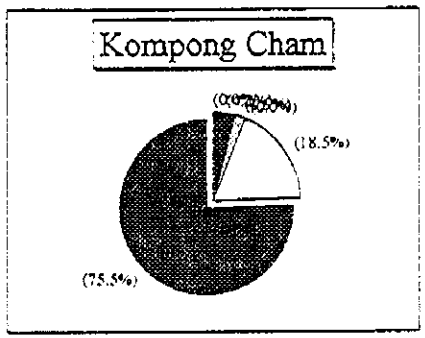
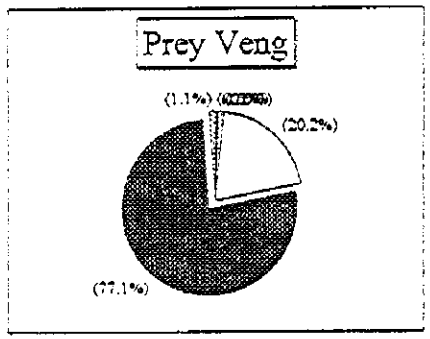
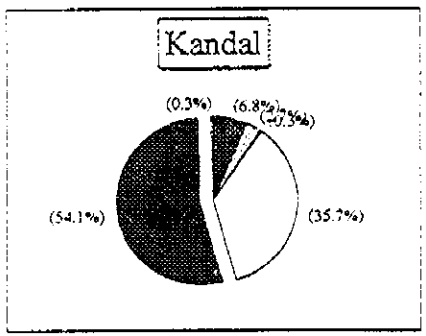


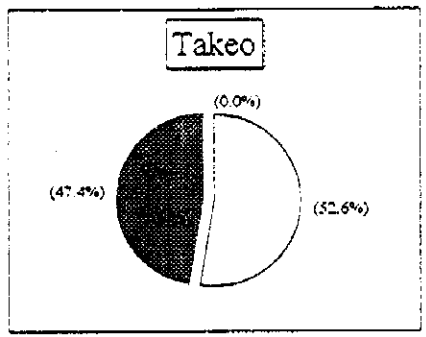
Figure G.1.5 The Ratio of Existing Drinking Water Source

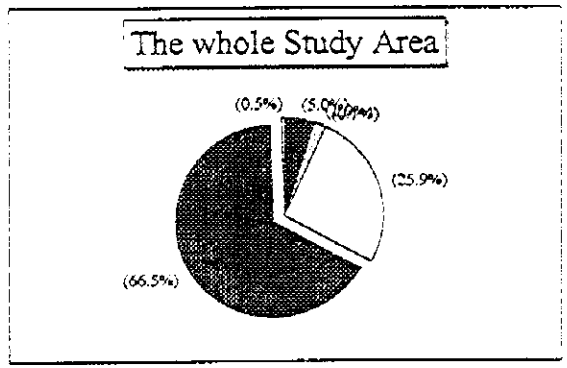












Ratio of Existing Power Resources

Province	Ratio (%) Power line (1)	Group Gen. (2)	Private Gen. (3)	Battery (4)	None (5)	n.a (6)	Total (7)=(1)~(6)
Kratie	23.5			14.7	58.8	2.9	100.0
Kompong Cham	4.2	1.9		18.5	75.5		100.0
Prey Veng	0.6	1.1		20.2	77.1	1.1	100.0
Kandal	6.8	2.7	0.3	35.7	54.1	0.3	100.0
Takeo				52.6	47.4		100.0
Total	5.0	1.9	0.1	25.9	66.5	0.5	100.0

Source : Rural Socio-Economic Survey by JICA Study team

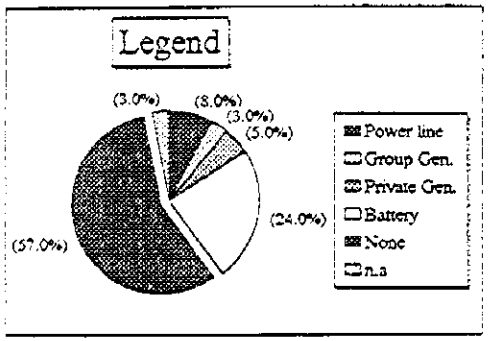


Figure G.1.6 The Ratio of Existing Power Resource