long way upstream accumulate water from small tributaries along the way with a consequent increase in the volume of the flow. The high volume of water carried downstream by such rivers impedes the incursion of saline seawater. In turn, this affects salinity in the river and vegetational distribution in the surrounding environment. Although gradient of the river channel was not actually surveyed during the Study, this is probably an important factor which may determine whether or not mangroves grow on the riverside. Where the channel gradient is steep, stream flow velocity also increases. Consequently, seawater cannot easily flow up the river/sheam.

(7) Effects of the Tide Level

Studies on the relationship between the tidal level and species composition/distribution were carried out at the Ulugan Bay site where zonation could be observed with a higher level of confidence than at the other sites. Three (3) plots were chosen for these studies. Survey results from one of those plots are illustrated on Figure 2-1-40 which shows a cross section of the plot ranging from the sea to the land.

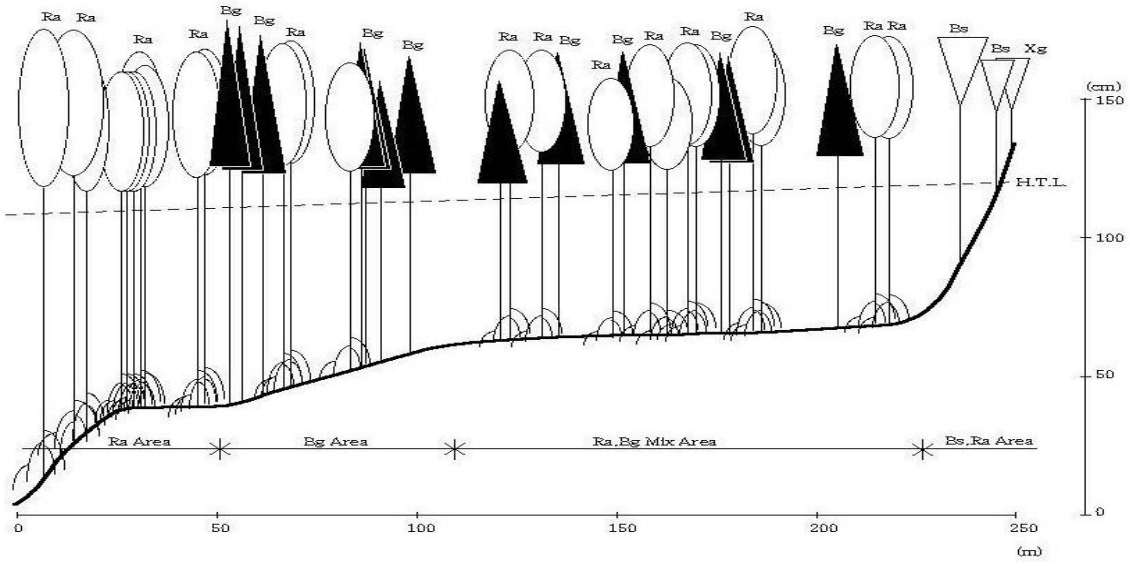


Fig. 2-1-40 Sectional Profile of Mangrove Zonation in Ulugan Bay

The line at the bottom of Figure. 2-1-40 was the basic reference point for measuring the height of submergence. This reference line was accurately determined in advance with a survey instrument as part of the transect survey. The

maximum tide level was determined by connecting marks placed on trees on the date of observation (July 22) as shown in the Figure. Since the sea floor is not even, the duration of submergence generate varies at different points along the sea floor line where vegetation has root. This variance is shown graphically in Figure 2-1-41.

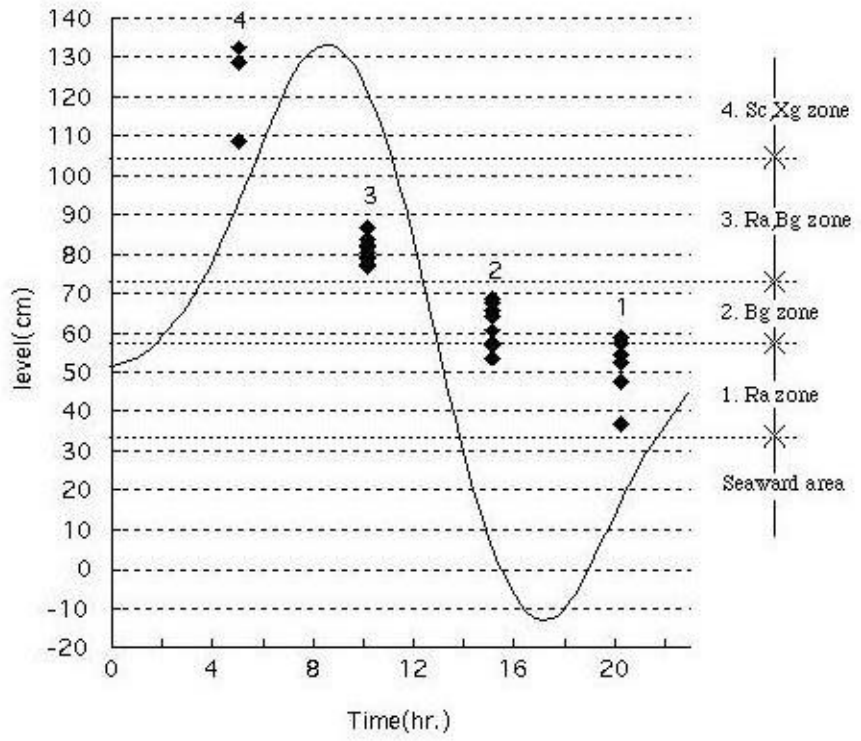


Fig. 2-1-41 Change of Tidal Level in Ulugan Bay (22, Jun., 1998)

The chart on Figure 2-1-41 was prepared using data from the table of hourly estimated tide level of Ulugan Bay prepared by the Japan Hydrographic Association.17_/ Since the marked maximum tide levels are plotted on a chart, the approximate range of adaptability of each species to different levels of water can be assumed. Subsequenly, it is important to take note of the water level at different hours of the day, in order to estimate the duration of submergence.

The plot referred to above may be divided into five species zones: (a) Seaward zone, (b) *Rhizophora* zone, (c) *Bruguiera* zone, (d) mixed *Rhizophora* and *Bruguiera* zone, and (5) Landward fringe mangrove zone. The duration of submergence in each of these zones was estimated as follows:

Zone	Approximate duration of submergence
a. Seaward fringe	about 15 hours and 30 minutes or more per day (above the water for about 8 hours and 30 minutes or less)
b. *Rhizophora*	about 11 hours to 15 hours and 30 minutes per day (above the water for about 8 hours and 30 minutes to 13 hours)
c. *Bruguiera*	about 9 hours to 11 hours or less per day (above the water for about 13 hours to 15 hours)
d. Mixed *Rhizophora /Bruguiera*	5 hours and 30 minutes to 9 hours per day (above the water for about 15 hours to 18 hours and 30 minutes)
e. Landward fringe	about 5 hours and 30 minutes or less per day (above the water for about 18 hours and 30 minutes or more)

The estimates above may be helpful when carrying out zonation studies, but they should be considered illustrative rather than final. Tide levels fluctuate considerably throughout the year and during the month. However, the methodology used can and should be replicated during the formulation of mangrove rehabilitation plans. Introduction of this methodology was part of the technology transfer process in the Study.

One obvious result of the exercise is the existence of a correlation between species composition and tidal levels. Recognition of this correlation should be fundamental in any mangrove rehabilitation initiative. For instance, the above estimates indicate that it is difficult to grow mangrove species if the aerial roots are exposed (i.e. not submerged) for more or less nine (9) hours during one day. Similarly, observations conducted in the Study indicate that the tolerable duration of submergence varies from species to species.

(8) Results of Studies Combining Salinity and Submergence

After completing the surveys that examined the correlation between (i) salinity and species composition and also (ii) duration of submergence and the zonation of mangroves, the Study team conducted an analysis of mangrove vegetation under the combined influence of both salinity and submergence. For this purpose, the team examined the data and conditions covering the same plots included in the enumeration surveys (i.e. the plot surveys). In many respects, these surveys were

identical to a standard forest inventory, even if the data will be used for rehabilitation and conservation objectives rather than as a guideline for timber production. Results of the enumeration survey could be directly utilized since the data contains a complete listing of species and the location of each plot within a mangrove environment. Accordingly, the analysis utilized data from the same number of plots: five (5) in Aparri, twenty-five (25) at Lamon, and twenty-one (21) at Ulugan, or a total of fifty-one (51) plots. The first step in this exercise was observation of the effects of rivers and the tide level at the study sites. The influence of rivers and tide relate of course to salinity and the duration of submergence, respectively.

The salinity factor involved classification of the plots into high, medium and low categories, depending on measurements taken with a salinometer, and furthermore, considering the distances from rivers to plots as determined by analysis of the aerial photography. Effects of the tidal level were classified into long, medium and short according to the level prevailing at the time of the plot survey and the surrounding conditions (soil moisture, leaf and branch litter on the ground, changes in microphotography, etc.). Using these procedures, mangrove locations were classified into the following nine groups.

1) High salinity and long submergence
2) High salinity and medium submergence
3) High salinity and short submergence
4) Medium salinity and long submergence
5) Medium salinity and medium submergence
6) Medium salinity and short submergence
7) Low salinity and long submergence
8) Low salinity and medium submergence
9) Low salinity and short submergence

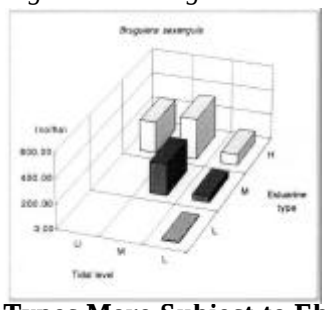
Eight (8) of these nine (9) groups/patterns were covered by the plot survey. The only exception was "High salinity and short submergence" (group 3). New numbers were assigned to the plots, in order to avoid confusion with the data from earlier work. The team then examined the characteristic tendencies of mangrove species appearing in the patterns by calculating the number of each species per ha

in each plot and aggregating such numbers on a pattern basis. Figures. 2-1-42 to 2-1-44 show some tendencies of mangrove species observed in the three study sites. As seen in these Figures, very few mangrove species appear in all the patterns and the species distribution is rather uneven. For instance, *B. gymnorrhiza* in the Lamon Bay site is concentrated in the higher salinity and long submergence group/pattern. (Figure 2-1-42 third line middle). *A. officinalis* in the same site appears unevenly in the lower salinity and long submergence group/pattern. (Figure. 2-1-42 third line left side).

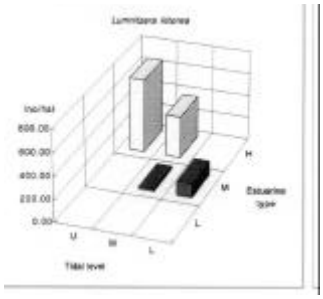
 # Types more subject to the influence of rivers

Low salinity Type

Bruguiera sexangula

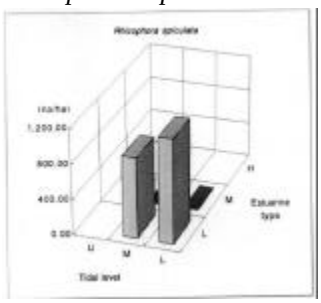


Lumnitzera littorea



High-Salinity Type

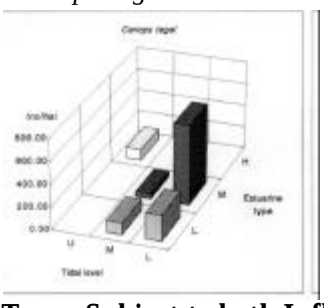
Rhizophora apiculata



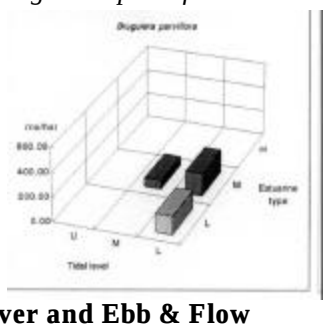
 # Types More Subject to Ebb and Flow

Long-submergence Type

Ceriops tagal

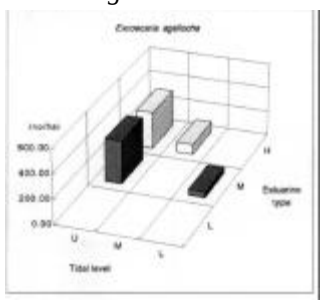


Bruguiera parviflora



Short-submergence Type

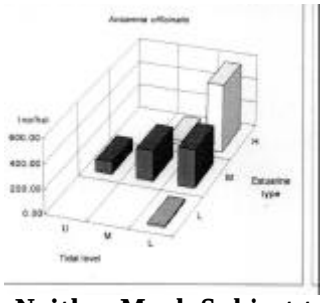
Excoecaria agallocha



 # Types Subject to both Influent River and Ebb & Flow

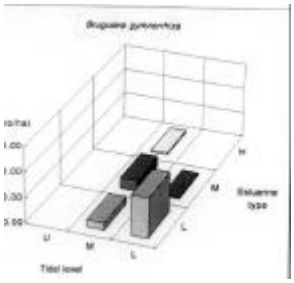
Low Salinity & Long-submergence Type

Avicennia officinalis



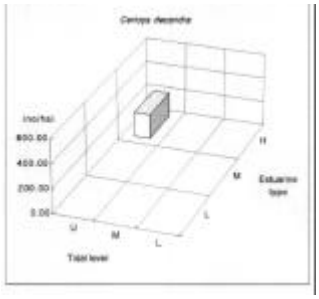
High salinity& Long-submergence Type

Bruguiera gymnorrhiza



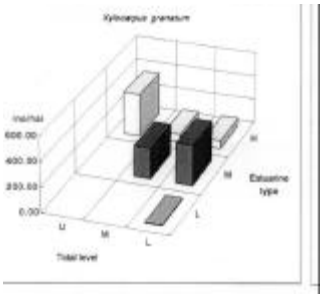
Low-salinity & submergence Type

Ceriops Decandra



 # Type Neither Much Subject to Influent River nor Ebb & Floe

Xylocarpus granatum



Scyphiphora hydrophyllacea

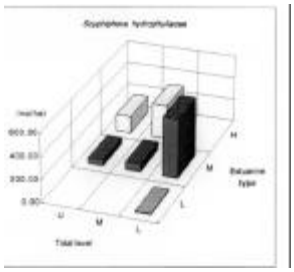
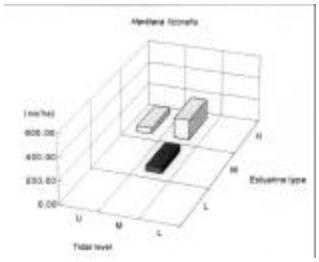


Fig. 2-1-42 Mangrove Species Distribution Pattern (Lamon Bay area)

 # Types more subject to the influence of rivers

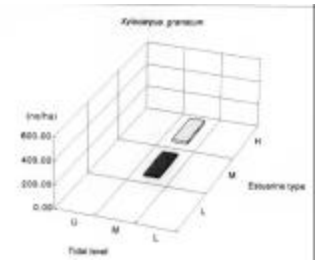
Low-salinity Type

Heritiera littoralis.



Low-salinity Type

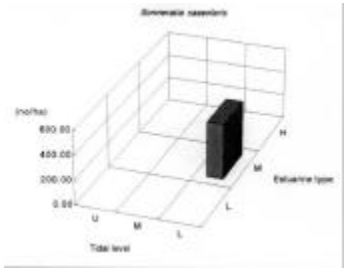
Xylocarpus granatum



 # Types More subject to ebb and flow

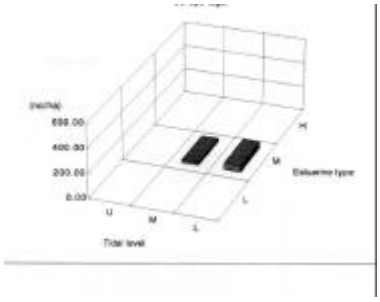
Long-submergence Type

Sonneratia caseolaris



Long-submergence Type

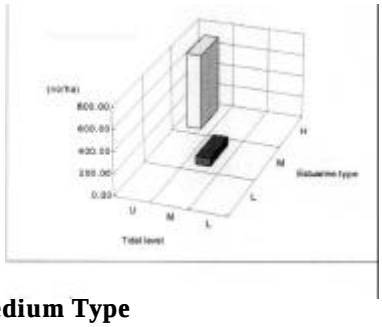
Ceriops tagal



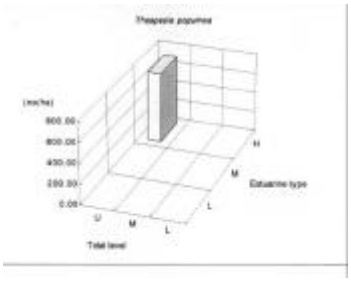
 # Types subject to both river influence and ebb & flow

Low Salinity & Short-submergence Type

Excoecaria agallocha



Thespesia populnea



 # Medium Type

Avicennia officinalis

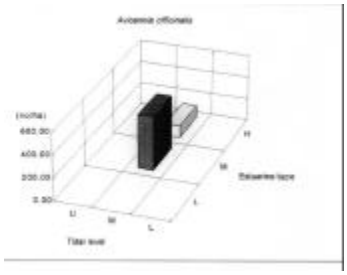
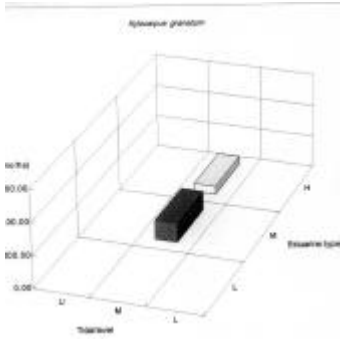


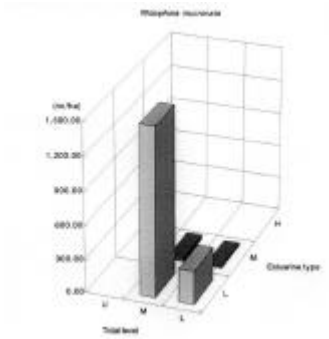
Fig. 2-1-43 Mangrove Species Distribution Pattern (Aparri area)

 # Types more subject to the influence of rivers

Xylocarpus granatum



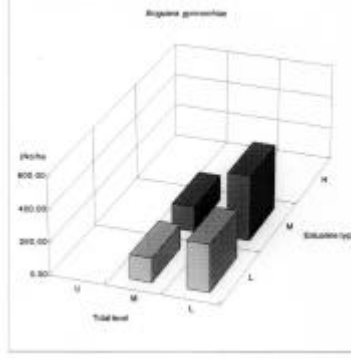
Rhizophora mucronata



 # Types More subject to ebb and flow

Long-submergence Type

Bruguiera gymnorrhiza



Rhizophora apiculata

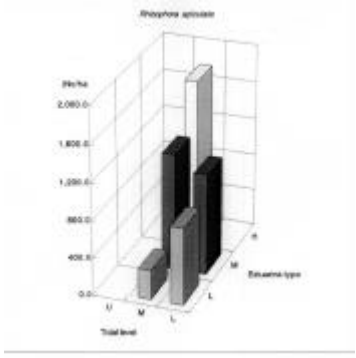


Fig. 2-1-44 Mangrove Species Distribution Pattern (Ulugan Bay area)

Another feature of mangrove species is that some are "subject to salinity but not much to submergence", while others are "subject to submergence but not much to salinity." *B. sexangula* in the Lamon Bay site is concentrated in low-and medium-salinity areas regardless of submergence (Figure. 2-1-42 first line, left side). By contrast, *C. tagal* in the same site is concentrated in longer submerged areas, if anything, and medium-salinity areas (Figure. 2-1-42 second line, left side).

Finally, results of this study on the adaptability of each mangrove species was compared with previous studies conducted by Arroyo (1974) (Table 2-1-7). Generally speaking, results of the Study correspond with the findings of Arroyo. There are however three (3) exceptions. At Aparri and Ulugan there was a clear absence of some species appearing on Arroyo's table that reportedly grow in those types of environments. Additionally, some species like *O. octodonta* grows under tidal level conditions different from those indicated on the table, and the locationed

adaptability of some species like *C. tagal* varies from area-to-area. These exceptions however, do not contradict with the report of Arroyo's studies, which after all were confined to one area. His work and results of the Study both clearly confirm the correlation between environmental factors and species composition.

It is of course recognized that the distribution patterns within mangroves depend not only on locational conditions but also on the availability of seeds and other factors which may significantly affect the species composition. Some species may even appear in different habitats from one site to another (e.g. *C. tagal* as mentioned above).

But taken in the broader context of mangrove rehabilitation, the fundamental importance of Arroyo's work and results of the Study is that both highlight the need to pay close attention to locational conditions, especially salinity and duration of submergence, when formulating mangrove reforestation programs and projects. If these factors are diligently and consistently incorporated in the program/project design process, a much higher success and survival rate can be expected in the future.

Table 2-1-7 Mangrove Species and Habitat

Species		abbreviation	Report by Cesar A Arroy [3] Estarine-Tidal	Observation by The Study		
				Aparri Area Estarine-Tidal	Lamon Area Estarine-Tidal	Ulugan Area Estarine-Tidal
Aegiceras	corniculatum	Ac	–	V-H,V	M-H,M,U	–
Aegiceras	floridum	Af	–	–	M-L	H-H,M
Avicennia	alba	Av.a	L-L,M	–	L-L	–
Avicennia	lanata	Al	–	–	M,H-H,V,U	–
Avicennia	marina	Am	L,M,-L,M,U	–	L,M,H-L,U	–
Avicennia	officinalis	Ao	M-L	M,H-H,M	M,H-L,M	–
Bruguiera	cylindrica	Bc	L,M-H,M	–	L,V-L,M	–
Bruguiera	gymnorrhiza	Bg	L,M-H,M,U	–	L,V-L,M	L,V-L,M
Bruguiera	parviflora	Bp	L,M-H,M	M-L	L,V-L,M	–
Bruguiera	sexangula	Bs	M,H-H,M,U	V-H,V	M,H-L,M,U	V-H,V
Ceriops	decandra	Cd	M-H,M,U	–	H-U	–
Ceriops	tagal	Ct	L,M-H,M,U	M-L,M	L,M-L,M,U	M-L
Excoecaria	agallocha	Ea	L,M,H-H,M,U	M,H-H,V,U	M,H-H,V,U	–
Heritiera	littoralis	H	M-H,U	M,H-H,V,U	M,H-H,V,U	–
Lumnitzera	littorea	Ll	V-H,M	–	M,H-L,M,U	–
Osbornia	octodonta	Oo	L-H,M,U	–	M-L	–
Rhizophora	apiculata	Ra	V-H,M	–	L,V-L,M	L,M,H-L,M
Rhizophora	mucronata	Rm	M,H-H,L,M	–	L-L	L,V-L,M
Scyphiphora	hydrophyllacea	Sh	M-H,U	–	M,H-H,L,M,U	–
Sonneratia	alba	Sa	L-L	–	L,M-L,M,U	–
Sonneratia	caseolaris	Sc	H-H,L	M-L	L-L	–
Thespesia	populnea	Tp	–	H-H,U	–	–
Xylocarpus	granatum	Xg	M-H,M,U	M,H-H,M	M,H-H,L,M,U	M,H-H,M

Estuary Location

L: Down stream M Inte-mediate H Upper stream

Tidal Position

L: Low M Medium H High

1-2-3 Mangrove Forests in the Philippines

(1) Extent and Distribution

Estimates by Brown and Fisher in 1918 indicated that the Philippines had a total mangrove area of 450,000 ha at that time. Seventy (70) years later, this had reduced to 140,000 ha (NAMRIA,1998) or about 70% of what existed in 1918. This implies an annual average deforestation rate of more than 4,000 ha. 1_/

Fig. 2-1-45 Mangrove Forest Distribution in the Philippines

Reports from various sources (below) showed the decline of mangroves but do not clarify whether stands of Nipa are included in the figures. It must be emphasized that available data on the exact extent of mangroves at any period of time may not be 100% accurate. Most of the more recent estimates are based on interpretation of LANDSAT imagery. However, these estimates were not always verified by a sufficient number of ground-truthing studies. Fig. 2-1-45 shows the Mangrove forest distribution in the Philippines. 19_/

Various Estimates of Mangrove Area

Year	Area(ha)	Source of data
1972	225,154	NAMC (NAMRIA) 19_/
1984	232,065	BFD 1_/
1985	146,134	NAMRIA, in cooperation with UNDP/UNESCO 1_/
1986	135,725	NAMRIA 19_/
1987	140,118	Prescillano M. Zamora 1_/
1988	146,140	NAMRIA 1_/
1997	123,000	FMB DENR 20_/

While completely accurate data is not available, there can be no doubt as to the severity of mangrove deforestation. The principal reasons have been identified as, (a) charcoal production and firewood gathering, (b) conversion to fishponds and (c) expansion of coastal communities. Government records indicate that 95% of conversion to fishponds occurred over the past thirty-five (35) years. Fishpond areas increased from 89,000 ha in 1952 to 205,000 ha in 1987, or a rate of about 300 ha per year. 21_/ Table 2-1-8 presents data from NAMRIA comparing the extent of mangrove areas at three different times (1972, 1982 and 1987). This table indicates that mangrove deforestation accelerated rapidly after 1982. This corresponds with the installation of policies designed to promote development of fishponds, focusing particularly on prawn production.

Table 2-1-8 Summary of Mangrove Areas and Distribution in the Philippines(ha)

Region	1988	1982	1972	Location/distribution
I	200	-	988.5	Pangasinan
II	3,400	1,400	2,674.7	Cagayan, Isabela
III	500	-	-	Pampanga
IV-A	47,000	62,590	40,753.3	Quezon, Mindoro, Palawan, etc.
V	9,900	22,506	16,277.3	Camarines, Albay, Sorsogon, etc.
VI	2,285	9,268	9,718.5	Capiz, Aklan, Iloilo, Negros Oc., Antique
VII	9,650	18,232	10,341.2	Bohol, Negros Or., Cebu, Siquijor
VIII	24,850	18,458	18,407.9	Samar, Leyte
IX-A	3,600	22,729	37,693.9	Basilan, Sulu, Tawi-Tawi
IX-B	15,700	32,901	34,590.0	Zamboanga peninsula
X	8,600	28,367	24,498.0	Misamis, Agusan, Surigao del Norte
XI	7,100	7,608	17,358.3	Surigao del Sur, Davao, S.Cotabato, Davao N.
XII	2,400	900	11,852.2	Sultan Kudarat, Maguindanao, Lanao N.
Total	135,725	224,959	225,153.8	

1972: Based on digital analysis: LANDSAT 1 NAMC

1982: Based on high altitude aerial photographs; LANDSAT BFD-NRMC-UPCF

1988: Based on manual interpretation of SPOT satellite data by NAMRIA

The figures just cited quantify total estimated mangrove area, but make no distinction between residual or degraded sites and primary, undisturbed mangrove forests. The latter are undoubtedly quite rare at present. Responding to the urgency of this situation, the Government has set aside approximately 78,593 ha of the remaining mangrove forests as preservation and conservation areas.

Additionally, some 4,326 ha on 52 islands have been designated as Mangrove Wilderness Areas. The remaining 74,267 ha have been declared Mangrove Swamp Forest Reserves, even while recognizing that parts of these reserves are already denuded. The current laws and existing rules and regulations strictly prohibit the conversion of mangrove forests into fishponds, salt beds and agricultural fields. The regulations also prescribe implementation of sustainable use and management in all sites outside of the preservation areas. This Study was conducted in support of Philippine government initiatives for conservation, preservation, rehabilitation and sustainable management.

(2) Major Mangrove Species in the Philippines

The first Taxa of Philippine mangroves was prepared by Brown and Fisher in 1920. While many botanical studies of the mangrove were conducted and published since then, the work of Brown and Fisher still serves as the most useful compilation of information on Philippine mangrove species. 22_/

Table 2-1-9 below was prepared on the basis of a report completed in 1997, which lists forty-one (41) species and the respective families to which they belong. 19_/ Another, more recent report (E.S. Fermando and J.V. Pancho, 1980) lists thirty-nine (39) species and one (1) variety distributed in twenty-six (26) genera and twenty-three (23 families). Data from these reports are presented in Tables 2-1-9 and 2-1-10. 22_/

Table 2-1-9 Mangrove Species in the Philippines

Family		Species	Philippine Name	Location/Position Estuarine-Tidal
1	Rhizophoraceae	R. mucronata	Bakauan-babae	l,U –L,M
2		R. apiculata	Bakauan-lalaki	I – M
3		Bruguiera sexanglua	Pototan	I, U – M, H
4		Bruguiera cylindrica	Pototan – lalaki	D, I – M
5		Bruguiera gymnorrhiza	Busain	D, I – M, H
6		Bruguiera parviflora	Langarai	D, I – M
7		Ceriops tagal	Tangal	D, I – M, H
8		Ceriops decandra	Malatangal	I – M, H
9	Avicenniaceae	Avicennia officinalis	Api-api	I – L
10		Avicennia marina	Bungalon	D, I – L, M. H
11		Avicennia alba	Api-api	D – L, M
12	Sonneratiaceae	Sonneratia alba	Pedada	D – L

13		Sonneratia caseolaris	Pagatpat	U – L
14	Combretaceae	Lumnitzera littorea	Tabau	I – M, H
15		Lumnitzera racemosa	Kulasi	D- M, H
16	Meliaceae	Xylocarpus granatum	Tabigi	I – M, H
17		Xylocarpus moluccensis	Piagau	
18	Sterculiaceae	Heritiera littoralis	Dungon-late	I – H
19	Palmae	Nypa fruticans	Nipa	U – L,M,H
20		Oncosperma filamentosa	Anibong	
21	Euphorbiaceae	Excoecaria agallocha	Buta-buta	D, I U – M, H
22	Lythraceae	Pemphis acidula	Bantigi	
23	Myrtaceae	Osbornia octodonate	Taualis	D - M, H
24	Malvaceae	Hibiscus tiliaceus	Malubago	
25		Thespania populnea	Banalo	
26	Bombaceae	Campotostemon philippinensis	Gapas-gapas	? - H
27	Aegiceratacea e	Aegiceras floridum	Tinduk-tindukan	
28		Aegiceras carniculatum	Saging-saging	
29	Fabaceae	Pongamia pinnata	Bani	
30		Derris spp.	Mangasin	
31	Rubiaceae	Scyphiphora hydrophyllacea	Nilad	I - H
32	Bignoniaceae	Dolichandrone spathaceae	Tiwi	U - M
33	Caesalpiniaceae	Insta retusa	Ipi-laut	
34		Cesalipinia crista	Kalumbibit	
35		Cesalipinia nuga	Sapinit	
36	Acanthaceae	Acanth ebracteatus	Tigbau	I - M, H
37		Acanth ilicifolius	Deliuariu	I,U - M, H
38	Malphighiaceae	Tristellateia australasiae	Binusisi	
39	Pteridaceae	Acrostichum aureum	Lagolo	I - H
40	Aizoaceae	Sesuvium portulacastrum	Dampalit	
41	Convulvulaceae	Ipomea pes-capre	Lambayong	

Source: 18_/

Legend:

Estuary Location : D - downstream; I - Intermediate; U - Upstream

Inter-tidal Position: L - low; M - middle; H - high

Table 2-1-10 Mangrove Species in the Philippines- Fernando and Pancho

Family		Species	Philippine name	Shape/form/ Size	Location within mangrove area
1.	Apocynaceae	Cerbera mangahas	Baraibai	Shrub to small tree	Sandy portion
2.	Avicenniaceae	Avicennia alba	Bungalon-puti	Medium to large	Muddy portion of seashore
3.		Avicennia eucalyptifolia alba	Bungalon-sahing	Small tree	Mudflat: rare: Mindanao
4.		Avicennia marina	Bungalon	Small tree	Muddy portion of seashore
5.		Avicennia marina var. Rumphiana	Piapi	Small tree	Muddy portion of seashore
6.		Avicennia officinalis	Api-api	Medium-sized tree	More inland along riverbanks on firm mud
7.	Baringtoniacea e	Barringtonia racemosa	Putat	Small tree	Marginal inland spp., along river banks

8.	Bignoniaceae	Dolichandrone spathacea	Tui	Small tree	Marginal inland spp., along river banks
9.	Bombacaceae	Camptostemon	Gapas-gapas	Small tree	On inner edges
10.	Caesalpiniaceae	Cynometra ramiflora	Balitbitan	Small tree	Marginal inland spp. on heavy firm soil
11.		Intsia bijuga	Ipil	Small to medium tree	Marginal inland spp. on drier portion of swamp
12.	Celastraceae	Cassine viburnifolia	Jolo Saffranhourt	Small tree	Along the border of mangrove area: Jolo Is.
13.	Combretaceae	Lumnitzera littorea	Tabau	Medium to large	Inner edge of the swamp along river banks
14.		Lumnitzera racemosa	Kulasi	Small tree	Inner edge or sandy portion of the swamp
15.	Euphorbiaceae	Excoecaria agollocha	Buta-buta	Small tree	Inner edge of the swamp on firm mud
16.		Glochidion littorea	Kayong	Small tree	Inland cleared area with dried soil
17.	Fabaceae	Pongamia pinnata	Bani	Medium sized tree	Marginal spp. on sandy portion near shore
18.	Lythraceae	Pemphis acidula	Bantigi	Small tree	Marginal spp. along the seashore
19.	Malvaceae	Mhibiscus tiliaceus	Malubago	Medium-sized tree	Marginal spp. on sandy portion near shore
20.		Thespesia populnea	Banalo	Small tree	Marginal spp.
21.		Thespesia populneoides	Malabanado	Small tree	Marginal spp.
22.	Meliaceae	Xylocarpus moluccensis	Pigau	Small tree	Marginal spp. along open shoreline
23.		Xylocarpus granatum	Tabigi	Medium-size tree	Bordering tidal streams
24.	Myrsinaceae	Aegiceras corniculatum	Sagin-sagin	Small tree	Inner part of swamp or more sandy spots
25.		Aegiceras floridum	Tinduk-tindukan	Small tree	Inner part of water channel or gravelly area
26.	Myrtaceae	Osbornia octodonta	Taualis	Small tree	On sandy or gravelly shore
27.	Rhizophoraceae	Bruguiera cylindrica	Pototan-lalake	Medium-sized tree	Inland portions of the mangrove
28.		Bruguiera gymnorrhiza	Busaing	Medium-sized tree	Rather common
29.	Rhizophoraceae	Bruguiera parviflora	Langarai	Small to medium tree	On firm flat mud on inner side of the swamp
30.		Bruguiera sexangula	Pototan	Medium-sized tree	Rather firm inland mudflat
31.		Ceriops decandra	Malatangal	Small tree	Near mouth of tidal stream
32.		Ceriops tagal	Tangal	Small tree	Near mouth of tidal stream
33.		Rhizophora apiculata	Bakauan-lalake	Medium-sized tree	On deep soft mud
34.		Rhizophora mucronata	Bakauan-babae	Medium-sized tree	On banks of tidal stream
35.		Rhizophora stylosa	Bangkau	Small tree	Along sandy shore
36.	Rubiaceae	Scyphiphora hydrophyllacea	Nilad	Small tree	Along river banks in the swamp on firm muddy soil

37.	Sonneratiaceae	Sonneratia alba	Pagatpat	Medium-sized tree	In less salty parts, on deep muddy soil with slow moving water
38.		Sonneratia caseolaris	Pedada	Small tree	Along mouth of tidal stream
39.	Sterculiaceae	Heritiera littoralis	Dungon-late	Medium-sized tree	On inner part of the swamp
40.	Tiliaceae	Brownlowia lanceolata	Maragomon	Small tree	Marginal spp. on sandy shore

Amplifying the information presented on Table 2-1-10, the report by Fernando and Pancho also describes mangrove species and the conditions favorable for their growth. This information is very useful for field officers responsible for accurate species-to-site matching in the establishment and/or rehabilitation of mangroves through reforestation/afforestation projects. Some of the information complied by Fernando and Pancho is presented below:

(a) The seaward side of the mangrove forests, where the soil is generally mixed with considerable amounts of sand or coral limestone, is usually dominated by species belonging to the families of *Avicennia* and *Sonneratia. Osbornia octodonta* is often associated with these species and forms almost pure thickets.

(b) Stilt-rooted species of the genus *Rhizophora* often occupy areas in the swamp most deeply flooded by the tides, along or close to water channels, and may extend further inland. They are often found associated with Sc*yphiphora hydrophllacea.* However, one of the *Rhizophora, (*i.e. *stylosa*) occurs on sandy or somewhat rocky areas on the seaward side.

(c) Species of the genera *Bruguiera, Ceriops, Lumnitzera, Aegiceras,* including *Camptostemon philippinense, Excoecaria agallocha, Heritiera littoralis* and *Cerbera manghas* are found on the inner edges of the mangrove forest.

(d) Along the borders of the mangrove forest occur *Glochidion littorale, Hibiscus tiliaceus, Thespesia populnea, Thespesia populneoides, Barriongtonia racemosa, Dolichandrone spathacea* and other minor species, which may be rare to frequent.

In a recent study at the experimental mangrove forest in Pagbilao, Quezon, more than 62 species were identified. 18_/ However, only about twenty (20) species are commonly observed. The Pagbilao mangrove forest has been heavily exploited and very little remains of the original growth. This site was also the location of a study conducted by Cesar A. Arroyo on species zonation, the results of which are presented in Table 2-1-11.

Table 2-1-11 Mangrove Zonation Pattern in the Philippines (Cesar A. Arroyo)

From the Sea to Landward Fringe	(a) Front line	Nypa fruiticans. Rhizophora wildlings sparsely scattered.
		Avicennia marina
		Avicennia officinalis
		Sonneratia alba
	(b) Central portions of the swamp	Ceriops decandra
		Ceriops tagal
		Bruguiera sexangula
		Lumnitzera racemosa
		Avicennia alba
		Excoecaria agallocha
		Aegiceras carniculatum
		Aegiceras floridum
	(c) Landward fringe	Herritiera littoralis
		Acrostichum aureum
		Acanthus spp.
From the Shel-tered Tidal Rivers	(a) Frontliners (toward the river mouth)	Rhizophora mucronata
		Rhizophora apiculata
		Nypa fruiticans
		Avicennia officinalis
	(b) Frontlines (landward fringe upstream)	Pure stands of Nypa fruiticans
		Avicennia officinalis
		Excoecaria agallocha
	(c) Central portion	Ceriops tagal
		Ceriops decandra
		Avicennia officinalis
		Bruguiera sexangula
		Lumnitzera racemosa
		Bruguiera pauriflora
	(d) Landward fringe	Herritiera littoralis
		Avicennia officinalis
		Excoecaria agallocha

1-2-4 Legal System on the Use and Protection of Mangrove Forest in the Philippines

(1) Brief History

The Philippine laws which describe prohibition of the cutting of Mangrove nationwide originated from the Presidential Decree No. 705 signed by President Ferdinand Marcos in 1975, known as the Forestry Code of the Philippines. The Decree, reflecting the criticism on uncontrolled development of the forest, regulated the human activities in the Forest Land (F/L). It also described the protection of Mangrove Area which was decreasing due to the conversion to fishpond, for the benefit by the function on Mangrove forest as wind/tidal barrier.

There are related other articles, such as, the 1) prohibition of activities like utilization, exploitation and occupation within any Forest Lands (SEC.20), 2) designation of strip of mangrove at least 20 meters wide along the shoreline and other bodies of water as Forest Land (SEC 16 (8)), and 3) prohibition of alienating such area (SEC 43). Also, there is a description of the reversion of Mangrove area leased to the Bureau of Fisheries and Aquatic Resources (BFAR) for fishpond purposes but not utilized nor abandoned for more than five (5) years.

PD705 has been revised and amended several times through the time of Aquino and Ramos administrations, however, it is still effective and is the basis of the comprehensive laws on forestry sector in the Philippines. In addition, the Mangrove Protection Area were designated by Presidential Decree in 1981, and also by the Department of Environment and Natural Resources Administrative Order (AO) No.42 of 1996, Mangrove forest belt area was set in storm surge and Typhoon prone areas (13 Provinces) as 100 meters strip inward along shoreline fronting seas, oceans and other water bodies, and 50 meters strip on both sides of river bank, and also operators/permittees of fishpond under Fishpond Lease Agreement shall be required and obliged to afforest the tidal flats to at least 50 meters strip.

Also, related to Mangrove forest belt areas, the Department of Environment and Natural Resources Administrative Order (AO) No.13 of 1992, clearly describes the emphasis on the protection of Mangrove forest, redefined as buffer zone and expanded its coverage to other kind of trees, and ordered the following; 1) strip of land at lease 50 meters in width fronting the sea/ocean and other bodies of water and 20 meters on both sides of river channels/banks shall be established as buffer

zone, 2) the buffer zone shall be 100 m. wide inward along shoreline and 50 meters strip river bank protection in storm-prone areas, and 3) 20 meter strips of land outside the boundaries shall be also designated as buffer zone. The AO describes that the buffer zones shall not be subject of applications for lease nor permit, and gathering of forest products shall be strictly regulated. The buffer zones are designated as maintained by the joint activities of DENR, Local Government Units and local people.

In the 1980's, the decrease of Mangrove forest has been intensively accelerated by the conversion to fishpond, due to the increase of prawn exportation to meet price increase in international market. To control such rapid decrease of Mangrove forest, DENR Administrative Order No. 15 was promulgated in 1990. In this AO, as specially made for the protection of Mangrove resources and titled as "Regulations governing the Utilization, Development and Management of mangrove Resources", clearly states the conservation, protection and rehabilitation of remaining Mangrove resources as the policy of the government.

There are articles such as the prohibition of permission/renewal of timber license and permit of any kind that authorizes the cutting of Mangrove trees for commercial purposes (Sec.3), total prohibition of fishpond conversion, and reversion of FLA fishpond abandoned for five (5) years to Forest Land (Sec.4), definition of Steward Contract with local people for reforestation project (Sec. 6), prohibition of cutting trees within FLA fishponds without permission of DENR (Sec.6), and establishment of Communal Mangrove Forest to be maintained by the community people (Sec.8).

Furthermore, the Government started the legalization of the National Integrated Protection Areas System (NIPAS) with the passage of the Republic Act No. 7586 of 1992 and DENR Administrative Order No. 25 of 1992. In this system, Mangrove was defined as endangered natural resources, and strengthened its protection by the total prohibition on the utilization/alternation of areas designated as NIPAS. The initial designation of the NIPAS shall be done by the DENR, and after the registration of the habitants in the areas, a survey on the intention of the registered habitants and listing of natural resources in the area is done. Then, formulation of protection plan shall be made for application to Congress and approval therefrom.

The latest Administrative Order regarding the prohibition of Mangrove forest conversion is DENR Memorandum Order No. 98-17 issued on 3 November 1998. This Order, defining the major cause of Mangrove deforestation as the conversion into fishpond, prohibits the further zonification of Mangrove forests for fishpond development, and also prohibits the release of already zonified Mangrove forests for the fishpond purpose. By this Order, further zonification activities shall be no longer allowed in all Mangrove areas in the Philippines.

(2) Present Legal System and Constraint on the Use/Protection of Mangrove

1) Fishpond Lease Agreement (FLA)

Detailed legalization on the definition and regulation of FLA started in the Fisheries Administrative Order No. 60 of 1960. In this AO, lease of fishpond to individual applicant shall be not be more than 50 hectares (400 hectares in case of firms registered under Securities and Exchange Commission), and period shall not be longer than 10 years. The permission of lease shall be canceled if at least one-fifth of the area would not be developed within 2 years from the issuance of permit, and if the remaining four-fifth of the area would not be developed within five years.

In 1975, Presidential Decree No. 704, known as Fisheries Decree of 1975, was signed. The PD704, similar to PD705 aforementioned, formed the basis of the integrated law system on fishery sector in the Philippines. Thereafter, periodical revisions and amendments (totally renamed with partial amendment in February 1998 as Republic Act No.8550, known as the Philippine Fisheries Code of 1998) were made .In 1979, the period of lease was modified from 10 years to 25 years by the Fisheries Administrative Order No.125, and its rentals defined as 30 pesos per hectare in the first 5 years. This long-term period of lease is occasionally considered as one of factor which contributed to the decrease of Mangrove forest area, together with the fact that some Mangrove area are once totally diversified but afterward no activities are seen in the area. Under this circumstance, new permit on FLA is no longer made after the aforementioned DENR Administrative Order No.15 in 1990 and General Memorandum No1, Series of 1990 by the Department of Agriculture. (The two Departments confirmed this prohibition by DA-DENR Joint General Memorandum No.3, Series of 1991.) The total number and area under present FLAs is shown in Table-2-1-12.

Table 2-1-12 Present Condition of Fishpond under FLA (1973 – 1998)

Location (Province)	No. of Agreements under FLA	Total Area of Fishponds Under FLA (ha)	Location (Province)	No. of Agreements under FLA	Total Area of Fishponds Under FLA (ha)
Philippines (Grand Total)	1,652	63,121.93			
Region-I (Total)	204	1,283.89	Region-VII (Total)	453	4,652.16
La Union		36.97	Bohol	188	2,594.03
Pangasinan	197	1,246.92	Cebu	177	1,350.43
			Negros Or.	87	701.48
Region-II (Total)	8	198.64	Siquijor	1	6.23
Cagayan		198.64			
			Region-VIII(Total)	214	5,792.11
Region-III(Total)	74	519.74	Eastern Samar	19	184.60
Bataan		4.00	Leyte	80	1,421.71
Bulacan	12	42.49	Northern Samar	39	1,252.66
Nueva Ecija	1	39.07	Southern Leyte	8	113.07
Pampanga	7	19.36	Western Samar	68	2,820.07
Zambales	53	414.82			
			Region-IX (Total)	446	9,627.31
Region-IV (Total)	794	12,899.92	Basilan	42	858.11
Batangas	16	161.64	Sulu	1	159.00
Cavite	1	5.89	Zamboanga City	133	1,960.05
Marinduque	68	436.52	Zamboanga Norte	58	662.71
Occ. Mindoro	168	3,369.57	Zamboanga Sur	212	5,987.44
Or. Mindoro	77	811.75			
Palawan	24	1,429.11	Region-X (Total)	43	395.39
Quezon	426	6,590.18	Misamis Occ.	24	288.77
Romblon	14	95.28	Misamis. Or.	19	106.61
Region-V (Total)	438	6,936.73	Region-XI (Total)	135	1,518.84

Albay	8	186.34	Davao City	2	12.88
Camarines Norte	103	1,366.54	Davao Norte	19	209.47
Camarines Sur	77	1,211.37	Davao Or.	14	351.24
Catanduanes	24	273.66	Davao Sur	91	842.63
Masbate	146	2,480.51	Sourth Cotabato	9	102.63
Sorsogon	80	1,418.30			
			Region-XII (Total)	83	2,231.50
Region-VI (Total)	1,652	14,346.74	Lanao Norte	26	1,150.55
Aklan	343	3,309.26	Maguindanao	49	860.23
Antique	5	150.65	Sultan Kudarat	8	220.73
Capiz	250	1,953.80			
Guimaras	99	696.35	Region-XIII(Total)	143	2,718.95
Iloilo	565	5,120.03	Agusan Norte	52	1,235.71
Negros Occ.	390	3,116.64	Surigao Norte	31	347.13
			Surigao Sur	60	1,136.11

Source : 18_/Bureau of Fishery and Aquatic Resources

2) Community-Based Forest Management (CBFM)

Common name of the integration of the various participatory reforestation and forest management programs, defined by Executive Order No. 263 in 1995, includes the Integrated Social Forest (ISF) Program which is the DENR portion of the Comprehensive Agrarian Reform Law (EO192 of 1988), and the Coastal Environmental Program mentioned below.

Participants to this program shall be People's Organization (PO), and forest land are distributed to qualified PO for a period of 25 years (with another extension of not more than 25 years). The PO will implement reforestation and other income-generating projects in the distributed area.

3) Coastal Environment Program (CEP)

Participatory environmental protection program for the communities facing coastal area, is regulated by Republic Act No. 7586 of 1993 and DENR

Administrative Order No. 19 of 1993. In this Program, DENR initiates the institutional development in the coastal area. The established People's Organization is designated as the implementing body of the projects for proper management and utilization of the natural resources in the coastal area. The governmental offices support the PO for the institutional development, public relation and training, technical assistance and research activities.

This CEP includes Fisheries Sector Program (FSP) launched through the Memorandum of Agreement with the DENR and the Department of Agriculture which implements Mangrove rehabilitation at 12 critical bays nationwide. The Mangrove rehabilitation projects under FSP emphasize the participation of Non-Government Organization (NGO), and consideration of the socio-economic and cultural aspects of the local area.

4) Mangrove Stewardship Agreement

The legal system on Mangrove Stewardship Agreement started by the DENR Administrative Order No. 3 of 1991, permits the local people (individual of organized group) to make contract with the Government (DENR) for the reforestation of Mangrove in designated areas. Different from CBFM and ISF, it does not have system of land distribution nor land lease. The participants shall implement Mangrove rehabilitation (reforestation), at their own expense, for an area of not more than 7 hectare per participant, and entitled to enjoy profits derived from Mangrove forest after the reforestation period.

(3) Present Constraint on the Use/Protection of Mangrove

Upon the analysis of the condition of protection, conversion and utilization and Mangrove resources, the following two issues shall be taken into consideration:

1) Fishpond Conversion

As mentioned before, conversion of Mangrove forest to fishponds is the biggest factor in the decrease of Mangrove forest in the Philippines. The total area of fishponds nationwide has been increased from 86,299 ha in 1970 To 142,145 ha in 1980 (64.7% increase in this 10 years) and 176,587 ha in 1994 (24.2% increase in this 14 years). This figure does not include the area occupied by fishponds

which are not officially registered/leased (i.e. illegal fishponds) due to its difficulty to be reflected in the statistics. Accordingly, the products (value) from brackishwater fishpond nationwide has increased from 6,522 million Peso in 1985 to 28,733 million Peso in 1994. This rapid increase of production value shows the possibility of further destruction (conversion) of Mangrove forest in the Philippines, unless more effort on the implementation of present legal system is considered.

2) Logging

Due to the intensive regulation and campaign for the implementation of law system on the protection of forest and control of illegal logging, logs production in the Philippines has been reduced from total 6.37 million cu.m in 1980 to 0.6 million cu.m in 1995. Likewise, hectarage of damaged area by illegal logging has also been reduced from 7,348 ha in 1980 to 107 ha in 1994 (Source : 1996 Philippine Statistical handbook). In case of Mangrove forest, as compared to the damages by conversion to fishponds, it may be considered that the volume and area of Mangrove forest damaged by illegal logging occupies not so much percentage, since the logging of Mangrove tree might not be feasible as commercial basis, and limited to personal consumption or small scale business in the local area (ex. As firewood, material for housing and repair, etc.). However, it is necessary to continue present effort of the governmental organizations/LGUs on public relation activities to the local people in the Mangrove area.

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2 Results of the Study in the Philippines

2-1 An Overview

As discussed earlier, the objective of the Study is to provide information that will be useful in the protection, rehabilitation and sustainable management of mangroves in the Philippines. Given the range of bio-physical and social variables which impact on mangroves, it was considered important to examine conditions in three (3) different representative parts of the country. Based on the data, experience and insights gained at these three Study areas, it would then be possible to identify common and/or specific problems, and options that could be pursued to help ensure the conservation of mangrove eco-systems.

Each of the three (3) study areas (Aparri, Lamon Bay and Ulugan Bay) are unique in their own right, but also share common features which undoubtedly exist in other parts of the country. Thus, the methodologies devised for conducting the Study were uniformly applied at each area, while also retaining the flexibility to produce important site-specific information. General results of the Study are summarized below.

2-1-1 Vegetation

In general, distribution of mangrove species within the study areas conforms to the zonation described previously in this report. Sometimes however, the distribution of dominant species varies from place-to-place within a area due to inter-tidal position and estuarine location. Transect surveys were conducted by the Study team to examine the forest structure, paying special attention to species distribution affected principally by the inter-tidal level. With this priority in mind, the team measured changes in the level of the forest floor along each transect line, starting at the boundary between dry land and mangrove habitat, and extending to the farthest point seaward where mangroves were still found. The length of transect lines ranged from 100 to 300 meters (m), depending on local conditions.

The lines were carefully chosen to avoid intersection with small rivers or streams running through the mangroves. All mangrove vegetation appearing on

the transect lines was assessed. The findings were recorded in terms of distance from the starting point, stand height, DBH, and the shape of stems, branches and crowns. Furthermore, plot surveys were also conducted to determine the number of trees, saplings and seedlings in each plot.

From the results of the transect survey exercise it was possible to accurately determine the height of the forest floor relative to the level of seawater. Results of the survey highlight relationships between three factors; (i) changes in the level of the forest floor, (ii) corresponding changes in the seawater level and (iii) the structure of mangrove forests along the transect lines. Based on this data, and enhanced by general observations of the Study team, the area conditions and topographical features of mangroves in the study areas may be summarized as follows:

Mangrove forests exist along coasts or rivers under conditions where the ground in which they take root (i.e. the forest floor) is submerged by seawater at high tide and emerges (i.e. not submerged) at low tide. However, wherever waves have a significant effect, or if the ground inclines steeply in the direction of the open sea, mangroves do not thrive even in coastal areas. Mangrove forests develop well in lagoons where large flats extend along the coastline or near tidelands and estuaries.

In the Aparri area, there are large sedimentary flatlands found at elevations lower than the high tide level. These flatlands were formed by the Cagayan and Abulug Rivers. Nipa are extensively distributed in the flatlands. At the Lamon Bay area there are several small bays where various types of mangrove forests are distributed in large tidelands and flats along coastlines in calm waters protected from wave action by coral reefs. Ulugan Bay is almost completely protected against waves from the open sea, and mangrove forests develop along the entire coastline of the bay.

Mangrove areas in the study areas may be roughly divided into three (3) topographic patterns: (1) Broad flat areas formed by sedimentation from big rivers (Big River Mouth Flat), (2) Tidal flats in lagoons (Tidal Flat), and (3) Seaside areas (Seaside Flat).

Flat areas near the river mouth in the Aparri area and are generally covered by nipa (*Nypa fruticans*). Most parts of these areas are submerged under seawater for a few hours during high tide, but are above the seawater the rest of the time. Moreover, a large river flooding is experienced occasionally carrying along sediments from the land and bringing about the influences of fresh water. These two factors are closely related to the growth of nipa.

Mangrove tree species also grow on the landward fringe of these Big River Mouth flats. The typical distribution pattern of mangrove trees consists of *Avicennia officinalis* and *Sonneratia caseolaris* in narrow belts (10 to 20 m wide) along rivers, with scattered patches of *Excoecaria agallocha* and *Heritiera littoralis* growing amongst the *N. fruticans*. Various bush species appear on the adjacent lands.

At the Lamon Bay area, tidal flat areas are represented by the Santo Angel Bay within Lamon Bay and by the Tinagong Dagat Bay in Basiad Bay. These tidelands are in the geological form of landward isles adjoining the shoreline. No large rivers flow into the bay. Therefore only small amounts of sediment are gradually carried in. The terrain of the tidal flats is relatively level. Most parts of the area are submerged in seawater at high tide, and large portions of the area emerge almost simultaneously at low tide. To a large degree, this accounts for the presence of a homogeneous mangrove community, mainly *Rhizophora,* extending over a wide area.

Seaside areas are covered by mangrove forests 100 m to 500 m wide along the coastlines of relatively large bays, such as Ulugan Bay, Lamon Bay and Basiad Bay.

The following three types of environment are observed in these areas depending on the status of small rivers flowing into them: (1) Medium riverside flat - comprising areas affected by the constant inflow of fresh water with a rather wide watershed area in the upper reaches, (2) Small riverside flat - referring to areas found at the mouth of small rivers which are constantly affected by seawater and periodically affected by rain, and (3) Seaside flat - meaning areas that are almost flat extending seaward from the coastline without any significant inflow from rivers. The "zonation pattern" of mangrove forests is most easily observed in

areas of the third type where the tide level changes in parallel with the coastline.

In this study, the classification of mangrove areas according to vegetative features and zonation provides basic information for designing effective rehabilitation and protective measures. It is essential to observe and analyze the relationship between topographical features and the actual distribution of mangrove species. For planners, it is equally important to recognize the differences between zonation patterns on aerial photo images. Development of these recognition skills was a major component of technology transfer initiatives in the Study.

Figure 2-2-1 below presents a schematic image of zonation patterns on a Big River Mouth Flat. Note the mixtures of nipa palms and mangrove trees. Except for the portion occupied by the river, the terrain is almost level. However, mounds of mud occur at varying intervals, in some spots rising abruptly to heights of several dozen centimeters immediately along the riverside, and eventually increasing to about one meter further inland.

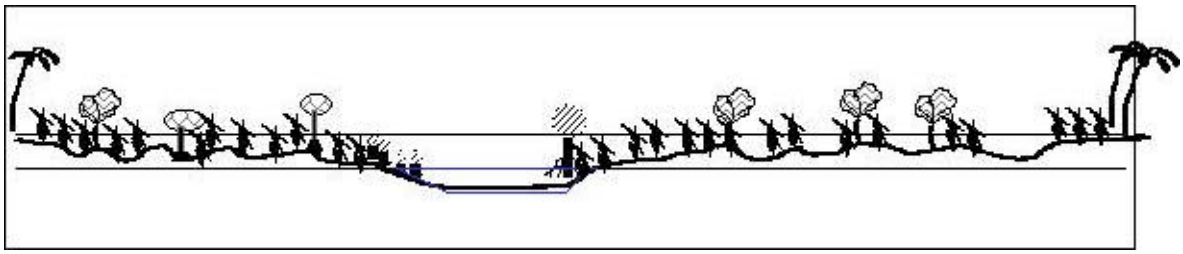


Fig. 2-2-1 Conceptual Image of Landscape and Mangrove Forest Distribution Pattern on a Big River Mouth Flat

Mangrove species can grow in a relatively wide belt when the riverside ground rises gently or slightly. In this illustration however, the river is quite wide at peak flow (e.g. after a heavy rain) and only a thin line of trees can be observed. A narrow belt of *S. caseolaris* may be found in the sediment that accumulates inside the curve of a river. The riverside slope has flat areas, punctuated by mud mounds, and criss-crossed by deep water channels. *A. officinalis* grows on the flank of the mud mound, while *H. littoralis* and *E. agallocha* grow on the mound. *N. fruticans* fills the interspaces between the trees. This pattern is typical of river mouth flats. There will of course be some difference between Big and Small River Mouth flats depending on the volume of fresh water inflow and sediment.

Figure 2-2-2 shows conceptually the relationship between topography and vegetation of a relatively narrow mangrove area in a seaside flat. A typical sample of this type is Ulugan Bay.

Low-height *R. mucronata* or *R. apiculata* grow as pioneers on the seaward edge of the mangroves. These species grow taller as one moves landward, and are gradually replaced by *B. gymnorrhiza*. Moving further landward, the water level at high tide level is less deep (becoming medium) and the *B. gymnorrhiza* gives way to stands wherein *R. apiculata* is dominant. Finally, a narrow belt of high inter-tidal

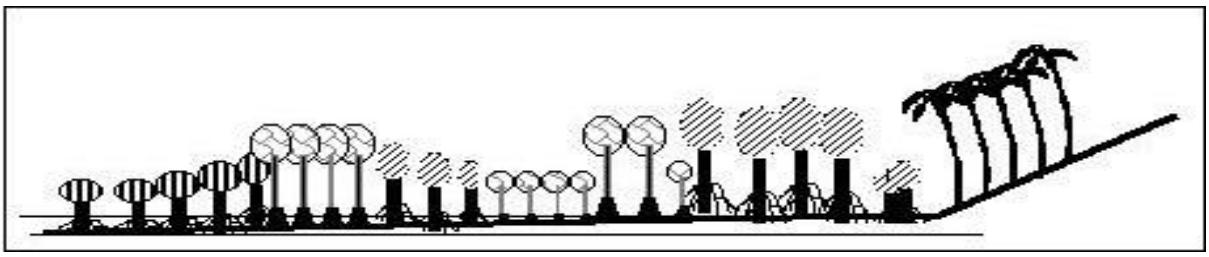


Fig. 2-2-2 Conceptual Image of Landscape and Mangrove Forest Distribution Pattern on a Seaside Flat

mangrove species appears at the landward fringe of the mangroves. Gentle slopes characterize the topographic pattern on a continuum from the seaward edge to the landward boundary of the mangroves. This is accompanied by a corresponding change in the mangrove vegetation pattern, with overlapping of species along the way.

The changes in vegetation patterns (zonation) illustrated in Figures 2-2-1 and 2-2-2 are not as clear nor as distinct in the case of wider seaside flats. When the breadth of a zone is wide, its features will be affected by tidal conditions in the adjacent zone and disrupted by changes in micro-topography and streams. This makes it difficult to identify a parallel zonation pattern from the seaward edge to the landward fringe of the mangroves. Typically however, the seaward edge is dominated by stands of *Rhizophora* followed by a mixture of *B. gymnorrhiza, B. sexangula* and *C. tagal,* and then a mixture of *H. littoralis, S. hydrophyllacea* and *X.s granatum*. Brush forests appear next with patches of *E. agallocha* at the inland edge of the mangrove. Fig. 2-2-3 provides an illustrative example of the mangrove distribution pattern in wider seaside flat areas.

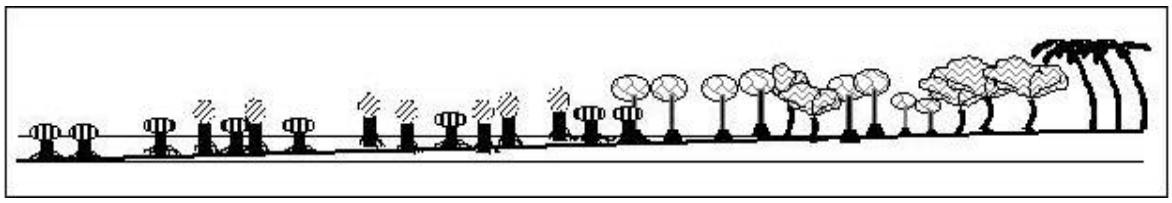


Fig. 2-2-3 Conceptual Image of Landscape and Mangrove Forest Distribution Pattern on a Seaside Flat

Gentle slope is continuously connecting from seaside to landward, accordingly the Mangrove vegetation also changes its patterns gradually and overlapping from seaside group to landward fringe group.

2-1-2 Socio-economic Conditions

The three (3) Study Areas for this Study are located in three (3) Provinces, eleven (11) Municipalities and seventy-seven (77) Villages (Barangays). The number of Municipalities and Barangays in each Study Area is described below:

Aparri Area (Cagayan Province) : 5 Mun., 29 Brgys.
Lamon Bay Area (Quezon Province) : 5 Mun., 43 Brgys.
Ulugan Bay Area (Palawan Province) : 1 City, 5 Brgys.

Following is the summary of the result of General Socio-economic Survey and detailed Socio-economic Survey based on interviews conducted on 200 household heads in each Study Area (i.e. total 600 households).

(1) Socio-economic Condition

1) Population

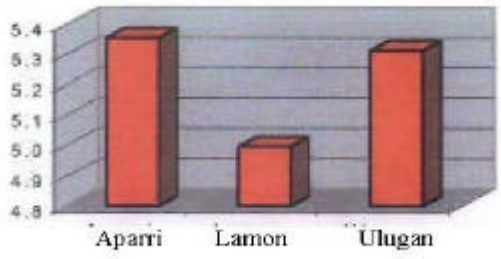


Fig. 2-2-4 Average Number of Family Members

The average number of household per Barangay in the three Study Areas is 209. For each Area, there is an average of 204 households in Aparri Area, 196 households in Lamon Bay Area and 229 households in Ulugan Bay Area.

Average number of family member is 5.23 person, which consists of an average

5.4 persons in Aparri Area, 5.0 person in Lamon Bay Area and 5.3 person in Ulugan Bay Area.

2) Income Source, House Economy

Fishery and agricultural sectors are the dominant income sources in all Study Areas. Distribution in each Area is as follows:

	Fishery	Agriculture
Aparri Area	38.6%	11.3%
Lamon Bay Area	33.8%	26.8%
Ulugan Bay Area	32.4%	21.8%

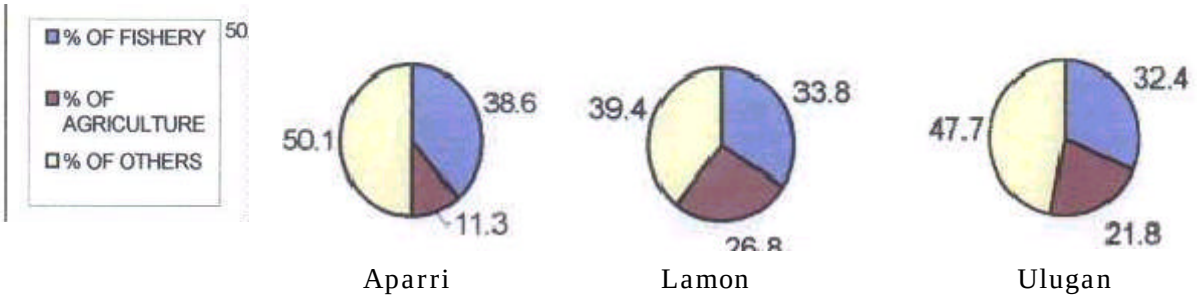


Fig. 2-2-5 Income Resources

Following is the average monthly income in the Study Areas based on the interview survey, in comparison with poverty threshold (minimum income estimated as enough to secure 2,000 calories per day for each family members, by the NSO), and also comparison with the average income of families in fishery sector in the Philippines.

	Monthly Income	Against Poverty Threshold	Against Fishery Fam. Ave.
Aparri Area	P4,917.50	1.00	0.90
Lamon Bay Area	P5,560.60	1.22	1.02
Ulugan Bay Area	P4,946.90	1.03	0.91

An average 39.7% of the products from these fishery and agricultural sector in this Area is domestically consumed. Figures in each Area are as follows:

Aparri Area	27.8%
Lamon Bay Area	46.7%
Ulugan Bay Area	44.6%

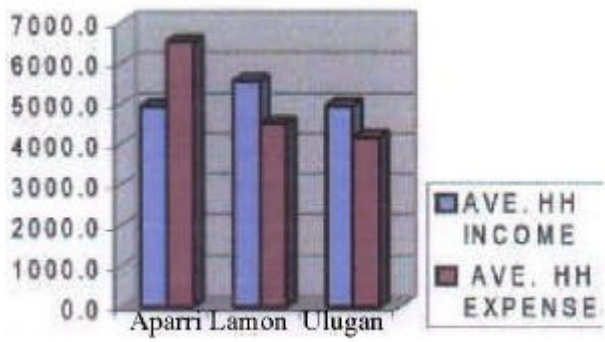


Fig. 2-2-6 Household Income and Expenses

15.7% of household replied that they availed of loan/credits from any organizations. Figures in each Area are as follows:

Aparri Area	29.2%
Lamon Bay Area	6.1%
Ulugan Bay Area	11.9%

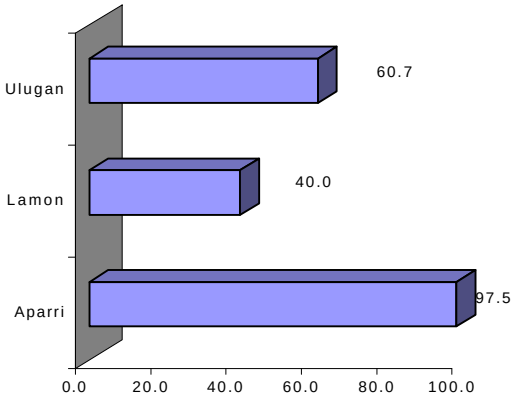


Fig. 2-2-7 Percentage of Household Using Firewood

(2) Condition of the Use of Mangrove

1) Actual Use Conditions

Hereunder is the result of aforementioned interview survey (interviewing 200 sampled households) regarding the utilization and perception towards conservation of Mangrove, focused on the comparison of characteristics in three Study Areas. (Refer to Figure-2-1-1 to 2-1-11.). Detailed result for each Areas are described from next Chapter.

a. Entering Mangrove Area

The percentage of household heads who replied that they have entered Mangrove area within one year is as follows. Aparri Area shows the largest percentage, indicating Nipa gathering as a major source of income.

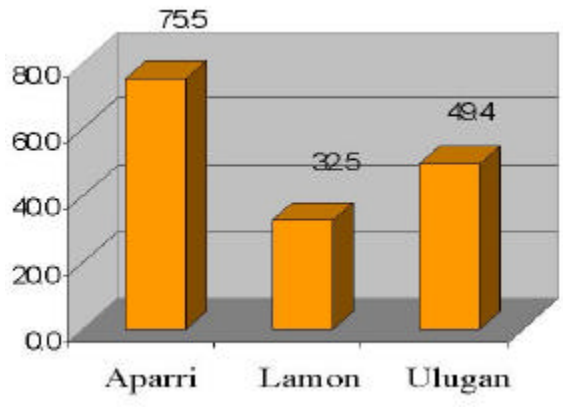


Fig. 2-2-8 Entry to Mangrove Areas

Aparri Area	75.5%
Lamon Bay Area	32.5%
Ulugan Bay Area	49.4%

As for the reason to enter Mangrove area, collection of Nipa shingles is dominant in Aparri Area, catching fish/crab is dominant in Lamon Bay Area and Ulugan Bay Areas, reflecting industrial structure in the Area.

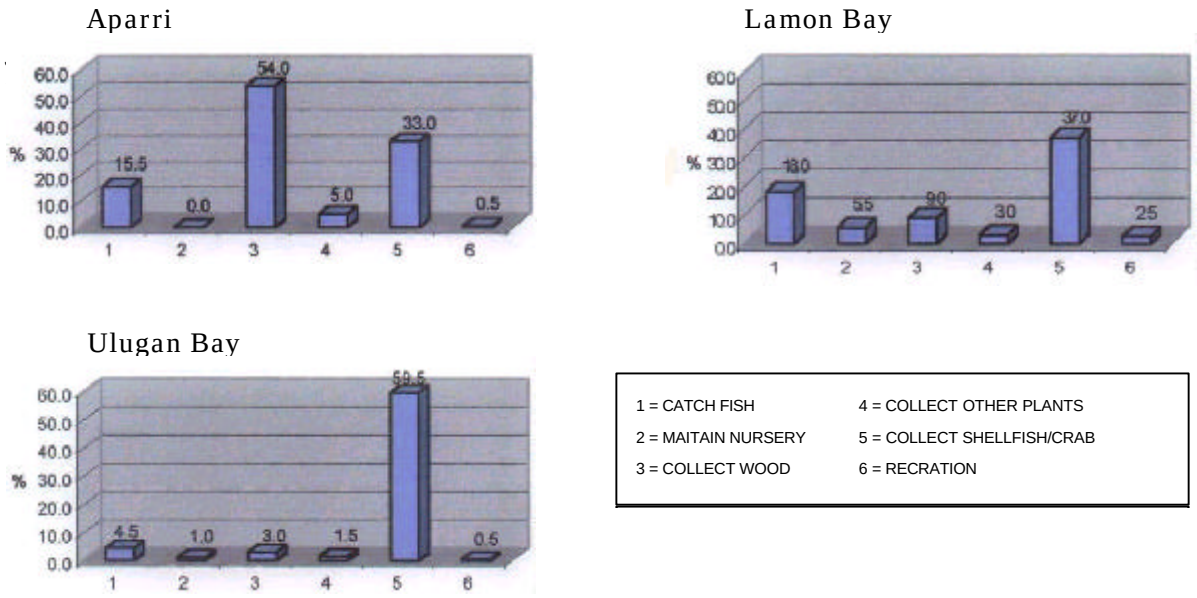


Fig. 2-2-9 Reasons to Enter the Mangrove Forest

b. Using Condition of Mangrove

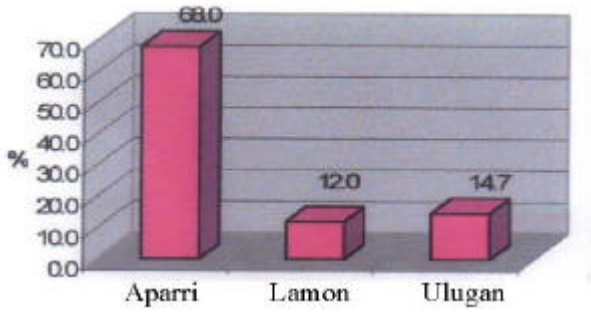


Fig. 2-2-10 Using Mangrove Tree

The highest percentage of people who replied that they are presently using Mangrove trees, and having used mangrove trees within three (3) years past and also for more than three (3) years past are as follows. Aparri Area shows the largest percentage to be 68.0%, hence, Ulugan Bay Area shows the largest percentage on use in the past 3 years and more than 3 years past, as 15.7% and 18.2%, respectively. This percentage of present use, 68.0% in Aparri Area is the largest among three Study Areas (12.0% in Lamon Bay Area, 14.7% in Ulugan Bay Area).

Areas.	Present Use	Use w/in 3 yrs. Past	Use 3 more yrs.
Aparri Area	68.0%	2.0%	1.0%
Lamon Bay Area	12.0%	8.0%	6.5%
Ulugan Bay Area	14.7%	15.7%	18.2%

c. Future Intention to Use Mangrove

Percentage of households who replied that they have intention to use Mangrove tree in the future, and intention to have their own fishponds is as follows. Aparri Area shows remarkable low percentage, in spite of large percentage on present use of Mangrove.

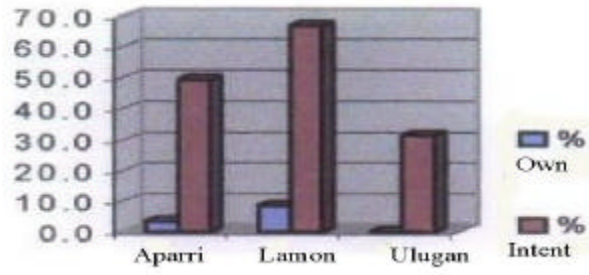


Fig. 2-2-11 Fishpond Ownership and Intention to Have

	Intention to use Mangrove	Intention to have Fishpond
Aparri Area	3.2%	49.5%
Lamon Bay Area	10.8%	67.5%
Ulugan Bay Area	30.0%	31.5%

d. Attitude toward Mangrove Cutting and its Controlling Factor

Percentage of people who replied that they have negative sense in cutting Mangrove trees, and percentage of people who answered that the legal prohibition is the reason of having negative sense are as follows. The percentage of the legal prohibition as psychological factor to control on cutting Mangroves, Aparri area with its highest present use ratio, shows the lowest figure, and Lamon Bay Area with its lowest present use ratio, shows the highest figure.

	Having Negative sense	Motivated by Legal Prohibition
Aparri Area	38.7%	0.0%
Lamon Bay Area	61.5%	47.9%
Ulugan Bay Area	41.1%	3.4%

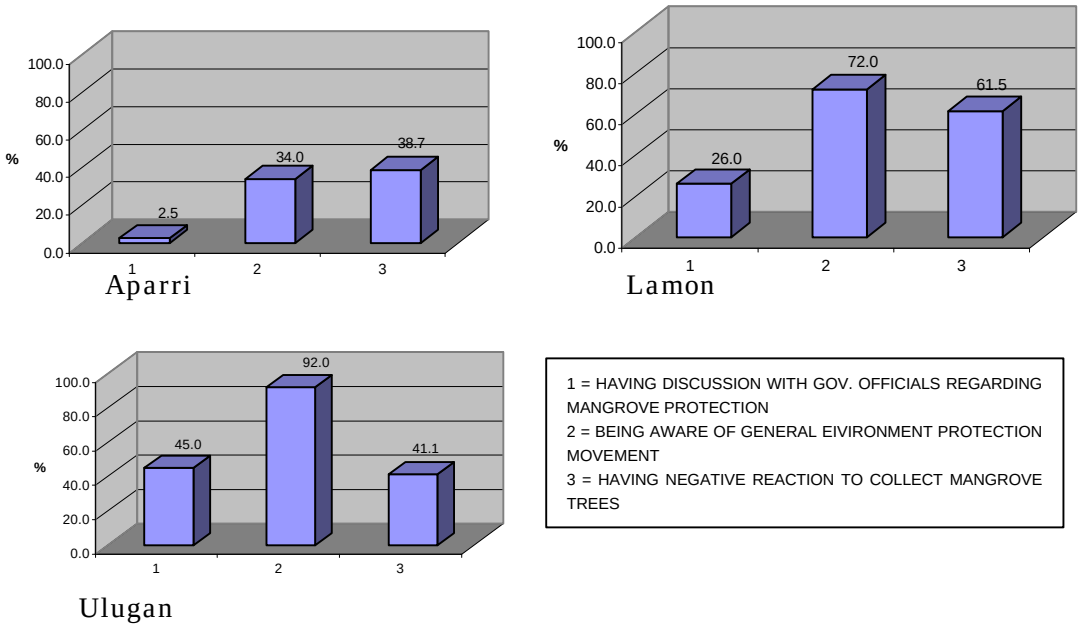


Fig. 2-2-12 Recognition about Environment Conservation

Percentage of people who replied that they remember their experience of discussing with the Government official regarding conservation of Mangrove is as follows. The large percentage in Ulugan Bay Area reflects the fact that the environmental conservation is the most important provincial policy, and Aparri Area, with the highest percentage on present use, shows the lowest percentage.

Aparri Area	2.5%
Lamon Bay Area	26.0%
Ulugan Bay Area	45.0%

e. Conservation Perception of Mangrove Forest

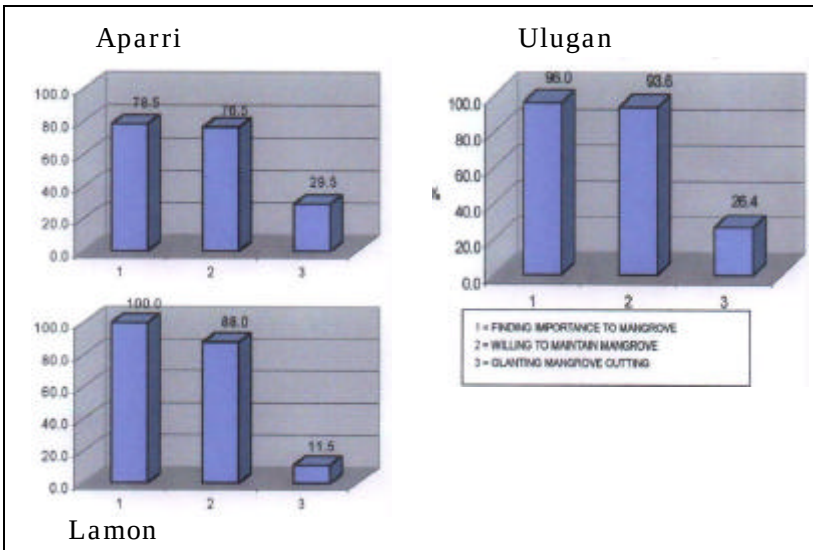


Fig. 2-2-13 Conservation Sense of Mangrove Forest

For any kind of environmental protection movement (governmental or non-governmental), not limited to Mangrove in the area, the highest percentage of people who are aware of such movement is as follows:

Aparri Area	29.5%
Lamon Bay Area	72.0%
Ulugan Bay Area	92.0%

Ulugan Bay Area indicates the highest percentage, showing that the present environmental protection policy is well informed to the people.

However, percentage of people who answered that they grant Mangrove cutting as the way to improve their economic condition are as follows:

Aparri Area	29.5%
Lamon Bay Area	11.5%
Ulugan Bay Area	26.4%

f. Benefit of Mangrove as Disaster Prevention Method

Percentage of the people who replied that they are benefited by Mangrove for the protection of their house and possession against high tide and from strong wind by Typhoon are as follows:

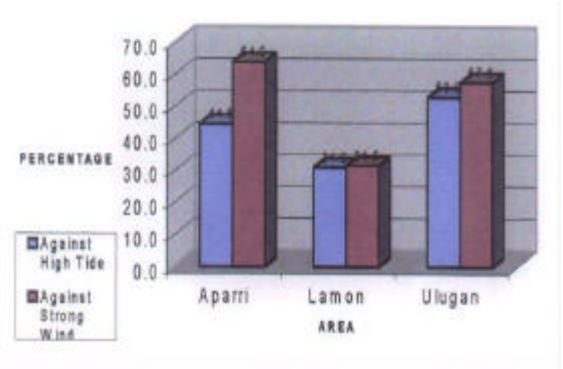


Fig. 2-2-14 Benefit of Mangrove as Disaster Prevention

	Benefit against High Tide	Against strong wind
Aparri Area	44.5%	64.0%
Lamon Bay Area	31.0%	31.5%
Ulugan Bay Area	53.0%	57.6%

2) Characteristics of each Area on the Use and Conservation of Mangrove

In consideration of the aforementioned results of Socio-economic Survey, the following is the relative, comparative feature of each Area.

a. Aparri Area

In this Area, both percentage of people entering Mangrove area and people presently using Mangrove are the highest among three Study Areas, thus, it is

considered that the use of Mangrove as source of firewood is common practice in this Area. Since the remaining Mangrove trees are scattered in the Nipa forest, people may be cutting Mangrove trees when they enter and cut Nipa which is the major source of income in this Area. The low percentage of people who have negative sense on Mangrove cutting, and the high ratio of people granting Mangrove cutting as the way to improve their income may be also reflection of this practice. As for the reason, it is considered that unawareness of legal prohibition on Mangrove cutting, less remembering discussion with government officials regarding Mangrove conservation, and also few oppoturnities to have understanding of the general movement on environmental protection in the Area.

As for the reason on the low percentage of having future intention to use Mangrove, it may be considered that the people are more sensitive on some fine or penalties from land owner without knowledge of legal prohibition, as the people are cutting Nipa three by receiving from land owners who is given consessional permission for Nipa from the Government, and this restriction from land owners may consciously or unconsciously affects the people to answer affirmatively on the future use of Mangrove.

In spite of the large percentage of people having knowledge on the benefit of Mangrove as the prevention method against natural disaster (high tide and strong wind), it might be concluded that the present use condition of Mangrove will be continued in the future, in consideration of present situations mentioned above.

b. Lamon Bay Area

In this Area, both the percentage of people entering Mangrove area and presently using Mangrove showed the lowest figure, and also high percentage on the knowledge of the people on the legal prohibition on cutting Mangrove trees. These facts are also supported by the fact that large percentage of having negative sense on cutting Mangrove trees and low percentage of granting Mangrove cutting as the way to increase their income.

However, percentage of people showing intention to have their own fishponds is large in this Area. In consideration also with the low percentage of people recognizing benefit from Mangrove against natural disaster, there will be a

possibility of increase on the volume of Mangrove cutting in the future, in case present knowledge and recognition of people toward prohibition of Mangrove cutting decrease, or rapid increase of commercial value of fishery products from brackish water fishculture in the Area.

c. Ulugan Bay Area

It is note warthy that environmental protection, which is the most emphasized policy in Palawan province, is well disseminated to the community through the information activities by the officials of the Agencies concerned. This is the reflection of the fact that discussions between government officials and local people in this Area on the Mangrove conservation are frequently held, and the percentage of people showing their understanding on the general environment protection movement is relatively high. However, the people who enters into Mangrove areas and those presently using Mangrove are not few. It may be considered that the present information drive can be more effective if the direction will be oriented on the viewpoint of community level to create more sound knowledge on the significance and background of legal prohibition on Mangrove use.

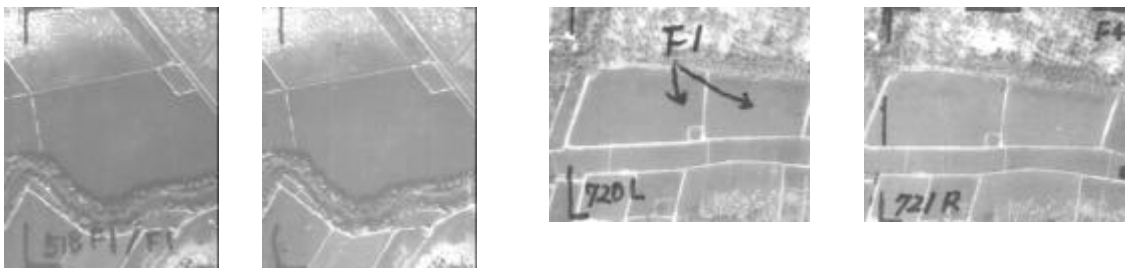
In consideration of the factors such as high percentage of Mangrove use in the past, high percentage of people that showed future intention of Mangrove use, and also high percent of people granting Mangrove cutting as the way to increase their income, it may be important to continue present efforts of the Agencies concerned on the information activities regarding Mangrove, for the protection and conservation of Mangrove resources in this Area.

2-1-3 Fishponds

As noted earlier, large areas of mangroves all over the Philippines have been converted to fishponds. This is especially true at two of the Study areas Aparri and Lamon Bay. Given the extent of conversion, the Study team deemed it important to cover not only the existing mangroves but also areas that were formerly part of the original mangrove ecosystem. This responds to a view frequently expressed by Philippine counterparts that restoration of mangrove vegetation on areas irrationally converted to fishponds is likely the most important target to pursue in the rehabilitation of mangrove areas. Thus, assessing the feasibility of initiatives emphasizing the replanting of mangroves in fishpond areas was considered a vital part of the Study. In conducting this assessment, the team paid special attention to determining the status of the fishponds including whether or not they were being utilized, developed, actively operated and so forth.

To gather information in this context, the Study team analyzed aerial photographs and categorized the fishponds into nine (9) different patterns of photo images based on different shapes and conditions of the dikes, color and texture of the pond surface and vegetation. These nine (9) patterns are shown on Figure 2-2-13. The column on Figure 2-2-13 entitled "Explanation" provides a brief description of principal features and conditions of the ponds in each type.

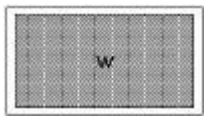
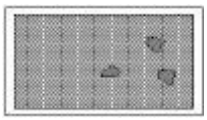
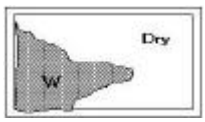
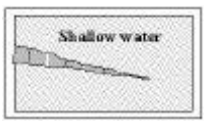
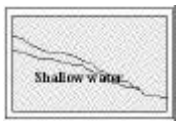
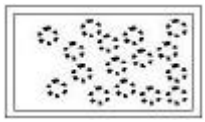
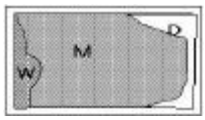
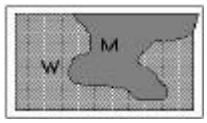
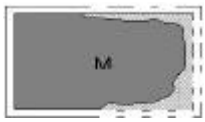
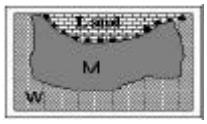
Type 1 illustrates an actively managed fishpond. There is a clearly discernible dike (bank) around the pond. The pond is filled with water and there is usually a small hut where the workers sleep or take their meals.



720-721 Aparri, Comp. 603-F49 435-434 Lamon bay, Comp.518-F1

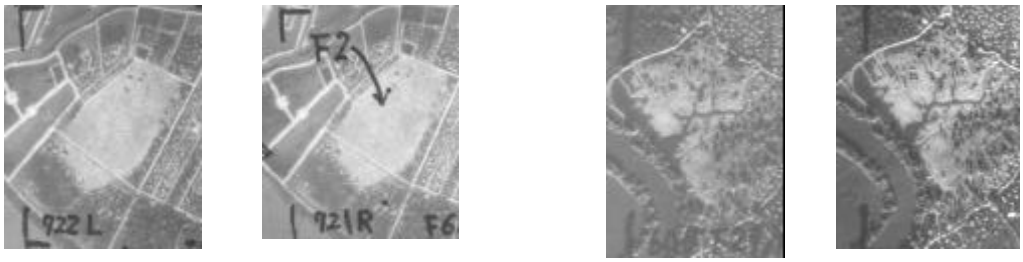
Fig. 2-2-15 Fishpond Type 1

Table 2-2-1 Fishpond Categorization Patterns

Type	Explanation	Image 1	Image 2	Image 3
F-1	Clear bank around the fishpond exists and filled with water.			
F-2	Clear bank around the fishpond exists but only less than 50% surface is covered by water.			
F-3	Clear bank around the fishpond exists and surface is covered by water but very shallow or mud mounds are developing.			
F-4	Clear bank around the fishpond exists but surface is covered with mud mounds and limited water and partly covered by vegetation.			
F-5	Clear bank around the fishpond exists but more than 50 % of surface covered by thin vegetation.			
F-6	Clear bank around the fishpond exists and water also observed but partly thick vegetation same as surrounding natural mangrove stands is developing.			
F-7	Clear bank around the fishpond exists, but surface is fully covered with vegetation, same as surrounding natural mangrove.			
F-8	Bank is not all around nor clears. Some ponds are dry, shallow water covered, and/or vegetation same condition as surrounding mangrove stands covered.			
F-9	Bank is not all around, but clear water exists in only some part. Vegetation covered is same as surrounding mangrove			

Type 2 is a pond surrounded by existing dikes, but water only covers about half (50%) of the pond area. In other words it is partially dry. There may be several reasons why the pond is not filled with water. For instance, perhaps the pond is not being effectively or consistently used and managed. Alternatively, the operator may be deliberately drying out the pond after harvest to sanitize it and get rid of

predators. Then too, perhaps the owner is only interested in partial untilization, or may be in the process of abandoning the pond or turning it over to local residents for their use. In some cases, the owner has given up the fishpond business and local people simply moved in to use the pond on a small scale.

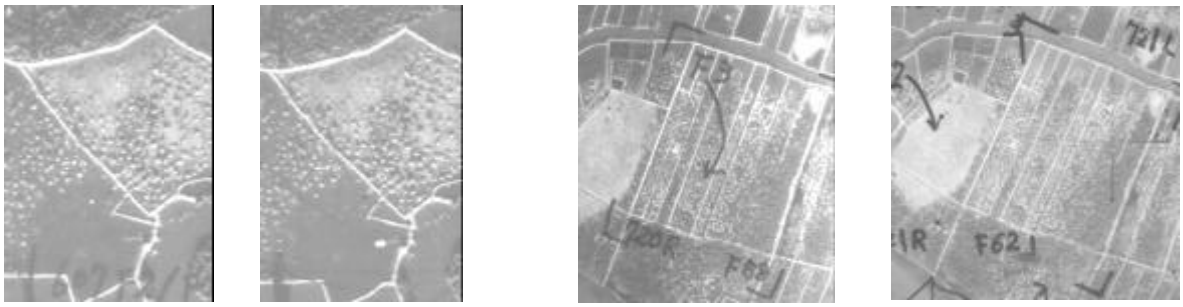


721-722 Aparri Comp. 603F62 488-489, Lamon Bay, Comp. 605F29

Fig. 2-2-16 Fishpond Type 2

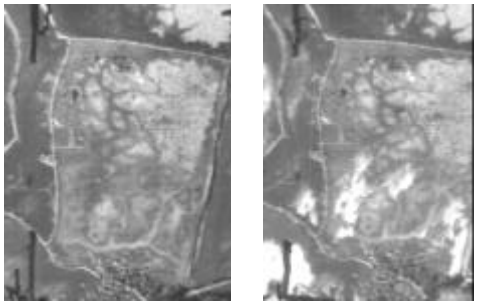
Type 3 is a pond with dikes in place and filled with water, but the water is very shallow and mud mounds have emerged through the surface of the water. The fishpond would seem to be in use, but not intensively. Perhaps there is some rationale for not levelling the mud mounds but this would not be consistent with normally accepted technical standards in fishpond management.

Type 4 is a pond similar to a Type 3 pond, but one that has dried out. This seems to indicate that the pond has not been used for a long time and maintenance has been neglected. The Type 4 pond on the photograph is located at the upper portion of the brackish water zone. The absence of water level control means that water may enter the pond for only a limited period of time (e.g. at high tide) and there is little or no input of fresh water to convert from saline water to the brackish water conditions favorable for fish culture. Both terrestrial and mangrove vegetation are slowly taking root, including pioneering stands of nipa.



448-447 Lamon Bay, Comp. 608F16 721-720 Aparri, Comp 603F1

Fig. 2-2-17 Fishpond Type 3



487-488 Lamon Bay, Comp. 607F2 673-674 Aparri, Comp. 704F7

Fig. 2-2-18 Fishpond Type 4

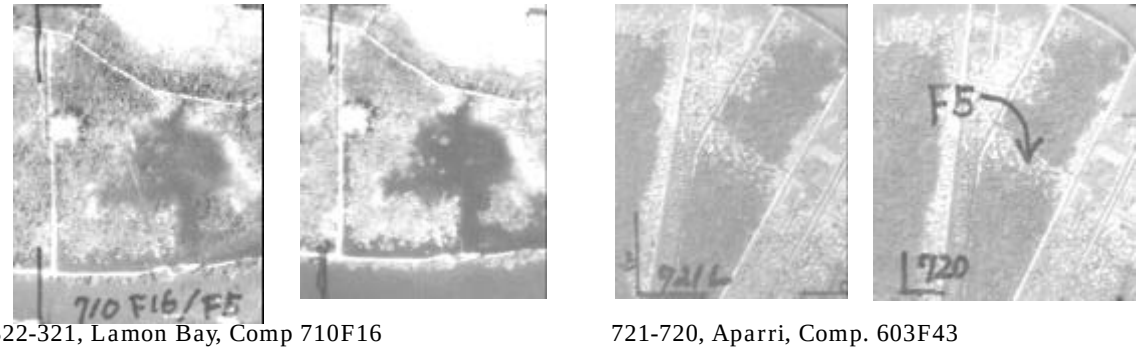
Type 5 illustrates a pond where the status is not clear (i.e. either active or inactive). This type is usually partly-vegetated by nipa, other high inter-tidal mangrove species and brush. The nipa stands are probably planted. The other vegetation may be natural regeneration that occurred after fishpond construction.

The vegetative structure is different from the composition of the adjacent original or natural stands. Water gates are apparently being used since the water level seems to be controlled. Many ponds of this type are found in the Buguey zone of the Aparri area, especially adjoining small rivers. Conditions at the pond suggest that the owner might be biding his time and waiting for the business to recover. Meanwhile, he may be implementing some development activities to demonstrate compliance with terms of his lease and thus maintain the right to continue using the area.

Type 6 has a pattern similar to Type 2. Part of the area has dried out and other parts still contain large mangrove roots. Several years after the first phase of conversion, vegetation is still present on dry portions of the pond. This may indicate inability of the owner to fully develop or maintain the pond, while still continuing to use part of the area. It is difficult to determine from aerial photographs whether or not active management and operations are in place.

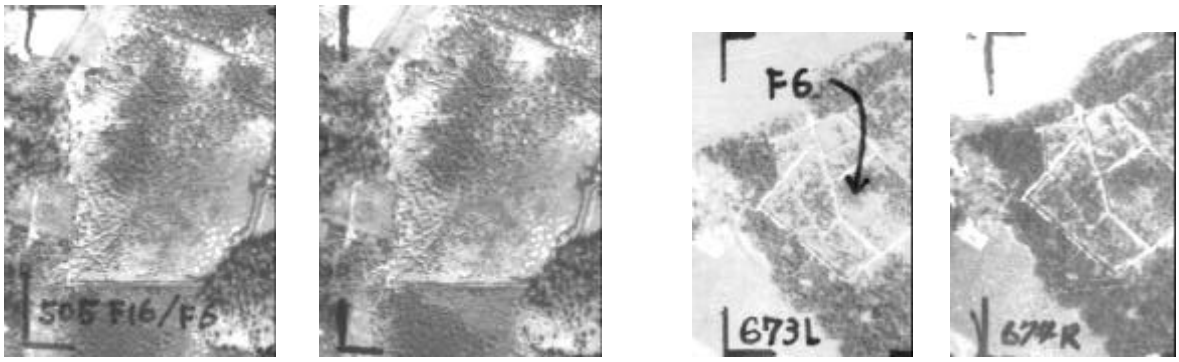
The presence of vegetation may indicate a deliberate decision not to clear-cut the area adjacent to the existing mangrove forest. It may also indicate that the owner decided or was unable to remove all the mangrove roots and regeneration from the stumps is taking place. However, regeneration from *Rhizophora* stumps is

very unlikely. One other possible explanation may be an intention to generate income from the mangroves as well as income from fish or shrimp culture.



322-321, Lamon Bay, Comp 710F16 721-720, Aparri, Comp. 603F43

Fig. 2-2-19 Fishpond Type 5



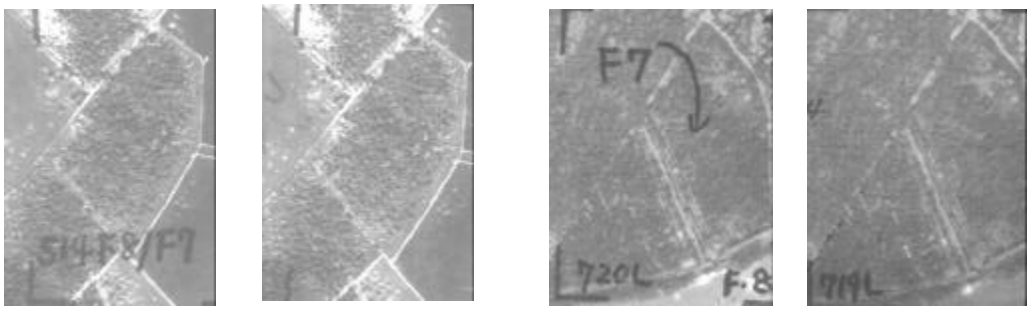
428-427, Lamon Bay, Comp. 505F16 673-674, Aparri, 603F4

Fig. 2-2-20 Fishpond Type 6

Type 7 illustrates either a Type 5 pond in the process of further development, or a pond where development has just started, or an abandoned pond. In the area bounded by the dikes, vegetation can be found and the vegetative structure is similar to that of the natural forest. The difference between abandoned ponds and ponds in the early stages of development is hard to determine from aerial photos. When Type 7 ponds are identified on the photos, this should be followed by field investigation to validate the actual status.

Type 8 is assumed to be an abandoned fishpond. The dikes are almost completely destroyed or deteriorated. In some cases, the fishpond surface is similar to Types 2 and 3, but the dikes have collapsed and water is running through open sections. In some instances, fishpond construction might have started but discontinued because of inadequate funds or some other reasons. The Study team found many ponds that had been damaged or destroyed by typhoons or other

natural disasters. Diseases or miss-management may also have led to abandonment. Abandoned fish ponds were found in many places, especially at Lopez, Kabibihan in the Lamon Bay study site.



435-434, Lamon Bay, Comp. 514F8 720-719, Aparri, Comp. 603F8

Fig. 2-2-21 Fishpond Type 7

488-489, Lamon Bay, Comp. 605F33 716-717, Aparri, Comp. 501F9

Fig. 2-2-22 Fishpond Type 8

Type 9 is assumed to be a pond in the early stages of development. The owner may have started fish culture in a limited part of the area covered by his permit. Development of the remaining of the area may be contingent on the ability to generate additional funds for construction. On the aerial photograph, there is a clear ridgeline comprised of original or mature vegetation which separates the developed portions (covered by water) and the undeveloped portions still containing mangroves. Presence of this ridgeline differentiates Type 9 from Types 5 and 7.

When aerial photographs are used in an attempt to assess whether the status of a fishpond is either active, abandoned, under construction or otherwise, one must be careful not to reach hasty conclusions. For example, on aerial photos taken at low tide it may appear that the fishpond is dry. But a photo of the same pond taken at high tide may show the pond filled with water. An abandoned fishpond and a fishpond under construction will have similar aerial photo images. If the dikes are not clear, or large parts of the area are still vegetated, the fishpond may

belong to either the abandoned or the partially-developed category.

However, despite the problems just cited, aerial photographs are still a useful source of valuable information. Images of the (9) patterns described above can provide a reasonably reliable preliminary assessment of status. Thereafter, field investigations can examine the fishponds one-by-one to validate the preliminary assessment. Since field investigations can be costly and time-consuming, preliminary identification of areas that should have high priority will help reduce expenses and contribute to greater efficiency. Aerial photography has the potential to provide this valuable service.

2-2 Aparri Area

2-2-1 Natural Conditions

(1) Climate

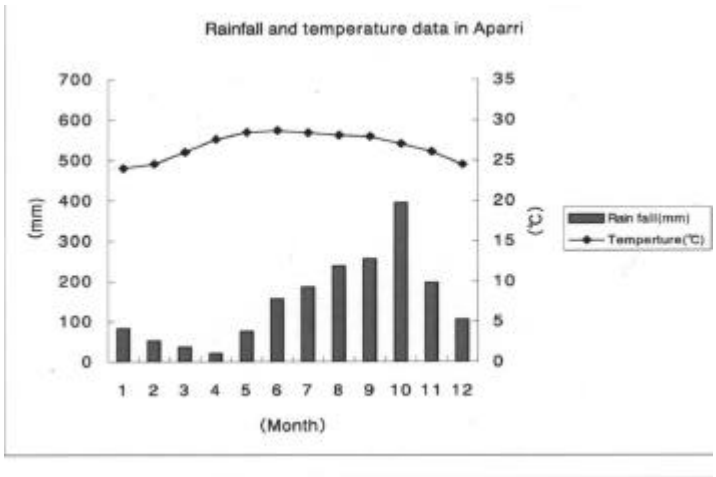


Fig. 2-2A-1 Mean Annual Temperature and Rainfall in Aparri

The Aparri is characterized of the intermediate climatic type (I). Figure 2-2A-1 shows the monthly average temperatures and rainfall from 1985 to 1994. Rainfall is low during the four (4) months from January to April. During the rest of the year, monthly rainfall is often more than 100 mm. October is the month with the maximum rainfall. The warmest month is June with an average temperature of 28.7 ° C. The coolest month is January with an average temperature of 24 ° C. In common with other low latitude regions, the temperature range does not fluctuate very much throughout the year. 1_/

(2) Topography and Geology

Aparri is located near the northern tip of Luzon island. Luzon has four (4) geologic zones aligned in a north-south direction. The easternmost zone is the Sierra Madre followed on the west by the Cagayan valley zone, the Cordillera Central zone and the Coastal folded belt in that order. Both the Sierra Madre and the Cordillera Central are upheaval zones. Cagayan valley and the Coastal folded belt are subsidence zones. The Cagayan valley zone subsided with the upheaval of the Sierra Madre and Cordillera Central zones. These formations are overlain by thick Neogene Tertiary sediments. As a whole, the Cagayan subsidence zone represents a semicircular basin structure open to the north.

The Cagayan River flows more-or-less south to north through the central part of the Cagayan subsidence zone, generally referred to as either the Cagayan river

basin or the Cagayan Valley. The area of the basin/valley is 28,110 km2, largely consisting of Quaternary alluvium transported in by the river. At 380 km, the Cagayan river is the longest in the Philippines. It originates in the Caraballo mountains (elevation approximately 1,500 m) and is joined by several tributary streams along the way before finally flowing into the Babuyan channel in Aparri town situated at the river mouth.

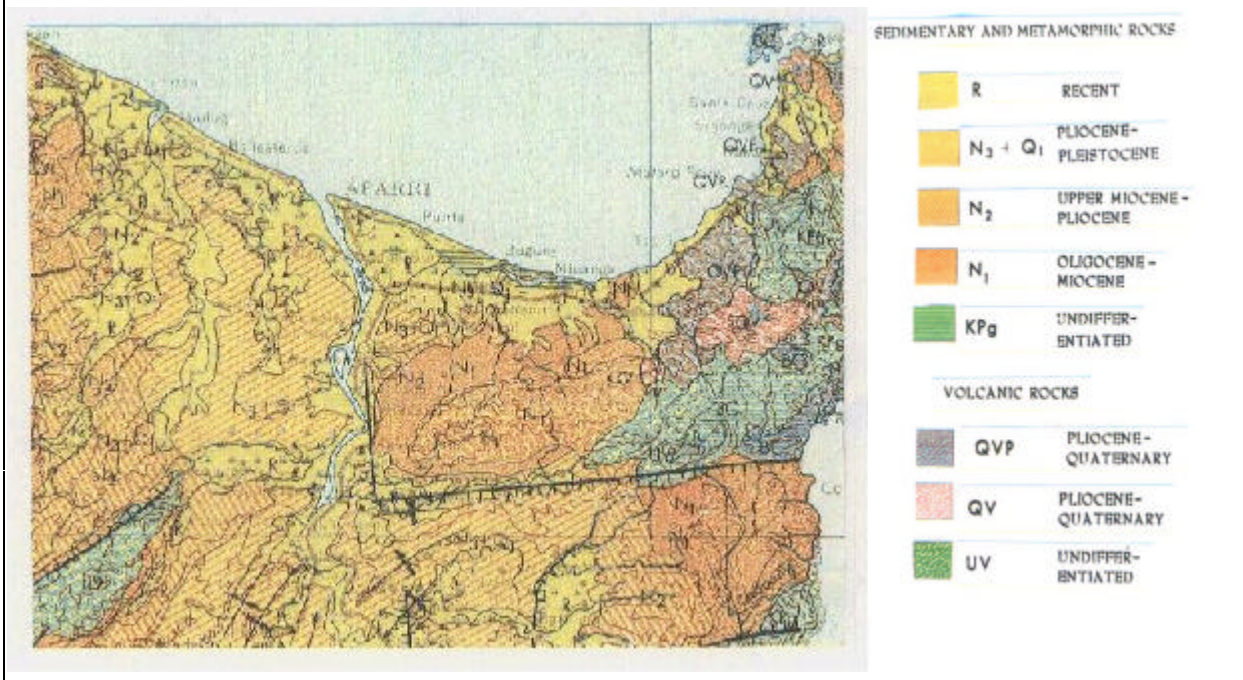


Fig. 2-2A-2 Geological Sturucture in Aparri Area

In the conduct of the Study, the team divided the study site into five zones: Santa Teresita, Buguey East, Buguey West, Linao and Pamplona.

Santa Teresita, Buguey East and Buguey West are in the eastern part of the Study site and are composed of beach ridges and tidal flats. The beach ridges were created from sediment carried down by the Cagayan River and other sediment washed in by marine currents and waves. The tidal flats are presumed to be probable remnants of former courses of the Cagayan River which changed over long periods of time.

Linao zone is located in the flood plain of the Cagayan River. The present topography may be attributed in its initial stages to tributary streams that branched off from the Cagayan River, meandering over land on the left side of the

river, and in the process bringing along sediment. Eventually, the course of the streams stabilized resulting in the build-up of natural levees behind which swamps developed. Groves of nipa have become established on the levees. 2_/

The Pamplona zone, located at the westernmost end of the study site, is situated on the flood plain of the Abulug River. Natural levees with swamps behind them have developed here in the same manner as at Linao. Mangrove trees and nipa grow together on the levees. Pamplona also has beach ridges similar to those in Buguey.

(3) Topology of the Mangrove Habitat

The study site is affected very significantly by the large Cagayan and Abulug rivers. Huge volumes of soil and sand carried down by these rivers have accumulated in lowlands near the estuaries, where mangroves have developed. In this respect, the pattern of sedimentation can be defined as the open-accreting coastal type. However, the height of mangrove riverbanks has been reduced due to excessive sedimentation filling, spilling over, and then spreading out behind the channels onto the adjacent areas. New land area created by this sediment is covered with terrestrial vegetation, *Nypa fruticans* and *Acrostichum aureum*. Furthermore, coastal ridges have built up from sand carried by waves and currents along the coastline. These ridges are too high to provide a favorable environment for mangroves. Everywhere except in the Pamplona zone, fishponds are found along the tidal flat. Moreover, many of present farmlands were formerly covered by mangrove forests that were converted for agricultural production.

(4) Soil

Soil consists principally of fine silt and clayish soil carried down from the upper reaches of the rivers. This material has accumulated in large quantities resulting in a thick soil depth often measuring more than two (2) meters. However, these soils contain very little humus except near the top layer and are colored dark-grey or grey. These two properties clearly indicate that the soils were not formed by mangroves.

(5) Result of Soil Survey

The soil sedimentation conditions in the Aparri area are stated below. Figure 2-2A-3 shows the results of the transect survey conducted in the Buguey zone. Along the belt transect in the zone, soil sampling was conducted with a piston soil sampler, and soil profiles and their conditions observed at point 0 m distance from the starting point (Plot.1) , the distance of Plot.2 is 50 m, and Plot 3 is 100 m.

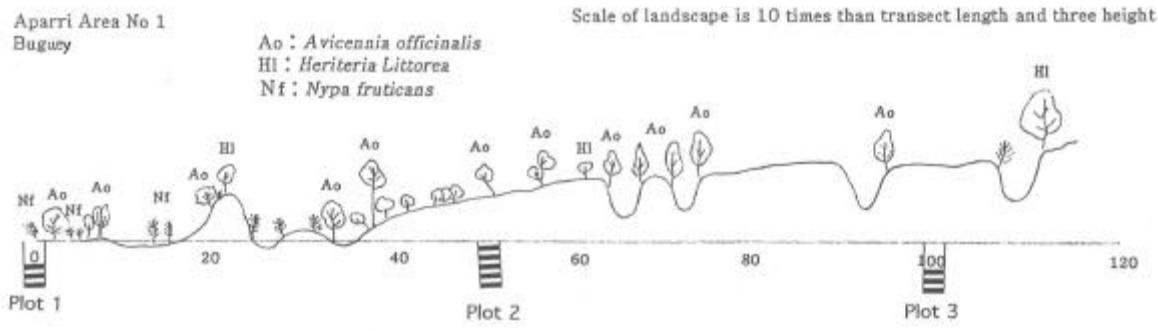


Fig. 2-2A-3 Soil Survey Sample Plot Location Along with Transect Survey

Figure 2-2A-4 shows the soil profile at point 0 m distance from the starting point (Plot.1). The vegetation is almost occupied with *Avicennia officinalis* and *N. fruticans*. The whole soil layer is more than 2 m in depth, and it is divided into 3 layers by soil texture and soil color.

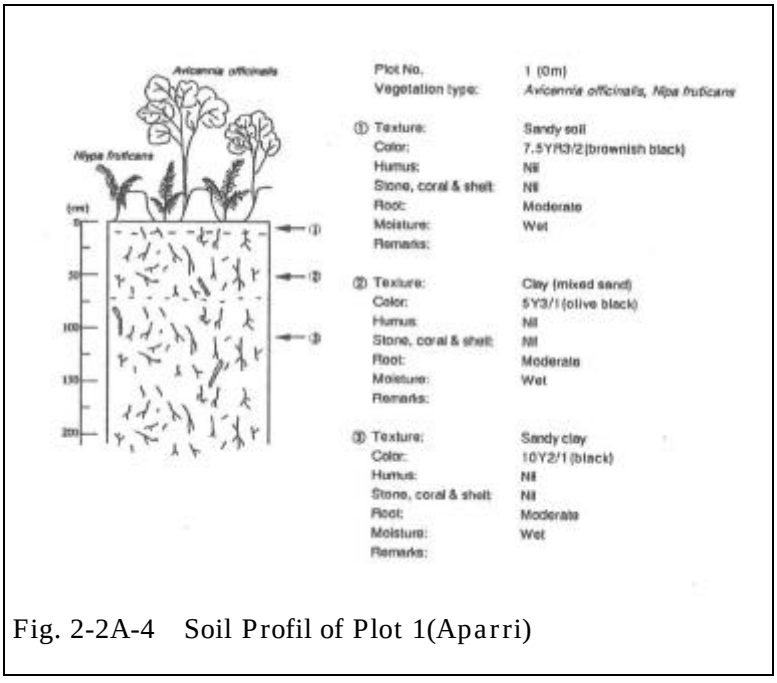


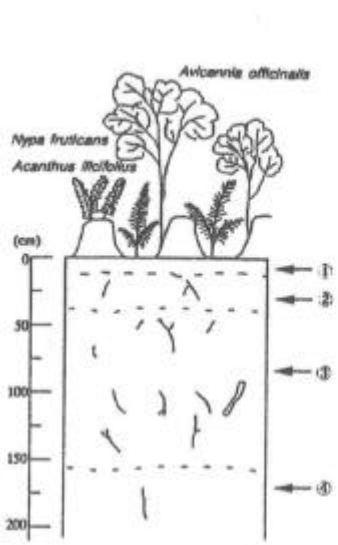
Fig. 2-2A-4 Soil Profil of Plot 1(Aparri)

The top layer has 15 cm depth. The soil texture is sandy soil, and the soil color is dark, 7.5YR3/2 (brownish black). Soil contains little humus, and no stone, coral or shell fragments are found, either. Roots of *A. officinalis* and *N. fruticans* are observed in the soil layer.

The middle layer is of 15 to 75 cm depth. The soil texture is sand-mixed clay,

the soil color is 5Y3/1 (olive black), no humus is contained, and no stone, coral or shell fragments are found, either. Roots of *A. officinalis* and *N. fruticans* are observed as well as in the top layer.

The bottom layer is of 75 cm depth and below. The soil texture is sand-mixed clay, the soil color is 10Y2/1 (black), no humus is contained, and no stone, coral or shell fragments are found, either. Roots of *A. officinalis* and *N. fruticans* are observed as well as in the top and middle layers.



Plot No.	2 (50m)
Vegetation type:	*Avicennia officinalis, Nipa fruticans, Acanthus sp.*
① Texture:	Sandy soil
Color:	7.5Y3/2(olive black)
Humus:	Nil
Stone, coral & shell:	Nil
Root:	Poor
Moisture:	Wet
Remarks:	
② Texture:	Clay sand
Color:	5Y4/1(gray)
Humus:	Nil
Stone, coral & shell:	Nil
Root:	Poor
Moisture:	Wet
Remarks:	
③ Texture:	Clay and sandy clay exist mutually
Color:	7.5Y2/1(black)
Humus:	Nil
Stone, coral & shell:	Nil
Root:	Poor
Moisture:	Wet
Remarks:	
④ Texture:	Clay sand
Color:	7.5Y2/1(black)
Humus:	Nil
Stone, coral & shell:	Nil
Root:	Poor
Moisture:	Wet
Remarks:	

Fig. 2-2A-5 Soil Profile of Plot 2 (Aparri 50m)

Figure 2-2A-5 shows the soil profile at 50 m away from the starting point (Plot.2). *A. officinalis*, *N. fruticans* and *Acanthus ilicifolius* are found in the plot. The whole soil layer is more than 2 m in depth as well as in Plot.1, and is divided into 4 layers by soil texture and soil color.

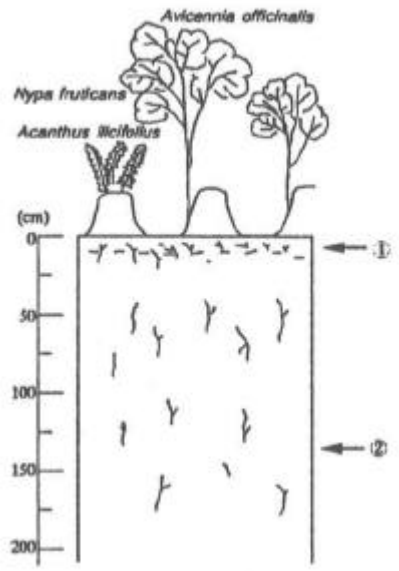
The top layer is at the surface to the depth of 15 cm. The soil texture is sandy soil, the soil color is 7.5YR3/2 (brownish black), no humus is contained, and no

stone, coral or shell fragments are found, either. Barely few roots are found.

The second layer is located at the depth of 15 to 40 cm. The soil texture is sand-mixed clay, the soil color is 5Y4/1 (gray), no humus is contained, and no stone, coral or shell fragments are found, either. Barely few roots are found.

The third layer is located at the depth of 40 to 160 cm. The soil texture is much-sand-mixed clay, and deeper soil contains more sand. The soil color is 7.5Y2/1 (black), no humus is contained, and no stone, coral or shell fragments are found, either. Barely few roots are found.

The bottom layer is located at the depth of 160 cm and below. The soil texture is sand-mixed clay, the soil color is 7.5R2/1 (black), no humus is contained, and no stone, coral or shell fragments are found, either. Roots are hardly found in this depth.



	Plot No.	3 (100m)
	Vegetation type:	*Avicennia officinalis*, *Nipa fruticans*, *Acanthus sp.*
①	Texture:	Clay
	Color:	2.5Y3/2(brownish black)
	Humus:	Nil
	Stone, coral & shell:	Nil
	Root:	Moderate
	Moisture:	Wet
	Remarks:	
②	Texture:	Clay sand
	Color:	10Y3/1 (olive black)
	Humus:	Nil
	Stone, coral & shell:	Nil
	Root:	Poor
	Moisture:	Wet

Fig. 2-2A-6 Soil Profile of Plot 3 (Aparri 100m)

As a feature of this plot, there are a lot of "crab holes," which squillae and crabs have dug, and this fact suggests aggressive activities of creatures.

Figure 2-2A-6 shows the soil profile at 100 m distance from the starting point (Plot.3). In this plot, *A. officinalis*, *N. fruticans* and *A. ilicifolius* are found in the vegetation of the plot as well as in Plot.2. The whole soil layer is more than 2 m in depth as well as in Plot.2, and is divided into 2 layers by soil texture and soil color.

The upper layer is from the surface to a depth of 10 cm. The soil texture is clay, the soil color is 2.5Y3/2 (brownish black), no humus and no stone, coral or shell fragments are found. Roots of *A. officinalis* and *N. fruticans* are found in the soil layer.

The lower layer is situated at depth of 10 cm and below. The soil texture is sandy soil, the soil color is 10Y3/1 (olive black), no humus is contained, and no stone, coral or shell fragments are found, either. Compared with the upper layer, roots are rather scarce.

As features of the whole soil sedimentation condition in this plot, the soil is characterized sandy, grayish dark color, and very active in oxygen reduction, and little humus throughout the whole layer. It is inferred that *A. officinalis* trees do not supply so much organic matter, and *N. fruticans* are cut down by the inhabitants for living materials, and as a result, humus, which would accumulate in different situations, does not. This fact indicates that the soil in the Aparri area is not created by mangroves, but is the soil and sand conveyed by the Cagayan and the Babuyan Channel, and on that soil, the mangrove forest has developed.

2-2-2 Mangrove Forest Distribution and Features

Aparri area was formerly an extensive mangrove area mainly consisting of nipa growing at the mouth of the Cagayan River at the northern end of Luzon island. However, many of the estuarine flatlands have been converted into paddy fields. Furthermore, fishponds have been developed largely in Buguey Lagoon near the coast. Farms and fishponds have replaced large portion of mangrove area.

After dividing the study site from east to west into the six zones such as Santa Teresita, Buguey East, Buguey West, Linao, Abulug, and Pamplona, the site was then further subdivided into compartments and sub-compartments. Each compartment/sub-compartment was assigned a number which was then entered in the inventory book to facilitate location on the mangrove land use map. Details of zone boundaries are shown in Appendix 2-8.

Mangroves in Santa Teresita and Buguey East extend on the riverside of bay-like estuaries protected by coastal dunes. Due to the development of many small fishponds, only remnants of the original mangroves exist. Mangrove trees only comprise a narrow fringe extending from a few to not more than ten (10) meters between the banks of fishponds and the river. These are generally stands of Avicennia officinalis with a maximum height of 5 to 8 meters.

Although the portions of Buguey West around Buguey Lagoon can be described as part of the mangrove ecosystem, the original mangrove forest has virtually disappeared because of large-scale fishpond development. All that remains is a bushy forest composed of high inter-tidal mangrove tree species, mainly *Excoecaria agallocha* with average heights of 3 to 5 meters, scattered on the boundaries between fishponds and the adjacent land.

Linao is a wetland influenced by brackish water extending on the left bank of the Cagayan River mouth. Thick groves of *N. fruticans* are found on both sides of the Linao River. The nipa are managed principally for the production of (i.e. nipa shingles) and fermented drinks. On the boundary between the nipa area and the adjacent land, there are stands of brush mixed with *E. agallocha* and a wetland populated by *Acrostichum aureum*.

Abulug and Pamplona are wetlands located at the mouths of the Abulug and Pamplona rivers. Elsewhere in the Aparri study site, the riverside areas are occupied by nipa. However, most of the nipa groves are mixed with brush and the area used for nipa production seems to be constricted by the inroads of agricultural development. Riverside mangrove vegetation is dense and relatively better than in other zones of the study site. Large-diameter trees of *A. officinalis* were found but they do not cover a wide area. A belt of *S. caseolaris* remains in the sandy soil at riverside.

Figure 2-2A-7 presents results of the transect surveys in a mangrove forest at the Buguey East Zone. These results are generally typical of mangrove forests in most of the Aparri study site. In this Figure, the vertical scale of the landscape is drawn ten (10) times larger than the horizontal scale in order to emphasize the height of the forest floor from the surface of the water. The same scale difference was applied to the following Figures which illustrates results of the transect surveys.

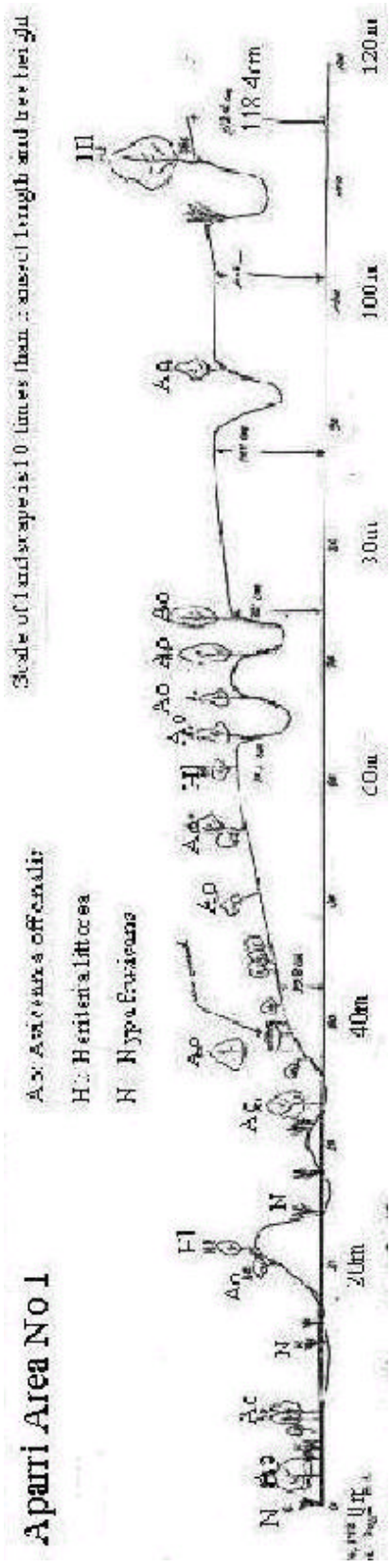


Fig. 2-2A-7 Transect Survey Result in Buguey

N. fruticans grows extensively along the riverbanks of the Buguey East zone. Mud mounds are scattered throughout the mangrove areas and small waterways criss-cross the ground in complex patterns that change at different tide levels. As a whole, the forest consists of a mixture of *A.*

officinalis at the edge of the riverbank and *H. littoralis* growing in the high-intertidal area. *A. officinalis* stands are found growing at approximately 50 cm above the seawater level, with their roots extending into the small channels at the edge of the mud mounds. *H. littoralis* is rooted in the upper part of the mounds which range from 50 to 100 cm in height. These mounds are generally covered by *A. ilicifolius* and *A. aureum*. Inland about 100 m from the riverside where the forest floor is about one (1) meter above the water level, the forest is composed mainly of *H. littoralis* and terrestrial trees. There are also dense stands of *N. fruticans* growing in this area.

Figure 2-2A-8 also shows results of the transect survey in a mangrove forest at Linao where relatively tall trees of *A. officinalis* can be seen from the riverside. Most of the mud mounds and water channels are located 60 m or further inland from the river. The land immediately adjacent to the river is used to produce nipa leaves from groves that are very intensively-managed. The appearance of mangrove species in the Linao zone is fundamentally similar to what can be observed in Buguey. The transect survey locations in these two zones are shown in Figure 2-2A-20.

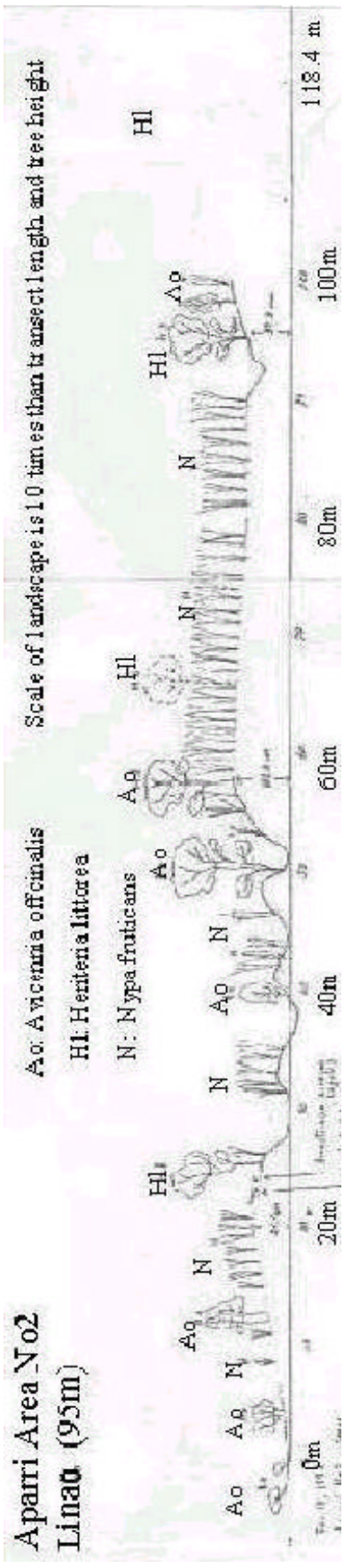


Fig. 2-2A-8 Transect Survey Result in Linao

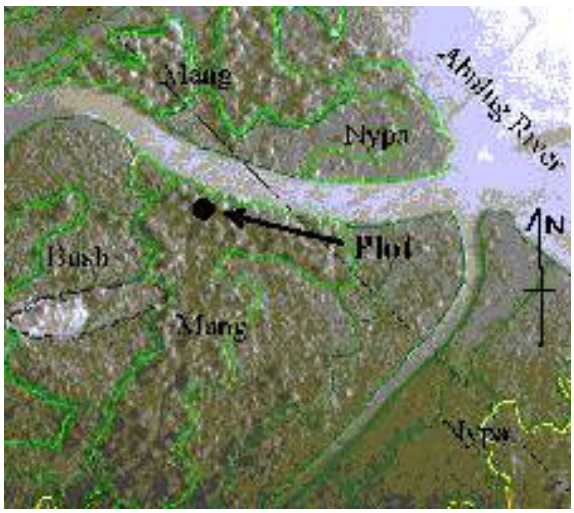


Fig. 2-2A-9 Plot Srvey Location (Ao stands in Abulug: Plot No-4 Comp.205M2)

Mangroves on the riverside in the Abulug Zone contain stands of *A. officinalis* that closely resemble an original undisturbed forest. The study team established a sample plot in these forests located at a point where a large crown was clearly visible on the aerial photograph.

Table 2-2A-1 Stand Number by Species and Height (/ha) : Plot No-4 Comp.205M2

	Low	Mid	Tall	High	Total
Ra	0	0	0	0	0
Rm	0	0	0	0	0
Ao	22	0	0	89	111
Xg	22	0	0	0	22
Hl	156	0	22	0	178
Br	133	0	0	0	133
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
0	0	0	0	0	0
Tot	333	0	22	89	444

Note: Height class on the following Tables and Figures is :

low	4-8 m
mid	9-11 m
tall	12-14 m
high	15 m and more

Species are represented by symbols in tables and figures. The comparative table of abbreviations, scientific names and local (Philippine) names is attached hereto as Appendix 2-5.

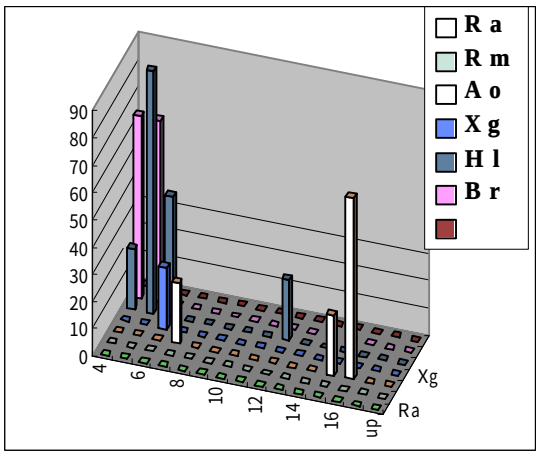


Fig. 2-2A-10 Stand Number by Species and Height (/ha) : Plot No-4 Comp.205M2

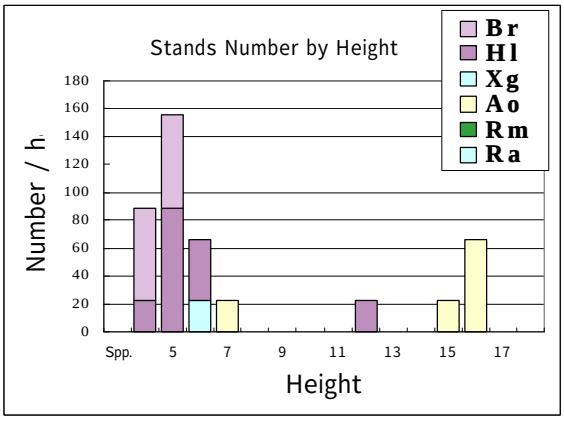


Fig. 2-2A-11 Stand Number by Species and Height (/ha) : Plot No-4 Comp.205M2

The location of the plot is shown in Figure 2-2A-9. The upper layer of trees in this plot consists of large *A. officinalis* measuring 50 cm to 1.0 m in DBH, and the

crown density reaches 70%. The middle layer is a mixture of younger *A. officinalis* and a few *H. littoralis*. The lower layer has scattered patches of *X. granatum* and *Barringtonia racemosa* trees 3 to 5 m high inter-spaced with terrestrial climbers and nipa. Data on the stand structure in the survey plot are shown in Table 2-2A-1 and Figures 2-2A-10 and 2-2A-11.

The only areas of the study site that have generally been spared from conversion into fishponds are belts of land along the riversides. Aside from these belts, the remaining forests usually consist of brush species found on high inter-tidal sites between fishponds and the land. The data below was obtained from a plot survey and shows one sample of these brush forests.

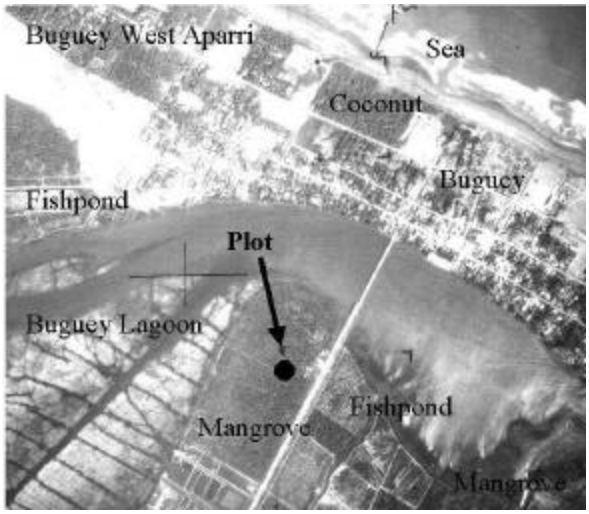


Fig. 2-2A-12 Plot Survey Location (Ao stands in Buguey West) Plot No 2 Comp 501M1

The plot a secondary forest located between Buguey Lagoon and the land area in the Buguey West Zone as shown in Figure 2-2A-12. The maximum tree height in these forests is about 4 to 6 m. Mangrove species found in this forest include *E. agallocha, Thespesia populnea* and *H. litoralis*. The crown density is approximately 40%. The forest floor is occupied by bushes and *N. fruticans*. Data on the stand structure in the plot are shown in Table 2-2A-2 and Figures 2-2A-13 and 2-2A-14.

Table 2-2A-2 Stand Number by Species and Height (/ha) Plot No 2 Comp 501M1

	Low	Mid	Tall	High	Total
Ra	0	0	0	0	0
Rm	0	0	0	0	0
Bg	0	0	0	0	0
Ea	700	0	0	0	700
Hl	50	0	0	0	50
Tp	700	0	0	0	700
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
0	0	0	0	0	0
Tot	1450	0	0	0	1450

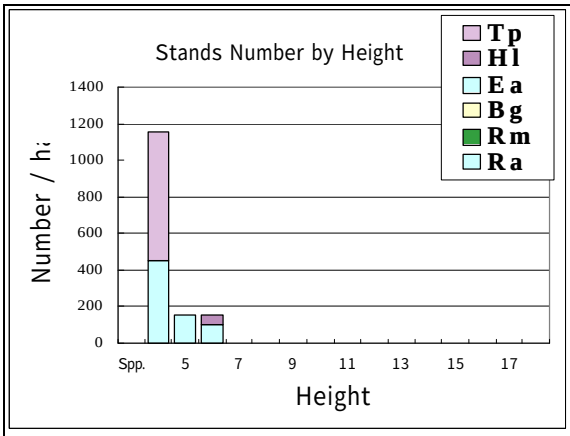


Fig. 2-2A-13 Stand Number by Species and Height (/ha) Plot No 2 Comp 501M1

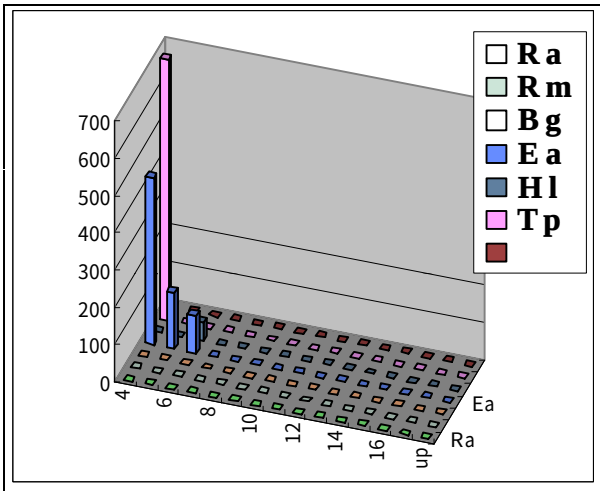


Fig. 2-2A-14 Stand Number by Species and Height (/ha) Plot No 2 Comp 501M1

Fig.2-2A-15 *Sonneratia caseolaris* Stands in Tabba Zone Plot No 2 Comp 501M1

In the Pamplona zone of the study site, the team found a mangrove forest growing in belts ranging from 5 to 20 meters wide along the river in sandy soil behind dunes near the sea. This forest consists of young *S. caseolaris* trees about 5 to 8 meters high in the upper layer as illustrated on Figure 2-2A-15

Classification of the mangrove forests by vegetative type, it is clear that *N. fruticans* is the most extensive, covering the largest area among all others. Most of the pure nipa forests are used for one purpose or another and are managed by the local people. Nipa forests may also be broken down into at least three (3) sub-types; Pure-nipa forests wherein over 90% of the vegetation is nipa; Nipa-dominated forests wherein nipa occupies over 50% of the area; and Mixed-nipa forests where nipa grows together with high inter-tidal mangrove tree and brush species, the latter covering over 50% of the forest floor. The distribution patterns of mangrove forests may be described as follows.

Forests of *A. officinalis* remain along the rivers, growing together with small-to-medium stands of *H. littoralis* and *X. granatum*. Some forests are dominated by *S. caseolaris* which grow in a very small and limited area of sandy soil along the rivers.

Low-height brush forests are found mainly on the boundaries of fishponds where the land is not covered by nipa palms. These forests are a mixture of *E. agallocha* and *H. littoralis* with *A. ilicifolius* and *A. aureum* growing on the forest

floor.

The patterns just described are based on vegetative features verified in the field. Results from field verification were compared with aerial photo imagery patterns, and the potential to distinguish spatial expanse by pattern and adjacent patterns on the photographs was comprehensively examined. Using results obtained from this comparison/verification exercise, the study team classified mangrove forests in the Aparri area into four (4) basic groups. Homogeneous forests were grouped into sub-compartments. The relationship between recognized vegetative features and classification into groups is shown on Figure 2-2A-19.

a. **APN**: Almost totally occupied by *N. fruticans.* (pure Nipa area).
b. **ANM**: *N. fruticans* is dominant but mixed with high inter-tidal mangrove tree species.
c. **AAN**: *A. officinalis* with rather big crowns growing within groves of *N. fruticans* or in narrow belts along with the riverside.
d. **ASN**: Shrubs mixed with *N. fruticans* and high inter-tidal mangrove species such as *E. agallocha*, *A. aureum* and *A. ilicifolius.*
e. **AMN**: Mangrove species such as *A.a officinalis*, *S. caseolaris*, and *B. sexangula* are dominant but are mixed with *N. fruticans.*

Narrow stands of *S. caseolaris* distributed in narrow belts on the riverside are difficult to show on a 1 to 10,000 scale topographical map. Therefore, they are included in adjacent sub-compartments, and this is noted in the "Remarks" column of the forest inventory book.

Interpretation of the aerial photographs was conducted to estimate the number of hectares occupied by each of the above-mentioned groups. The area by group was calculated by computer using GIS on the Mangrove Forest Classification Map. The results are shown on Table 2-2A-3 and the graphs on Figures 2-2A-16 to 2-2A-17. The estimated total area of the inter-tidal mangrove ecosystem including trees, brush species, nipa and fishponds as originally mangrove zone is 3740.18 ha. The largest single group is the nipa-dominated area comprising 1,631.91 ha (APN+ANM+ASN). Approximately 1,436 ha or about 38% of the total area has been converted to fishponds. Mangrove species other than the nipa-dominated areas

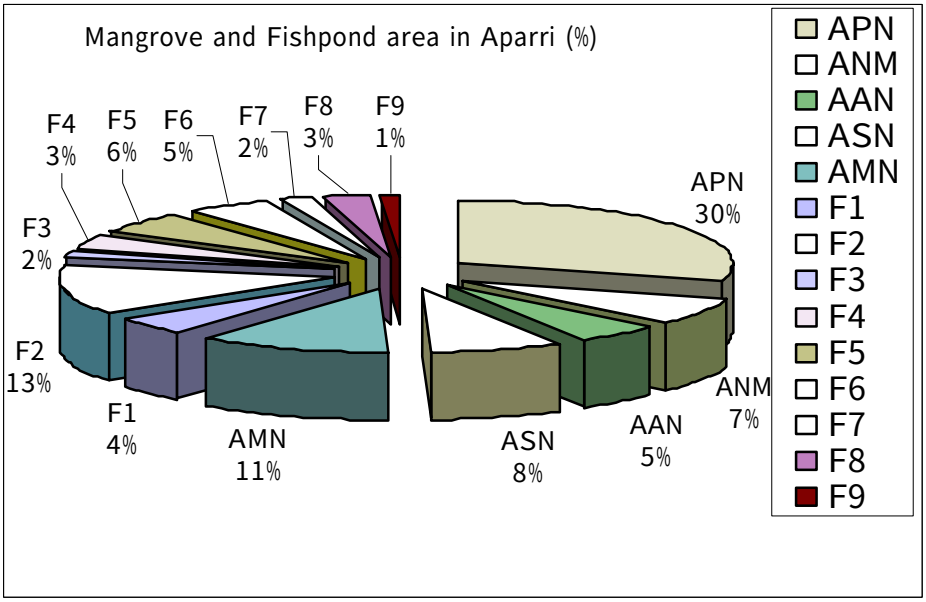


Fig. 2-2A-16 Mangrove and Fishpond Area in Aparri Area

(AAN+AMN)) cover only 468.51 ha.

Typical mangrove areas classified as AAN comprise only 182.88 ha. Some portions of the fishponds also include mangrove trees and nipa. The total area of mangrove trees and nipa within fishponds is 467.82 ha. Therefore, the combined total of mangrove trees and nipa is 2,700.78 ha equivalent to 72% of the Aparri area.

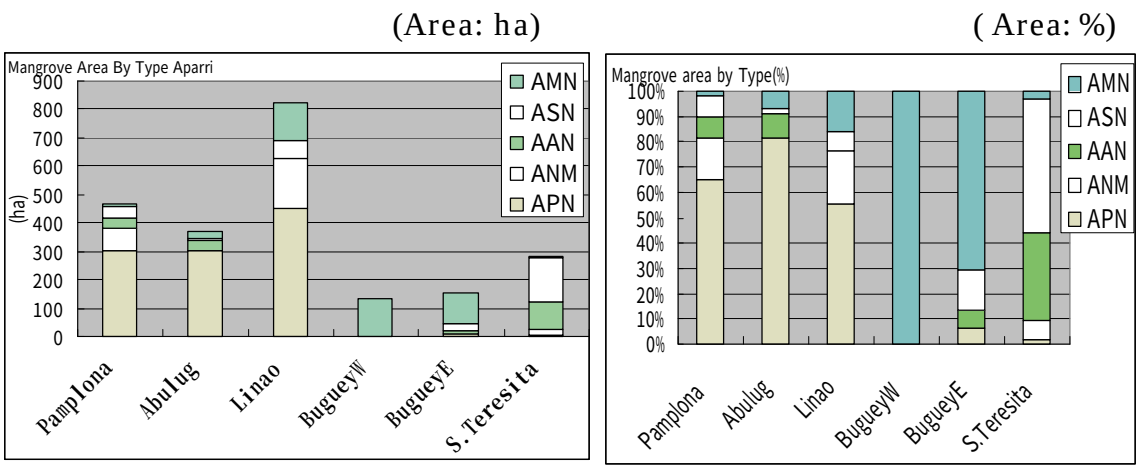


Fig. 2-2A-17 Mangrove Area and Type in Aparri Area

Fishponds comprise 38% or about 1,435.82 ha of the study area. Density is rather low in Pamplona, Abulug, and Linao zones, ranging from 5 to 8% of these

areas. However, fishpond density is high in Buguey East, Buguey West, and Santa Teresita with the highest found in Buguey West where fishponds cover 86% of the zone. Table 2-2A-3 and Figure 2-2A-18 show the areas by fishpond type. Only 161 ha are under Type 1 of fishponds (i.e. ponds filled with water). Fishponds that seem to have dried out (Type F2-F8) comprise 1232ha. Except for Type F1, Type F9, and areas covered by vegetation, the open and apparently abandoned fishponds without mangroves may be identified as priority targets for mangrove rehabilitation. About 760 ha belong in this category (Total areas of F2 to F8 is 1232.15 ha. Within F2-F8 total area covered with vegetation is 467.82 ha. Remaining open and may be unused area is 764.33 ha.) are scattered throughout the Aparri area.

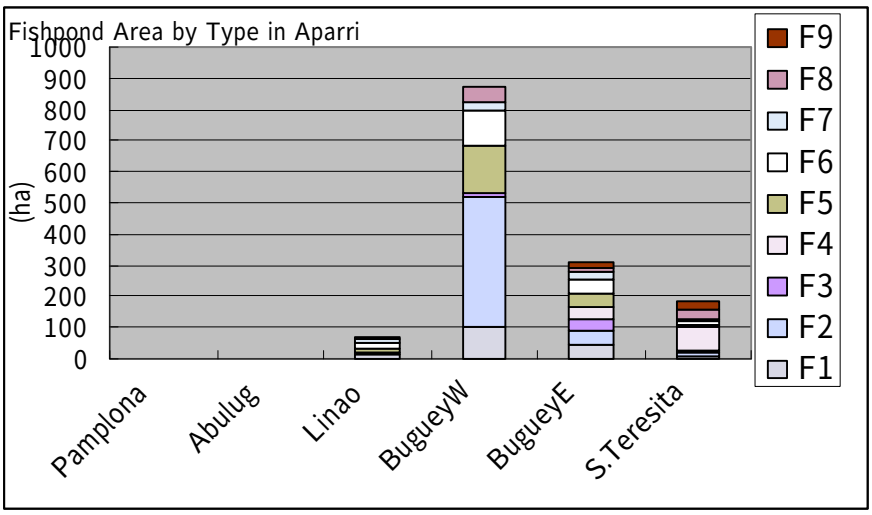


Fig. 2-2A-18 Fishpond Area by Type in Aparri Area (ha)

Table 2-2A-3 Vegetation and Mangrove Area Classification in the Aparri Area

		Pamplona	Abulug	Linao	BugueyW	BugueyE	S.Teresita	Total
Mangrove	APN							0
	ANM	0						0
	AAN	19.64	30.7					50.34
	ASN							0
	AMN	9.64	26.8	130.49	133.40	109.26	8.58	418.17
	sub Total	29.28	57.5	130.49	133.40	109.26	8.58	468.51
Nipa	APN	304.19	304.36	454.10		9.35	5.12	1077.12
	ANM	75.99		174.41			21.76	272.16
	AAN	19.26	4.65			10.78	97.85	132.54
	ASN	37.27	6.09	62.88		24.49	151.9	282.63
	AMN							0
	Sub Total	436.71	315.1	691.39	0	44.62	276.63	1764.45
Total		465.99	372.60	821.88	133.40	153.88	285.21	2232.96
Fishpond	F1		1.47	11.84	98.28	44.74	5.17	161.5
	F2			5.66	419.03	44.71	12.61	482.01
	F3		0.40	2.24	11.36	36.14	7.65	57.79
	F4			1.50	3.78	39.08	76.04	120.4
	F5			13.05	151.06	41.21	7.17	212.49
	F6			17.08	112.65	45.01	9.11	183.85
	F7			9.77	25.49	28.76	8.80	72.82
	F8			7.91	51.03	14.65	29.20	102.79
	F9				2.98	14.49	24.70	42.17
Total		0	1.87	69.05	875.66	308.79	180.45	1435.82
Others		20.65	9.31	4.78	11.25	7.10	18.31	71.4
G Total		486.64	383.78	895.71	1020.31	469.77	483.97	3740.18

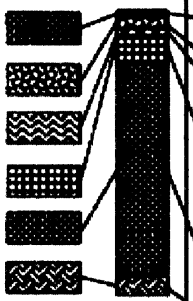
(%)

		Pamplona	Abulug	Linao	BugueyW	BugueyE	S.Teresita	Total
Mangrove	APN	0	0	0	0	0	0	0
	ANM	0	0.0	0.0	0.0	0.0	0.0	0.0
	AAN	67.1	53.4	0.0	0.0	0.0	0.0	10.7
	ASN	0	0	0	0	0	0	0
	AMN	32.9	46.6	100.0	100.0	100.0	100.0	89.3
		100	100	100	100	100	100	100
Nipa	APN	69.7	96.6	65.7		21.0	1.9	61.0
	ANM	17.4	0.0	25.2		0.0	7.9	15.4
	AAN	4.4	1.5	0.0		24.2	35.4	7.5
	ASN	8.5	1.9	9.1		54.9	54.9	16.0
	AMN	0.0	0.0	0.0		244.9	3.1	0.0
		100.0	100.0	100.0		100.0	100.0	100.0
Total	APN	65.3	81.7	55.3	0.0	6.1	1.8	48.2
	ANM	16.3	0.0	21.2	0.0	0.0	7.6	12.2
	AAN	8.3	9.5	0.0	0.0	7.0	34.3	8.2
	ASN	8.0	1.6	7.7	0.0	15.9	53.3	12.7
	AMN	2.1	7.2	15.9	100.0	71.0	3.0	18.7
		100.0	100.0	100.0	100.0	100.0	100.0	100.0

Fig. 2-2A-19 Vegetation and Mangrove Area Classification in Aparri Area

Consideration on Mangrove Forest Distribution Categorizing

Are	Vegetation Type (Dominant Species)	Landscape Condition: Inter tidal level (High / Middl / Low)	Landscape Condition: Estuarine Location (Up / Middl / Down / No)	Location	Soil: Character.	Soil: Depth	Salinity (H / M / L)	Stands Condition: Crown size (B / M / S / N)	Stands Condition: Tree height (H / M / L / S)	Occupied Area
Aparri	S.c , Ac& some Nf	■	■	On river side fringe	Sandy	Thin	■	■	■	Narrow river side sediment part
	Ao & some Hl, Nf	■	■	On river side narrow area	Clay/Silt	Middle/ Thick	■	■	■	Narrow river side part
	B. spp. & some Nf	■	■	On middle inter-tidal surrounding small stream	Clay/Silt	Middle	■	■	■	Beside small stream on middle inter tidal zone. Almost this part had converted
	Hl, Xg, & Nf + Bush	■	■	On all around in spots	Clay/Silt	Middle	■	■	■	On mud mound arising all around
	Nf	■	■	On all around	Clay/Silt	Middle	■	■	■	On every inter-tidal zone except land-ward fringe
	Ea & Bush +Nf	■	■	On land ward fringe	Clay/Silt	Middle	■	■	■	On high inter-tidal zone

(Dominant Species)	Possibility to identify on serial photo graph and draw on 1:10,000 map	Size of Areas by Vegetative types	Mangrove forest Types on Map	Explanation of Mangrove forest types
				Marge to surrounded sub compartment
S.c , Ac& some Nf	Difficult, too narrow		AAN	Ao rather big crowns are observed within Nf or narrow belt along with riverside
Ao & some Hl, Nf	Possible		AMN	Mangrove species such as Ao, Sc and Bs are dominated and Nf are mixed
B. spp. & some Nf	Possible but only limited place on Linao zone			Marge to surrounded sub-compartment Nf
Hl, Xg, & Nf + Bush	Difficult, too small patch		APN	Almost occupied by Nf (Pure Nipa area)
Nf	Possible		ANM	Nf are dominated and high inter tidal mangrove species mixed.
Ea & Bush +Nf	Possible		ASN	Shrubs mixed with Nf and high inter tidal mangrove species such as Ea, Aca and Al

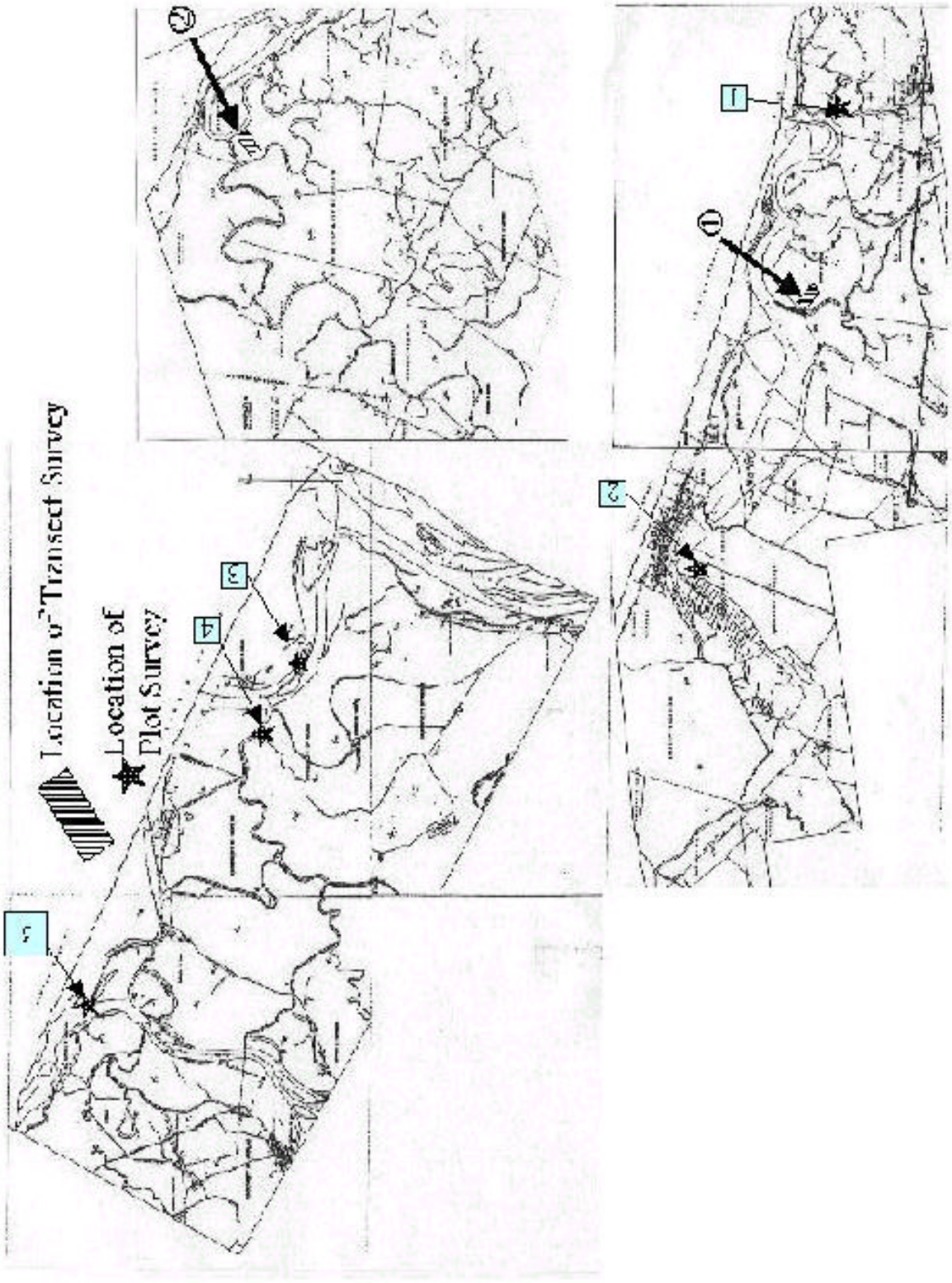


Fig. 2-2A-20 Location Map on Transect and Plot Survey in Aparri Area