CHAPTER II

NATURAL ENVIRONMENT

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II-1 Climate

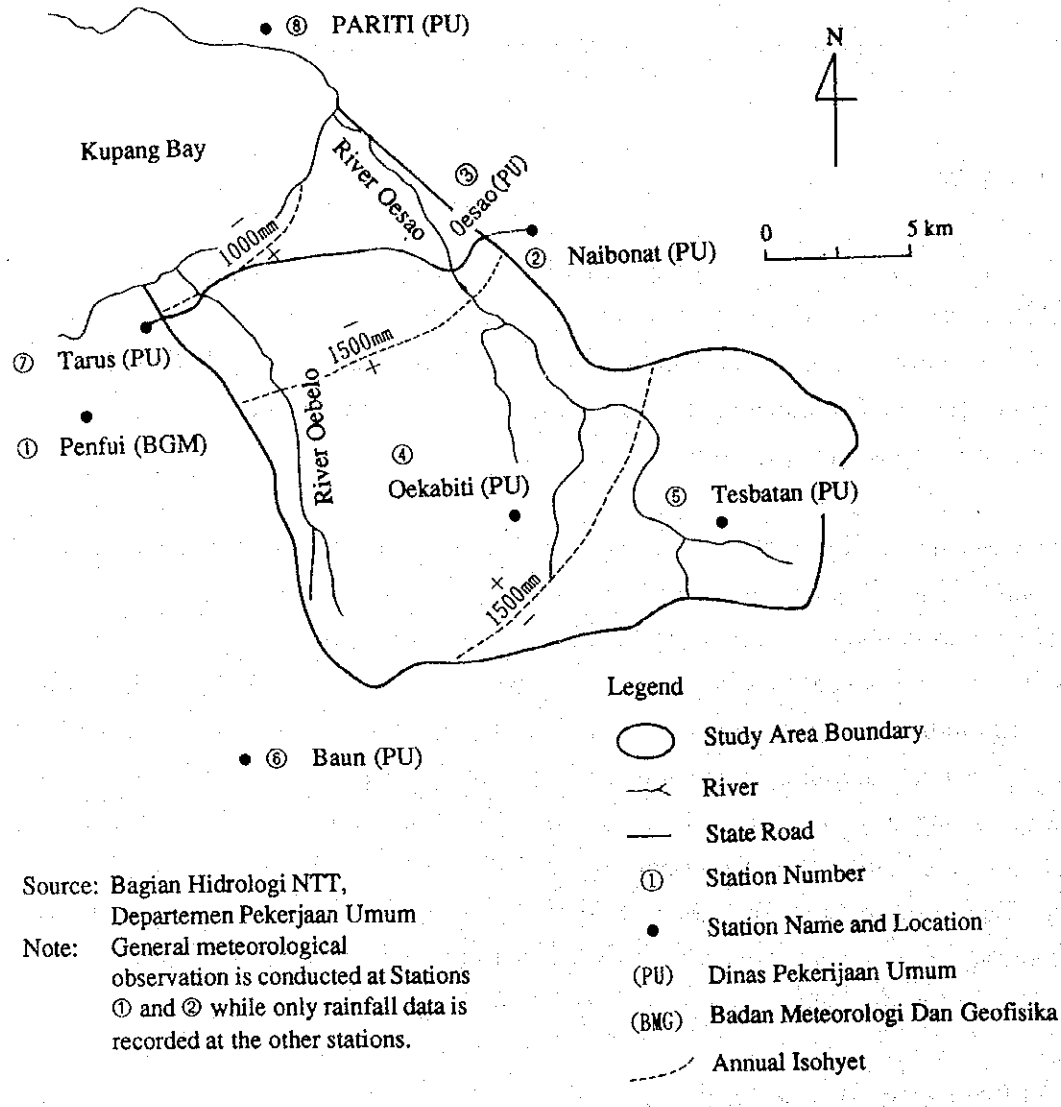
The lowland part of the Study Area has a mean annual temperature of approximately 27°C, an annual fluctuation range of the mean monthly temperature of 3 - 4°C and a generally high temperature during the rainy season, indicating a tropical climate. Although there is no observation data for the mountainous part of the Study Area, the temperature certainly drops in accordance with an increase in elevation.

While the mean annual rainfall at 8 observation stations located in and around the Study Area is 1,375 mm, this largely depends on the geographical location with mountainous areas generally recording higher rainfall. As Fig. II-1 shows, the Study Area can be divided into 3 zones based on the annual rainfall, i.e. central zone of 1,500 mm or more, southern zone of 1,000-1,500 mm and northern lowland and coastal zone of less than 1,000 mm. More than 93% of the annual rainfall is concentrated between November and April with the two month period of January and February accounting for 50% of the annual rainfall and 40% of the annual number of rainy days, indicating a clear distinction between the rainy season and dry season. The rainfall data at all of these 8 observation stations largely fluctuates from year to year. Even in the relatively short period of the last 10 years, the annual rainfall of many years is less than half of the highest rainfall recorded in the period.

II-2 Topography and Geology

The geology of the Study Area is relatively simple with recent fluvial deposits, Pleistocene coralline rock, marl believed to have been deposited between the Pliocene and Pleistocene (containing some sandstone and tuff) and Triassic shale. The mineral resources are poor and only soil and sand are used for brick-making and civil engineering work.

The topography is also simple as alluvial lowland, raised coral terraces, hills and mountains are distributed in an almost regular pattern.



Source: Bagian Hidrologi NTT, Departemen Pekerjaan Umum

Note: General meteorological observation is conducted at Stations ① and ② while only rainfall data is recorded at the other stations.

Fig. II-1 Location of Meteorological Observation Stations and Annual Rainfall Isohyets

(1) Alluvial Lowland

Large-scale alluvial lowland is distributed in the northeastern and northwestern parts of the Study Area and the narrow coastal belt linking this lowland is also classified as alluvial lowland. Narrow valley bottom lowland extending towards the upper reaches is observed along the major rivers. Several large areas of valley bottom lowland are also observed in the mountain areas in the upper reaches. The sediment is generally fine and a huge rounded gravel layer, which appears to consist of debris flow deposits, forms the base of the valley bottom lowland in the mountain areas.

(2) Raised Coral Terraces

Several coral terraces are observed in the Study Area between the coastland and drainage divide. The lower the elevation of the terrace is, the better the preservation of its flat surface. The upper terraces increasingly show wave-like micro-relief which most likely reflects the length of time since rising above sea level. Those located in the southeastern part of the Study Area have lost their terrace characteristics (classified as low relief mountains as described later).

(3) Hills

Hills generally run in the east-west direction along the northern edge of the terrace area and their own northern edges join the lowland. The hills mainly consist of marl with coralline rock frequently observed at the hill tops. The relief energy is generally small. The slope length is short and slopes are gentler than mountain slopes. Scattered, small landslide sites are observed.

(4) Mountains

Mountains are found in the southern part of the Study Area. Their appearance vastly differs depending on the location. Those in the eastern area consisting of coralline rock are characterised by small relief energy, low valley density and gentle slopes, showing a generally rounded outlook. A karst landform is observed in some parts. In contrast, those in the western area consisting of shale and marl are characterised by advanced dissection, sharp contrast between ridges and dales, large relief energy, high valley density and long, steep slopes. There are also many large-scale landslide sites. These differences can presumably be attributed to different features of the geomorphic process where corrosion and deepening play a major part in limestone areas and soft shale areas respectively. In the western area, however, the main ridges still maintain accordance of the summit levels and fragmentary blocks of coralline rock are observed at these ridges.

II-3 Soil

A soil survey was conducted using the following method and the soil map required for preparation of the land rehabilitation plan was prepared.

(1) Survey Method and Preparation of Soil Map

1) Description of Soil Profiles and Soil Grouping Method

The observations on and descriptions of the soil profiles are based on the FAO's Guidelines for Soil Profile Description (Second Edition, 1977) while the soil grouping is based on the FAO-UNESCO's Soil Map of the World (Revised Edition,

1990). The hardness of the solum was measured using the Yamanaka soil hardness meter. Given the objectives of the Study, paddy soils, mangrove soils and swamp soils were omitted from the soil survey. A description of Lithic Leptosols is omitted from the present report. (Appendix B-2)

2) Analysis of Soil Samples

The physical and chemical analyses of the soil samples obtained from the representative profiles were entrusted to the Pusat Penelitian Tanah dan Agroklimat in Bogor.

3) Preparation of Original Soil Map

Having clarified the soil distribution mainly along roads, an original soil map (scale: 1/10,000) was prepared. The mapping units used are shown in Table II-1.

The symbol C.L indicates the soil complex consisting of Eutric Cambisols and Lithic Leptosols. As these two soils do not necessarily show a regular distribution corresponding to the micro-topography, the area in question should strictly be described as a soil mosaic. Nevertheless, it is classified as a soil complex for convenience. The soils of paddy fields in the Study Area originate from Fluvisols, Vertisols and Cambisols, etc. but are classified under the single grouping of paddy soil (P). Mangrove soils and swamp soils are shown by the same symbol (M.S) based on the aerial photograph interpretation results.

Table II-1 Mapping Units

Symbol	Dominant Soils	Complex Soils*	Included Soils**
L	Chromic Luvisols		
V	Eutric Vertisols		
C	Humic Cambisols		Eutric Cambisols Rendzic Leptosols Lithic Leptosols
C · L	Eutric Cambisols	Lithic Leptosols	Rendzic Leptosols
F	Eutric Fluvisols		Mollic Fluvisols
P	Paddy Soils derived from Fluvisols, Vertisols or Cambisols		
M · S	Mangrove Soils or Swamp Soils		
s · r	Sand, Stone or Rock		
ls	Landslide		

* Soils covering at least 20% of the area
** Important soils covering less than 20% of the area

4) Tracing of Final Soil Map

The tracing of the final soil map was conducted by PT. Aerokarto Indonesia under the supervision of the Study Team.

(2) Soil Nature and Distribution

The soil units of the seven soils of which the characteristics and distribution are described below were clarified in the Study Area, excluding soils related to paddy fields, mangrove, swamps, rocky land, sandy beaches and landslide sites, etc. The physical and chemical properties of these soils are shown in Tables II-2 through II-5 and the characteristics and distribution of each type of soil are described below (Appendix B-1).

1) Chromic Luvisols

This soil is equivalent to Terra Rossa and is called Mediteran in Indonesia. It is derived from calcareous parent material and the dark reddish brown or reddish brown solum is deep. Although it is generally silty, clay accumulation is observed in the case of the B horizon. These characteristics have been lost in some samples (Typical Profile No. 3) due to surface erosion. Compared to other soils in the Study Area, the pH value is slightly low and the cation exchange capacity is small. The degree of base saturation is also low but is not below 50%. This soil is widely distributed throughout the Study Area at terrace surfaces, gentle slopes of hills and gentle slopes of the low relief mountainous area in the southeastern part of the Study Area, excepting the dissected mountainous areas.

2) Eutric Vertisols

This soil type is called Grumosol in Indonesia. It is also derived from calcareous parent material and the clayey black A horizon is exceptionally thick. As the survey was conducted in dry season, well developed cracks as wide as 2 - 3 cm on the ground surface or of approximately 1 cm at a depth of several tens of centimeters were observed. While the total porosity is high, the permeability is low. The cation exchange capacity is large. Due to the abundance of bases, the degree of base saturation is higher than 100%, resulting in an unmistakably high pH value. This soil is distributed at flat or gently sloping land, including the relatively old depositional surfaces of alluvial lowland, terrace surface and the bottom of karst areas, etc., with slightly inferior drainage compared to land where Chromic Luvisols are found.

3) Humic Cambisols

This soil is mainly derived from shale but is also derived from marl or coralline rock. It is generally clayey and contains much gravel. The solum is relatively shallow. It has a Mollic A horizon and the Cambic B horizon has a yellowish brown colour. There are some instances where the degree of base saturation of the Cambic B horizon is more than 100% as in the case of Profile No. 4 which does not fit the definition of Humic Cambisols. As this base condition is the remaining character of the basic material, however, the presence of the Mollic A horizon is given priority in the classification of the subject soil as the Humic Cambisols soil. The Mollic A horizon tends to be thin in the upper part of steep slopes. The total porosity is high and the permeability is good. Rich with bases, the pH value is high. Compared to brown forest soils in Japan (a type of Cambisols), it has superior chemical properties. It is widely distributed in the mountainous areas, particularly in the dissected mountainous areas in the southwestern part of the Study Area.

4) Eutric Cambisols

This soil is mainly derived from marl and is rich with gravel. The solum is generally thin. It has a thin, greyish brown A horizon. Ring samples were not collected due to the gravelly nature of the soil but the permeability is believed to be good. While the amount of bases is small compared to other soils in the Study Area, the degree of base saturation is fairly high due to the low cation exchange capacity. It is distributed at hills of low elevation and is accompanied by Lithic Leptosols. The morphological and distributional features suggest that this soil is formed by surface erosion due to over-grazing.

5) Lithic Leptosols

This soil is equivalent to Lithosols defined in Japan. This poor soil has a solum thickness of less than 10 cm with much gravel. Small individuals are found among Eutric Cambisols at steep hill slopes and also scattered in the mountainous areas among Humic Cambisols. It is formed by extensive surface erosion.

6) Rendzic Leptosols

This soil is mainly derived from coralline rock. It has a black or blackish brown A horizon and is quite gravelly. The solum is generally thin. Although ring samples were not collected, the permeability is believed to be good. It has rich bases and the degree of base saturation is high. Small individuals are found among Humic Cambisols or Eutric Cambisols in the mountainous and hilly areas.

7) Eutric Fluvisols

This is slightly immature soil derived from relatively new fluvial deposits. It is generally loamy but sometimes sandy. The solum is deep and tends to have several layers of different soil textures. The cation exchange capacity is relatively small. Because of its rich bases, the degree of base saturation exceeds 100%, showing a high pH value. The permeability is good. It is widely distributed in the lower reaches of the main rivers as well as in narrow strips of lowland along the river channels.

(3) Soil Productivity and Soil Erodibility

Because of the small number of survey plots, it is impossible to quantitize the soil productivity. The land utilisation potential and soil erodibility based on the actual soil properties are outlined below for each mapping unit. The soil erodibility index (K) is calculated based on the Universal Soil Loss Equation (Wischmeier & Smith, 1978). The calculation bases are shown in Table II-5.

1) Chromic Luvisols (L)

Compared to other soils in the Study Area, this soil shows a marked lack of bases, especially calcium. Its pH value is slightly low as is its productivity compared to other soils. No special element strongly restricting land use is observed, making this soil suitable for farmland, grassland and forest land. Its high erodibility, however, makes the use of sloping areas dominated by this soil as forest land appropriate from the viewpoint of soil conservation. Measures are required to prevent erosion for cultivation or forest regeneration purposes.

2) Eutric Vertisols (V)

This soil is considered to have the highest productivity in the Study Area because of its excellent physical and chemical properties and low erodibility level. Farming is the most advantageous way of using this soil. In view of the little rainfall during the dry season in the Study Area, the development of irrigation facilities should be actively promoted to achieve a high level of land use.

3) Humic Cambisols (C)

The physical and chemical properties of this soil are good, implying high soil productivity. The fact that it is mainly distributed at steep mountain slopes is a major obstacle to the active exploitation of this soil's potential. Such steep slopes are unsuitable for use as farmland or grassland and are currently actually used as forest

land although large diameter trees with a good character are sparse. The land productivity should be increased by means of the tending of existing useful species as well as the planting of such species. The high pH value suggests the unsuitability of planting conifers. Because many of the areas in question are important headwater areas, large-scale regeneration cutting must be avoided. In the case of small soil individuals consisting of Lithic Leptosols, Rendzic Leptosols and Eutric Cambisols of shallow solum observed in the upper parts of the mountain sides and ridges, the preservation of natural forests is desirable.

4) Eutric Cambisols - Lithic Leptosols Complex (C.L)

While the chemical properties show no defects, the generally gravelly nature and shallow solum restrict the scope of land use. This soil is unsuitable for farming purposes. The present vegetation is mainly grassland or scattered forests of Eucalyptus and/or palm trees and the land is used as poor pasture, presenting a highly degraded landscape. While afforestation is possible, a high yield cannot be expected. Improvement of the grass species and the introduction of fodder shrubs is desirable with a view to increasing the land productivity. The preservation of the current vegetation is recommended at sites of Lithic Leptosols or Rendzic Leptosols.

5) Eutric Fluvisols (F)

Due to the excellent physical and chemical properties, this soil is suitable for farmland, grassland or forest land. In the case of its use as farmland, the consolidation of irrigation facilities is desirable in view of the water shortage in the dry season to increase the land productivity. Despite the high erodibility, its distribution at flat land almost nullifies the risk of erosion.

6) Paddy Soils (P)

No specific problems are envisaged from the viewpoint of land use involving this soil.

7) Mangrove Soils and Swamp Soils (M.S)

Priority should be given to the preservation of the current vegetation. Re-planting of mangrove is required in places where this plant is destroyed.

Table II-2 Mechanical Composition and Texture Class of Different Soils

(Unit: %)

Soil Unit	Profile No.	Horizon	Sand		Silt	Clay	Texture Class
			2 - 0.1 - 0.05 - 0.002 mm>				
Chromic Luvisol	5	A	5.4	14.3	61.1	19.2	silt loam
		Bt1	3.3	9.4	63.1	24.2	silt loam
Chromic Luvisol	7	A	35.6	10.7	26.6	27.1	sandy clay loam
		Bt1	0.7	1.8	58.2	39.3	silty clay loam
Chromic Luvisol	3	A	5.5	8.8	75.9	9.8	silt loam
		B	6.1	10.4	75.3	8.2	silt loam
Eutric Vertisol	2	AU1	4.3	2.5	41.2	52.0	silty clay
		AU2	7.1	2.5	36.5	53.9	clay
Humic Cambisol	4	A	30.0	8.4	27.0	34.6	clay loam
		BU1	1.5	1.0	38.6	58.9	clay
Eutric Cambisol	8	A	8.3	13.0	58.0	20.7	silt loam
Rendzic Leptosol	1	A	3.9	2.7	21.1	72.3	clay
Eutric Fluvisol	6	A	26.7	10.8	40.9	21.6	loam
		2BC	1.4	4.7	62.4	31.5	silty clay loam

Table II-3 Physical Properties of Different Soils

Soil Unit	Profile No.	Horizon	Bulk Density (g/cc)	Total Porosity (% Volume)	Water Content (% Volume)				Drainable Porosity (% Volume)		Capillary Water[3] (% Volume)	Permeability (cm/h)
					pF 1	pF 2	pF 2.54	pF 4.2	Rapid[1]	Slow[2]		
Chromic Luvisol	5	A	1.17	55.8	49.8	42.7	36.9	24.1	13.1	5.8	12.8	3.96
		Bt1	1.22	54.0	47.0	40.6	35.3	25.0	13.4	5.3	10.3	2.95
Chromic Luvisol	7	A	0.97	63.4	39.9	34.6	30.7	22.8	28.8	3.9	7.9	7.45
		Bt1	1.30	50.9	48.1	43.3	39.1	29.3	7.6	4.2	9.8	2.09
Chromic Luvisol	3	A	1.09	58.9	54.9	48.5	43.0	27.3	10.4	5.5	15.7	0.51
		B	0.96	63.8	44.2	39.2	35.3	23.9	24.6	3.9	11.4	5.64
Eutric Vertisol	2	AU1	0.97	63.4	58.0	50.9	45.4	35.3	12.5	5.5	10.1	0.15
		AU2	1.00	62.3	52.7	46.5	41.8	33.3	15.8	4.7	8.5	0.99
Humic Cambisol	4	A	0.83	68.7	45.8	44.7	40.7	27.8	24.0	4.0	12.9	5.77
		BU1	0.98	63.0	55.7	48.8	43.4	33.9	14.2	5.4	9.5	3.00
Eutric Fluvisol	6	A	0.99	62.6	55.1	47.8	42.1	28.4	14.8	5.7	13.7	3.60
		2BC	1.16	56.2	52.1	46.8	42.3	30.6	9.4	4.5	11.7	6.93

1) Total Porosity - Water Content at pF 2 ≒ Gravitational Running Water
2) Water Content at pF 2 - Water Content at pF 2.54 ≒ Available Water
3) Water Content at pF 2.54 - Water Content at pF 4.2 ≒ Capillary Water

Table II-4 Chemical Properties of Different Soils

Soil Unit	Profile No.	Horizon	pH		Cation Exchange Capacity	Exchangeable Cation (m.e./100g)				Base Saturation	C	N	C/N
			H20	KCl	(m.e./100g)	Ca	Mg	K	Na	(%)	(%)	(%)	
Chromic Luvisol	5	A	5.9	5.0	21.91	10.18	3.35	0.52	0.07	64	1.90	0.19	10
		Bt1	5.7	4.7	18.50	8.45	2.36	0.09	0.09	59	0.84	0.12	7
Chromic Luvisol	7	A	6.2	5.4	30.68	15.90	3.31	0.67	0.10	65	3.07	0.29	11
		Bt1	5.8	4.6	20.78	10.37	1.57	0.15	0.09	59	0.78	0.13	6
Chromic Luvisol	3	A	6.6	5.9	35.34	24.21	2.00	0.32	0.16	76	2.22	0.25	9
		B	6.8	6.0	34.26	24.75	0.81	0.17	0.12	75	1.21	0.17	7
Eutric Vertisol	2	AU1	7.1	6.7	67.12	62.71	3.85	0.94	0.14	>100	2.10	0.18	12
		AU2	7.6	6.9	61.47	72.66	2.76	0.24	0.53	>100	0.78	0.04	20
Humic Cambisol	4	A	7.3	6.7	41.65	44.75	1.67	1.25	0.19	>100	4.16	0.36	12
		BU1	7.7	7.0	41.11	66.99	1.09	0.53	0.31	>100	0.86	0.07	12
Eutric Cambisol	8	A	6.4	5.2	20.14	11.94	3.16	1.12	0.16	81	1.25	0.11	11
Rendzic Leptosol	1	A	7.2	6.6	57.29	62.36	3.30	1.07	0.21	>100	4.77	0.38	13
Eutric Fluvisol	6	A	7.6	6.8	33.88	58.52	1.58	1.43	0.18	>100	1.30	0.11	12
		2BC	7.9	7.0	24.60	51.14	1.38	1.48	0.19	>100	0.49	0.05	10

Table II-5 Soil Erodibility Index (K) of Different Soils

Soil Unit	Profile No.	Horizon	Silt & Very Fine Sand (%)	Sand (%)	Organic Matter (%)	Soil Structure		Permeability		Erodibility
						Type	Class	cm/h	Class	(K)
Chromic Luvisol	5	A Bt1	75.4	5.4	3.27	coarse subangular blocky structure	3	3.96 2.95	4 4 → 4	0.37
Chromic Luvisol	7	A Bt1	37.3	35.6	5.28	fine subangular blocky structure	2	7.45 2.09	3 4 → 3	0.10
Chromic Luvisol	3	A B	84.7	5.5	3.82	fine and medium angular blocky structure	2	0.51 5.64	5 3 → 4	0.35
Eutric Vertisol	2	AU1 AU2	43.7	4.3	3.61	medium angular blocky structure	3	0.15 0.99	6 5 → 6	0.15
Humic Cambisol	4	A BU1	35.4	30.0	7.16	medium crumb and fine subangular blocky structure	2	5.77 3.00	3 4 → 3	0.07
Eutric Cambisol	8	A	71.0	8.3	2.15	medium angular blocky structure	3	–	–	–
Rendzic Leptosol	1	A	23.8	3.9	8.20	fine and medium angular blocky structure	2	–	–	–
Eutric Fluvisol	6	A 2BC	51.7	26.7	2.24	medium subangular blocky structure	3	3.60 6.93	4 3 → 4	0.32

II-4 River System

The main rivers in the Study Area are Oebelo River in the west, Olio River in the centre and Oesao River in the east. All of these rivers originate from the mountain range located in the south of the Study Area and flow northwest to Kupang Bay (Fig. II-2). The river lengths are 30 km for Oebelo River, 37 km for Olio River and 49 km for Oesao River. The river system generally shows a dendritic pattern. While the river system is fairly clear in the mountainous upper reaches and middle reaches, it is not very clear in the lower reaches, especially in the plain to the north of the state road which runs from east to west. In the case of Oesao River in particular, the river channels formed by the natural topography are crisscrossed with irrigation channels. Oesao River has flowing water throughout the year except for one tributary, i.e. Taklale River. Both Olio River and Oebelo River also have water throughout the year, at least in the form of baseflow or sub-surface flow, although the surface flow generally disappears in the dry season.

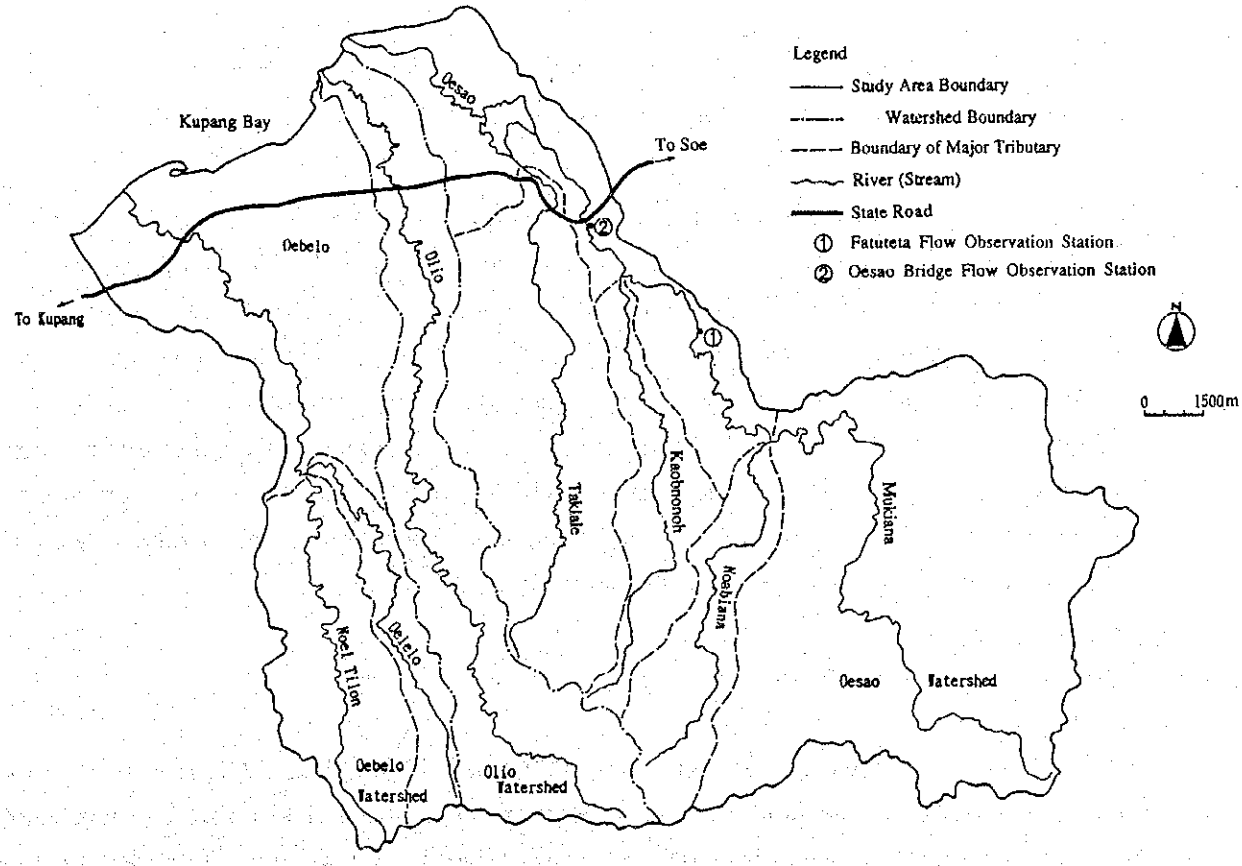


Fig. II-2 River System and Watershed Boundaries

While there are several major tributaries in the Oebelo and Oesao Watersheds, no major tributary exists in the Olio Watershed where one long but narrow main stream is served by several minor tributaries. Among the major tributaries in the Oebelo and Oesao Watersheds, Mukiana River has the largest catchment area with Oelelo River having the smallest. In terms of length, Oesao River (tributary section) and Mukiana River are the two longest while Noabiana River is the shortest. The characteristics of the three watersheds are compiled in Table II-6. In terms of size, the Oesao Watershed is the largest and the Olio Watershed is the smallest. The length of the main stream is generally short with Oesao River (main) and Oebelo River being the longest and shortest respectively.

Table II-6 Some Parameters of Subject Watersheds

Watershed	Area (ha)	Main Stream Length (m)	Form Factor	Total Valley Length (m)	Valley Density (m/ha)
Oebelo	8,376	30,000	0.093	141,000	17.0
Olio	4,512	37,000	0.033	86,000	19.0
Oesao	20,292	49,000	0.084	327,000	16.1

Note: Main stream length & total valley length are measured on the topographical map (scale: 1/10,000).

In terms of the form factor (ratio of the area of a square which equals that of the watershed and the area of a square of which the side length equals the length of the main stream), the Oebelo and Oesao Watersheds are relatively large with 0.093 and 0.084 respectively while the form factor of the Olio Watershed of 0.033 is small. This indicates that among these three watersheds, the Olio Watershed has a long rectangular shape. The total valley length is the longest in the case of the Oesao Watershed, followed by the Oebelo Watershed and the Olio Watershed in that order. The valley density which indicates the degree of river channel development is high in the case of the Olio Watershed because of its small catchment area. In contrast, the corresponding figure for the Oesao Watershed is low.

II-5 Land Use and Vegetation

Aerial photographs taken in 1991 (scale: 1/25,000) and 1993 (scale: 1/30,000) were used for the Study to produce the land use and vegetation maps (scale: 1/10,000). The minimum mapping unit for the topographical map (scale: 1/10,000) is approximately 5 mm × 5 m. The interpretation categories are listed in Table II-7.

The next step was the establishment of a grid consisting of 2 cm × 2 cm square meshes (each mesh equalling 4 ha in actual land size) and the land use and vegetation conditions for each mesh were interpreted to totalise the area of each interpretation category as shown in Table II-8 and Appendix B-3. Grassland with scattered palm trees has the largest area of 10,656 ha, accounting for 32.1% of the Study Area, followed by shrub and bush land of 5,892 ha (17.8%), grassland with scattered trees other than palm trees of 3,652 ha (11.0%) and open grassland of 3,428 ha (10.3%). Combined together, these four land use categories account for 71.2% of the Study Area. Open grassland and grassland with scattered trees totals 17,736 ha (53.5%), suggesting that grazing in the region over many years may have promoted the formation of grassland. The grassland mainly consist of *Corypha utan* LAM. (Gewang) and *Borassus flabellifera* L. (Lontar) Non-palm tree species consist of such trees as *Schleichera oleosa* (Kesambi), *Eucalyptus alba* REINW (Kayu putih), *Casuarina junghuhniana* and *Tamarindus indica* (Asam), *Zizyphus sp.* etc. Shrubs consist of *Acacia catechu* (Duri putih), *A. leucophloea* (Kabesak) and *Leucaena leucocephala* (Lamtoro; Ipil-Ipil), etc. Many *Acacia catechu* trees are also observed near the coast. Slash and burn agriculture is conducted on much shrub land as this type of land use forms part of the shifting cultivation cycle. Moreover, a list of local names and scientific names of trees and crops mentioned in this report is provided in Appendix B-4.

In addition to the above-mentioned types of land use in the Study Area, other types also exist as described below.

Natural/secondary forests with *Pterocarpus indicus* (Kayu merah), and *Shorea* spp. covers 1,768 ha of land (5.3% of the total) and are located mainly along the ridge line in the south of the Study Area and along the banks of ever flowing torrents. Most stands consist of a tree height of upto 15 m although some stands in Desa Tesbatan have trees with a height of upto some 30 m along a torrent which has a relatively abundant flow throughout the year. Man-made forests cover only 144 ha of land (0.4%). The main planted trees are *Tectona grandis* (Jati), *Cassia siamea* (Johar) and *Aleurites moluccana* (Kemiri) and many have a height of some 20 m.

Paddy fields cover 2,532 ha of land (7.6%) and are widely distributed in the lower reaches of Oesao River and are also often seen near the mouth of Oebelo River and at middle & lower reaches of Olio River. Dry crop fields cover 1,572 ha of land (4.7%) and are mostly distributed near settlements. Mixed gardens cover 848 ha of land (2.6%) and are also found around settlements. Settlements occupy 1,432 ha of land (4.3%) and are distributed on the east-west axis along the state road in areas of upto 50 m in elevation in the north of the Study Area. They are also located like stepping stones laid in the east-west direction in areas of more than 200 m in elevation in the south of the Study Area.

Table II-7 Land Use and Vegetation Interpretation Categories

Category	Symbol	Category	Symbol
Lowland Forest	H	Paddy Field	Sw
- Mangrove	Ha	Dry Crop Field	Tg
- Others	Hb	Mixed Garden	Kc
Open Grassland	Pr	- Crown Density: < 70%	Kca
Grassland with Scattered trees	Pp	: ≥ 70%	Kcb
- Palm Trees	Ppa	Salt Field	Pg
- Other Trees	Ppb	Industrial Site	Bi
Shrub and bush	Sb	Seasonal/Temporary Swamp	Rm
Bamboo Grove	Bb	Water Surface (Pond and Lake, etc.)	W
Natural/Secondary Forest	S	Quarry and Sand Pit	Ga
- Tree Height : < 15 m	H1	Landslide Site	Gb
: ≥ 15 m	H2	Riverbed	Sn
- Crown Density: < 70%	C1	Road	Jl
: ≥ 70%	C2	Settlement	Kp
Man-Made Forest	T		
- Tree Height : < 15 m	H1		
: ≥ 15 m	H2		
- Crown Density: < 70%	C1		
: ≥ 70%	C2		

Table II-8 Land Size by Land Use and Vegetation Category in Study Area

Category	Land Size (ha)	Ratio (%)
Lowland Forest (Mangrove)	200	0.60
Lowland Forest (other than Mangrove)	120	0.36
Open Grassland	3,428	10.33
Grassland with Scattered Palm Trees	10,656	32.12
Grassland with Scattered trees other than Palm	3,652	11.01
Shrub and Bush	5,892	17.76
Bamboo Grove	104	0.31
Natural/Secondary Forest	1,768	5.33
Man-Made Forest	144	0.43
Paddy Field	2,532	7.63
Dry Crop Field	1,572	4.74
Mixed Garden (crown density: < 70%)	604	1.82
Mixed Garden (crown density: ≥ 70%)	244	0.74
Salt Field	44	0.13
Industrial Site	4	0.01
Seasonal/Temporary Swamp	728	2.19
Water Surface (Pond and Lake, etc.)	28	0.08
Landslide Site	4	0.01
Riverbed	20	0.06
Road	4	0.01
Settlement	1,432	4.32
Total	33,180	100.00

Note: Due to rounding off, the total figure for the ratio is not 100%

CHAPTER III

SOCIOECONOMIC ENVIRONMENT

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III-1 Outline of Local Community

(1) Local Administrative Structure

The administrative hierarchy in Indonesia is composed of provinces, kabupatens/Kotas (Districts/cities), kecamatans (Sub-Districts) and desas (Villages). Those desas related to the Study Area are 23 desas of 3 kecamatans, i.e. Kupang Tengah, Kupang Timur and Amarasi, all of which are located in Kab. Kupang of East Nusa Tenggara Province. (Refer to Appendix C-1 for the list of desas.)

While the Gubernur (provincial governor), Bupati (head of Kabupaten) and Camat (head of Kecametan) are nominated, the Kepala Desa (village chief) is publicly elected. Fig. III-1 shows the typical administrative structure of desa in the Study Area.

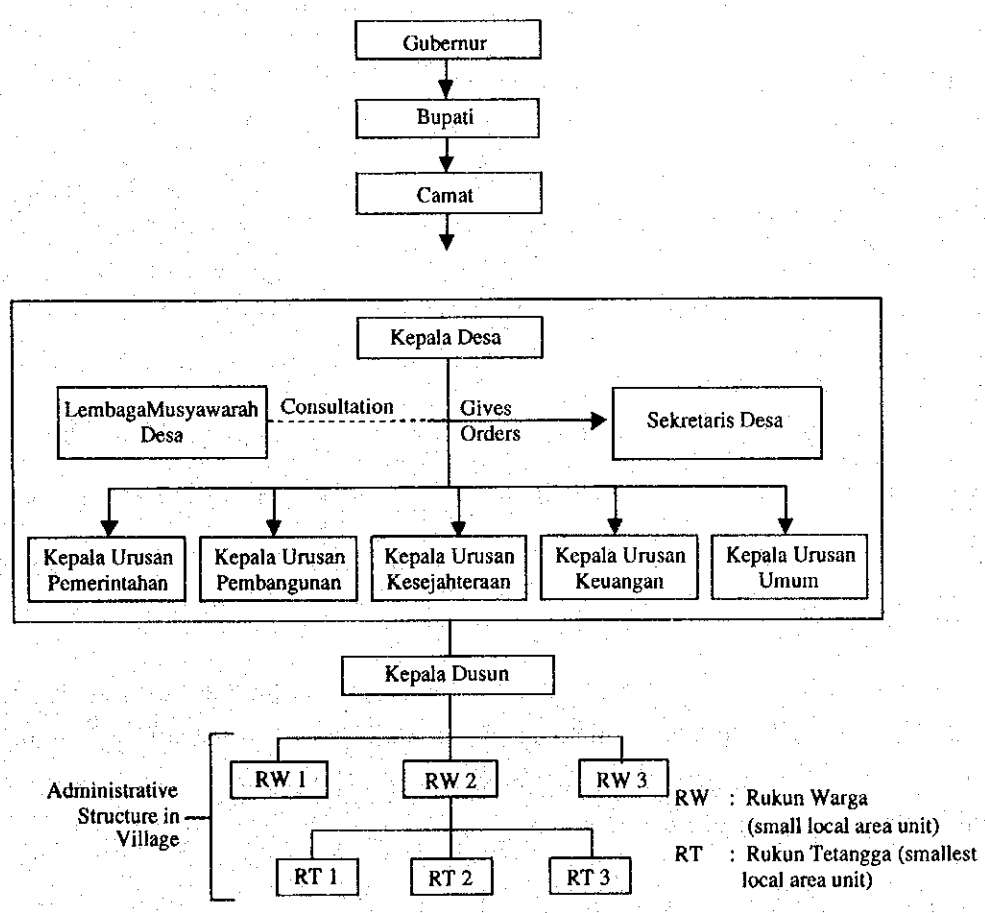


Fig. III-1 Typical Administrative Structure in Study Area (Desa Noelbaki)

(2) Population

The population, land area and population density of East Nusa Tenggara Province, Kab. Kupang and the Study Area are compiled in Table III-1. The Study Area accounts for approximately one-seventeenth of the population of Kab. Kupang and approximately one-twenty second of the land area. In turn, Kab. Kupang accounts for approximately one-sixth of the population and land area of East Nusa Tenggara Province. While the population density of Kec. Kupang Timur and Kec. Amarasi in the Study Area is higher than the average figure for Kab. Kupang or East Nusa Tenggara Province, the corresponding figure for Kec. Kupang Tengah in the Study Area is similar to that for Kab. Kupang and East Nusa Tenggera Province.

Table III-1 Population, Land Area and Population Density of East Nusa Tenggara Province, Kab. Kupang and Study Area

Classification	Population	Land Area (km^2)	Population Density (persons/km^2)
Study Area			
- Kec. Kupang Tengah	6,665	96	69
- Kec. Kupang Timur	13,453	115	117
- Kec. Amarasi	10,882	121	90
Study Area Total (1993)	31,000	332	93
Kab. Kupang (1993)	537,033	7,339	73
East Nusa Tenggara Province (1992)	3,322,782	47,350	70
Indonesia ('000) (1990)	179,379	1,919,317	93

Sources
- Three Kecamatans and Kab. Kupang : Penduduk Kabupaten Kupang, 1993 (Hasil Registrasi, Kantor Statistik Kabupaten Kupang, 1994)
- East Nusa Tenggara Province : Nusa Tenggara Timur Dalam Angka, 1992, Kantor Statistik Propinsi NTT
- Indonesia : Statistik Indonesia, 1993, Biro Pusat Statistik, 1994; World Resources 1994 - 1995, World Resource Institute

Details of the population and land area, etc. by desa related to the Study are compiled in Appendix C-1. The number of persons per household is approximately 5 with notable features being the high proportion (approximately 40%) of those aged upto fifteen years and the larger number of men than women.

(3) Religion, Education and Health Care

Most of the Study Area's inhabitants are Christians with Protestants being dominant, comprising approximately 92% of all inhabitants, and Catholics comprising

approximately 6%. The general educational level is relatively high as the illiteracy rate of the population of 10 years of age or more is estimated to be between 4.6% and 6.8% (according to the Local Inhabitants Survey) which is much lower than the 21.9% for East Nusa Tenggara Province (1992 statistics) and 15.9% for the whole Indonesia (1993 statistics). The medical facilities and manpower strength of the medical care sector in Kab. Kupang are shown in Table III-2.

Table III-2 Health Care Data for Kab. Kupang

General Hospitals	Health Centres, etc.	Doctors	Nurses	Midwives	Beds
3	171	37	157	51	307

(4) Transport

Road transportation is the only mode of transportation in the Study Area. As of 1992, the number or registered vehicles in Kab. Kupang is 17,496, consisting of motorbikes (61%), wagons and jeeps (14%), trucks (15%) and microbuses (10%). However, the number of vehicles in use in the Study Area is believed to be very small. Even the use of bicycles appears to be rare in the mountainous areas.

Public roads are classified as state, provincial, kabupaten and desa roads, all of which are constructed and maintained by the Ministry of Public Works or organizations related to the Ministry.

An asphalt-paved state road runs in the east-west direction in the north of the Study Area between Desa Noelbaki and Desa Oesao while a similarly asphalt-paved provincial road branches from the said state road at Desa Oesao in the northeast, reaching Desa Nonbes, Desa Kotabes and Desa Tunbaun in the south. Partially asphalt-paved (34 km in total in the Oesao Watershed, accounting for 47% of the total length of Kabupaten roads) Kabupaten roads serve most parts of the Study Area except the northern part. Almost all desa roads are paved by either stones or gravel. Table III-3 shows the current conditions of these roads by Working Area. The road density is 7.5 m/ha for the Study Area, 6.0 m/ha for the Olio Working Area, 7.8 m/ha for the Oebelo Working Area, 4.9 m/ha for the Oesao West Working Area and 10.3 m/ha for the Oesao East Working Area.

Table III-3 Aggregate Road Length by Road Category and Working Area in Study Area

Road Category		Standard Width (m)	Length (km)				Total
			Oesao East	Oesao West	Olio	Oebelo	
Public Roads	State	12	-	5.0	2.0	8.0	15.0
	Provincial	8	14.0	3.0	6.0	2.0	25.0
	Kabupaten	6	32.0	8.0	11.0	21.0	72.0
	Desa	4 or less	63.0	31.0	8.0	34.0	136.0
Forest Roads		3	1.0	-	-	-	1.0
Total			110.0	47.0	27.0	65.0	249.0

Notes
1. The road length is estimated based on the topographical map (Scale: 1/10,000) prepared under the Study.
2. As some sections of the roads in state forests, particularly those in the Oesao East Working Area, do not appear on the topographical map due to crown cover, the actual aggregate road length may be longer than given in the table.

The surface conditions of the asphalt-paved sections of the state, provincial and Kabupaten roads are good. Most gravel-paved Kabupaten roads in the Oebelo Working Area are constructed along ridges and erosion tends to occur during the rainy season at those sections where the longitudinal slope is particularly steep and the surface conditions are poor, disturbing the traffic. In contrast, most gravel-paved Kabupaten roads in the Olio Working Area run along the valley bottom at that in Desa Oefafi is subject to both partial and temporary flooding during the rainy season. In Desa Bokong, the traffic often comes to a halt during the rainy season due to the lack of a bridge. While the stone or gravel-paved desa roads provided with drainage ditches pose no problem in view of soil and water conservation, unpaved desa roads, paved roads without drainage ditches and road sections with a steep longitudinal slope are liable to erosion. These roads are estimated to account for some 30% of all desa roads.

(5) Fuel and Water Supply

As of 1992, 31% of the households in Kab. Kupang are supplied with electricity. However, kerosene is the most popular lighting source and is used by 61% of all households. While 17% of the households use either electricity or kerosene for cooking purposes, most of the remaining households use firewood (some use charcoal). Water is supplied to 20% of the households in Kab. Kupang. The most popular sources are wells and fountains (67%). 6% of the households rely on river water or rainwater.

III-2 Outline of Local Industries

(1) Regional Gross Domestic Products (RGDP)

The economy of East Nusa Tenggara accounts for 0.6% of Indonesia's total GDP and its RGDP per capita is the lowest in the country (Appendix C-2). The RGDP per capita in Kab. Kupang is 50% higher than the average figure for East Nusa Tenggara Province and is the highest among the kabupatens in the province.

In summary, the RGDP level of the three kecamatans in which the Study Area is located is lower than that of average of Kab. Kupang but is higher than that of East Nusa Tenggara Province. Within the Study Area, the RGDP per capita is high for Kec. Kupang Timur while the RGDP per capita of Kec. Amarasi is almost level with the provincial average (Table III-4).

Table III-4 RGDP per Capita for Kec. Kupang Tengah, Kec. Kupang Timur and Kec. Amarasi (1991)

Kecamatan	RGDP per Capita	Relative Ratio vis-a-vis Kec. Kupang [1)]	Relative Ratio vis-a-vis East Nusa Tenggara Province [2)]
Kec. Kupang Tengah	Rp 451,000	77.9%	111.6%
Kec. Kupang Timur	Rp 494,000	85.3%	122.3%
Kec. Amarasi	Rp 419,000	72.4%	103.7%

Notes
1) These figures show the relative level of each kecamatan's RGDP per capita vis-a-vis the corresponding figure for Kab. Kupang.
2) These figures show the relative level of each kecamatan's RGDP per capita vis-a-vis the corresponding figure for East Nusa Tenggara Province.

Sources
1) Amarasi, Kupang Tengah, Kupang Timur dalam Angka 1992/1993, Kantor Statistik Kabupaten Kupang, 1993

Compared to the national picture for Indonesia, East Nusa Tenggara Province shows a high share (approximately 50%) of the agriculture, forestry and fisheries sector in terms of the RGDP. The share of the government's administration/defence sector is also relatively high (approximately 16%). In Kab. Kupang, the share of the agriculture, forestry and fisheries sector is relatively low (25%) while the shares of the administration/defence sector (26%), trade/hotel sector (17%) and transportation/ communication sector (16%) are high compared to the corresponding figures for East Nusa Tenggara Province as a whole because of Kab. Kupang's status as the provincial capital. The main trade commodities produced in East Nusa Tenggara Province (1992)

are coffee/coffee substitutes and crude vegetable materials which accounted for 36.4% and 31.4% respectively of the province's total export value of 7,630,000 dollars in 1992. Apart from cement and fabrics, the main provincial products for domestic consumption are dominated by such agricultural products as coffee, horses/oxen/water buffaloes, fish, green peas, copra and cashew nuts, etc. The volume of livestock shipments for domestic consumption which once stood around 60,000 - 70,000 heads dropped by half in 1992 but recovered to the 60,000 head level in 1993. The share of the agricultural sector of Kab. Kupang in the RGDP of the agricultural sector in East Nusa Tenggara Province is 13%. By production type, Kab. Kupang's contribution to the provincial economy is relatively large in the case of livestock and livestock products (20%) and fisheries (24%). As far as Kab. Kupang is concerned, food crops and livestock and livestock products are the main contributors to the RGDP of the kabupaten's agricultural sector (see Appendix C-3).

(2) Agriculture

1) Production of Main Crops

With regard to the main agricultural products, the items of which the production share of three kecamatans in question is relatively high in Kab. Kupang are paddy rice (33.5%, particularly in Kec. Kupang Timur), maize (33.8%, particularly in Kec. Kupang Timur), cassava (75.0%, particularly in Kec. Amarasi) and sweet potatoes (43.2%, particularly in Kec. Amarasi) (see Appendix C-4). Production of Vegetables, fruites and forest products is high in Kec. Amarasi (see Appendix C-5). The agricultural activities in the Study Area are outlined below based on the findings of the Local Inhabitants Survey (Appendix C-6).

Oebelo and Olio Watersheds

The cultivation of maize is very popular in these watersheds, particularly in the upper and middle reaches, and other farming products include paddy rice, cassava, onions, peanuts and vegetables. Some farmers also grow sweet potatoes, green peas and tomatoes. The average plot size for maize cultivation is 0.63 ha in the middle reaches and 0.58 ha in the lower reaches which are almost double the average size of 0.33 ha in the upper reaches. More than half of those interviewed are engaged in paddy rice cultivation in the middle and lower reaches and the average planted area in the lower reaches is more than double the figure for the middle reaches.

Oesao Watershed

Farming in the Oesao Watershed is characterised by the widespread cultivation of maize, as in the case of the Oebelo and Olio Watersheds (86.7% of those interviewed in the Oesao Watershed). 87% of the respondents living in the lower reaches of the Oesao Watershed stated that they cultivate paddy rice. (The figures of 12.6% for the upper reaches and 37.2% for the middle reaches are much lower.) The average paddy field size in the Oesao Watershed is larger than that in the Oebelo and Olio Watersheds for the upper, middle and lower reaches. Most of the respondents cultivate crops on private land. The farming products cultivated by more than 10% of the respondents living in the Oesao Watershed are maize, paddy rice, cassava, dry field rice, tomatoes, onions, peanuts and vegetables, indicating the more active engagement of farmers in many different products compared to those in the Oebelo and Olio Watersheds.

2) Realities of Farming

The average farmland size per farming household is 0.6 ha and 1.3 ha for the upper reaches and lower reaches respectively of the Oebelo and Olio Watersheds and 0.8 ha and 1.8 ha for the upper reaches and lower reaches respectively of the Oesao Watershed. This tendency to a smaller farmland size towards the upper reaches is particularly noticeable in the case of paddy fields (See Apendix C-6-1-1).

Although there are slight variations depending on the specific area and farming household, the general production period from planting to harvesting is from November to around June of the following year for paddy rice, maize, cassava, dry field rice and peanuts. In the case of soybeans, green peas, tomatoes, onions and peanuts (in some areas), the production period is from April to around October (the period varies, however, for the production of tomatoes from one farming household to another). As the number of sellers of these products is relatively large vis-a-vis the number of growers, it can be inferred that they are produced for direct marketing, making the best use of the slack season and water availability.

Many of the farming households in the Study Area use urea, TSP and agrochemicals (in the case of the first crop, 44.2%, 37.5% and 35.3% of the respondents use urea, TSP and agrochemicals respectively). The proportion of those using these additional inputs and the input volume are both high in the lower reaches than in other areas. Fertilisers and agrochemicals are mainly purchased from a Toko (retail shop) or KUD while the seeds are mainly self-supplied. The general price levels of the main crops in the Study Area are given in Table III-5.

Table III-5 Price Levels of Main Crops

Product	Yield (per ha)	Unit Price (Rp/kg)	Approx. Income (Rp/ha)
Rice	1.5 tons	900	1,350,000
Maize	1.2 tons	500	600,000
Cassava	1.0 tons	300	300,000
Coconuts	100/tree	150	15,000 (/tree)

As part of the local farming practice, shifting cultivation, i.e. slash-and-burn farming, is conducted in all three kecamatans in the Study Area. A farmer generally cultivates a field of 0.5 - 1.0 ha for upto 2 years before moving on to another field. Normally, one shifting cultivation cycle involves 3 - 6 sites. Shifting cultivation is usually conducted on private land and burning takes place between September and November. The distance from the house to the cultivation site is usually 2 - 8 km. The crops produced using this method are maize, cassava, peas, dry field rice, pumpkins, water melons and cucumbers, etc. and are planted in November or December for harvesting in March through June. While such trees as Lamtoro spp., Kemiri and Kapok are planted, the planting of Lamtoro spp. is said to have been declining in recent years due to insect damage.

3) Standard of Living of Farmers

Calculation of the average gross income (agricultural and non-agricultural income prior to the deduction of agricultural expenses, etc.), household expenses, cash income and cash expenditure per household for each watershed based on the questionnaire replies reveals certain facts (Table III-6).

- Roughly 50% of the gross income is used for household expenses (the ratio of household expenses vis-a-vis the average gross income is particularly high for those households in the middle reaches of the Oebelo and Olio Watersheds).
- The amounts of average gross income and household expenses are the lowest for those households in the middle reaches and highest for those in the lower reaches.
- There appear to be many poor people in the Study Area, particularly in the upper and middle reaches of each watershed, in the light of the poverty line of an annual income of 1,200,000 Rp/household (5.4 family members) set by the Central Bureau of Statistics for East Nusa Tenggara Province.
- The annual cash expenditure of 300,000 Rp/household is the minimum expenditure level.

Table III-6 Average Gross Income, Household Expenses, Cash Income and Cash Expenditure per Household

(Unit: '000 Rp/year/household)

Area	Gross Income (A)	Household Expenses (B)	Cash Income (C)	Cash Expenditure (D)
Oebelo-Olio Watershed				
Upper Reaches	1,261	748	305	307
Middle Reaches	901	587	316	313
Lower Reaches	1,720	942	565	614
Oesao Watershed				
Upper Reaches	1,367	802	339	394
Middle Reaches	1,252	574	360	314
Lower Reaches	2,419	1,279	835	426

Notes

(A) Average Gross Income: Average total of agricultural and non-agricultural income (prior to the deduction of agricultural expenses, etc.)

(B) Household Expenses: Originally itematised as food, electricity, transport, water supply, kerosene, education, clothing, health and medical, house rehabilitation or rent, village membership fees, tax, interest on loans and others. As some items are left blank, the total sum for the entire number of households in each watershed is divided by the number of households to obtain the average figure. The original daily food expense and monthly electricity, transport, water supply and kerosene expenses are converted to annual figures.

(C) Cash Income: Average annual figure of the total replies, each of which falls within a pre-determined range.

(D) Cash Expenditure: Average annual figure of the total replies, each of which falls within a pre-determined range.

In order to eradicate poverty in the country, the Government of Indonesia is implementing the Poverty Eradication Project (IDT: Inpres Desa Tertinggal) under Presidential Instruction. Three desas in the Study Area, i.e. Desa Oelpuah, Desa Fatuknutu and Desa Apren, receive an annual grant of Rp 20 million each under the IDT project to create groups to conduct various activities.

(3) Livestock Production

1) Overview

The production of beef cattle and chickens is very popular in the three kecamatans in which the Study Area is located. Kab. Kupang accounts for slightly less than 30% of the cattle raised in East Nusa Tenggara Province while the three kecamatans raise 41% of the cattle in Kab. Kupang. The share of Kec. Kupang Timur is particularly high. In terms of chicken raising, Kec. Kupang Tengah accounts for some 10% of the production in Kab. Kupang (see Appendix C-7).

The ratio of households raising beef cattle in the Study Area is high in the Oesao Watershed compared to the Oebelo and Olio Watersheds. In contrast, the ratio of households raising chickens is low in the Oesao Watershed compared to the other two watersheds. With regard to beef cattle raising in the Oebelo and Olio Watersheds, the ratio of households increases towards the upper reaches. In the Oesao Watershed, the ratio of households engaged in beef cattle production does not vary much between the upper reaches and lower reaches.

2) Realities of Beef Cattle Raising

① Number of Cattle Raised and Scale of Operation

The number of beef cattle raised in the Study Area is estimated to be approximately 23,000 heads (1993 data). The resulting density of 69 (Appendix C-8) heads/km^2 is more than double the average density of 32 heads/km^2 for the three kecamatans, indicating the importance of beef cattle raising in terms of land use and local economy in the Study Area.

With regard to the operation scale in East Nusa Tenggara Province, it is estimated that around more than 82% of the households raise upto 10 heads of cattle, accounting for slightly more than 20% of the total number in the province. The average number of beef cattle per household is 3 heads (see Appendix C-9).

In Kab. Kupang, 14,400 farming households (18% of the total) raise beef cattle. As 12,000 households (85% of those engaged in cattle raising) keep some 44,000 heads, the operation is rather small with an average number of cattle per household of less than 3.7 heads. The remaining 2,400 households (15% of those engaged in cattle raising) keep some 18,000 heads. The average number of cattle per household, therefore, is 75 heads, resulting in the operation of these households being classified as large-scale. While the number of cattle raised by ordinary farming households in mountainous areas in the Study Area is an average of approximately 3 - 4, the number of households engaged in large-scale operation increases in the lowland areas.

② Raising Method

In general, beef cattle raising in East Nusa Tenggara Province is conducted using one of the following three methods.

i) Intensive Method: Raising in a shed by feeding cultivated and harvested grass, fodder crops and fodder trees.

ii) Semi-Intensive Method: Not entirely raising in a shed but allowing the cattle which are tied to a fence, etc.to feed around the house while also being fed harvested grass, wild grass, fodder trees and the remains of harvested crops, etc. This method is often employed by small-scale operators.

iii) Free Grazing Method: Traditional, extensive method allowing free grazing on natural grassland or forest land.

Note: Cattle provided by the government must be raised using either the intensive method or the semi-intensive method.

The free grazing method has traditionally been popular in the Study Area with some 80% of the cattle being raised using this method while the remaining 20% are raised using either the intensive method or the semi-intensive method.

According to the interview results, the price of free range cattle is Rp 200,000 per head for a one year old, Rp 400,000 for a two year old and Rp 550,000 for a three year old. In contrast, cattle raised in a shed fetch a price of some Rp 150,000-200,000 per head higher than that of free range cattle

③ Realities of Grazing

In those areas where grazing on natural grassland and/or forest land is possible during the rainy season (from December to March), followed by grazing on post-harvest paddy fields, the cattle are raised on the post-harvest paddy fields using stubble and wild grass for a limited period of 2 - 3 months (from April to June). In the dry season after this period, the cattle are again raised on natural grassland or forest land.

In those areas where the double-cropping of rice or rice in combination with another crop is conducted or in those areas where the use of paddy fields for grazing purposes is difficult, the normal practice is grazing on natural grassland all year round.

Grazing often takes the form of free grazing without any enclosures but in some cases, a boy is appointed to control a herd of some 40 to 50 heads. Construction of fences around farms and houses to control invasion by cattle is a normal practice, but invasion of cattle during free grazing into farms which result into damages is not rare.

④ Seasonal Productivity of Natural Grassland

Natural grassland in the Study Area provides the most common grazing grounds and the productivity of such land per unit area shows seasonal fluctuations as can be expected. This means that the number of cattle which can reasonably be grazed per unit area significantly differs according to the season. The grazing capacity of natural grassland in the Study Area is believed to change from approximately 4 heads/ha in the period from January to June, which includes the rainy season and the post-rainy but still wet season, to 0.7 heads/ha in the early dry season from July to September and further to 0.5 heads/ha during the late dry season from October to December (see Appendix 10). If the same grazing density during the rainy season is adopted throughout the year, there will certainly be a fodder shortage during the dry season, hampering the growth of cattle. The actual survey on year-round grazing on natural grassland near the Study Area found a cyclical change of the body weight which increases during the rainy season but which decreases to almost the original level during the dry season, indicating inadequate grazing on natural grassland, i.e. excessive grazing (Appendix C-11).

The mortality rate of newly born calves in the Study Area is as high as 30% which can presumably be attributed to inadequate feed during the dry season. Using the grazing capacity of 0.5 heads/ha under the most severe conditions during the dry period as the criterion, the maximum cattle grazing limit for a total grassland area of 18,000 ha in the Study Area is approximately 9,000 heads. The estimated presence of some 17,000 heads (75% of the total number of cattle in the Study Area) in the Study Area appears fairly excessive from the viewpoint of a feasible production capacity of grassland.

⑤ Government Assistance

The authority supervising livestock production in East Nusa Tenggara Province provides a number of assistance measures. For example, extension workers who are assigned at a rate of one worker/2 - 3 desas provide technical assistance and guidance in such areas as (i) the planting of fodder grass and trees, (ii) the stockpiling of fodder in silos for the use of dry grass and stubble during the dry season, (iii) preventive injections to maintain health and (iv) artificial insemination for breeding, etc. for those cattle loaned to farmers by the government. In addition, stud bulls are also loaned for breeding.

The government loan of stud bulls involves upto 4 cows and one bull for a single household. After 5 - 6 years, the cattle are returned to the government in the form of calves at a rate of 2 calves for each cow and one calf for each bull. These calves are then used for new loans. Loans of 500 heads are planned for fiscal 1994/95. The total number of cattle on loan by the government in East Nusa Tenggara Province stands at 16,742 heads. The loan of live cattle, however, is restricted to those households engaged in well-controlled, intensive or semi-intensive grazing. Moreover, the loan requires sufficient planting of fodder trees (such as Turi) by the beneficiaries to secure enough fodder during the dry season.

While the loan system of the World Bank is similar to that of the government, the 6 kabupatens which are the subjects of the loans do not include Kab. Kupang. Furthermore, there is an entrusted raising scheme which is operated by the government through which farmers are entrusted to raise cattle for 6 months, taking a 70% portion of the increased weight at the end of this period (the government takes the remaining 30%). This scheme is operated in 3 kabupatens which do not include Kab. Kupang.

⑥ Future of Cattle Raising

As described so far, extensive cattle raising faces a number of problems, including low grassland productivity during the dry season, difficult health care of calves and difficult nutritional control throughout the raising period, all of which have resulted in the low productivity of this method. The excessive grazing and frequent burning to stimulate fodder growth have caused a deterioration of the grass growth and loss of the surface soil, necessitating the introduction of environmental conservation measures. It is, therefore, essential to firmly implement appropriate grazing control and fodder production measures throughout the Study Area. In particular, the strict control of indiscriminate grazing is urgently required as the sediment outflow resulting from indiscriminate grazing tends to cause a deterioration of both grassland and forest land.

(4) Land Use Plan

1) Land Use and Ownership Categories

While most land in the Study Area is, in principle, owned by the state, that land of which the use by individual persons or desa communities, etc. is permitted is

classified as private land in this study. Real private land with the land legally being owned by private individual seldom exists in the Study Area at present. In addition, there is also land which is part of a state forest but the use of which is permitted as farmer's land etc. This land is called an enclave. The land size data for these categories in the Study Area are 12,824 ha (38.6%) for state forests, 1,924 ha (5.8%) for enclaves and 18,432 ha (55.6%) for private land. While the realities of land use in the Study Area are already shown in Table II-8 based on the land use and vegetation map, the actual picture of land use by land ownership category is given in Appendix B-3.

2) Spatial Plan

Spatial plans in Indonesia are formulated at the provincial, kabupaten and kecamatan levels as long-term plans to form the basis for land use planning (see Appendix C-12). In East Nusa Tenggara Province the provincial Spatial Plan (Scale for plan map 1/250,000) was formulated in 1994 and the preparation of similar plans at the kabupaten level (scale for plan map: 1/100,000) is currently in progress.

Because of the small scale of the provincial plan map and its lack of conformity with the newly prepared topographical map (scale: 1/10,000) as part of the Study, it is admittedly risky in terms of accuracy to use the provincial plan to describe the future land use prospects in the Study Area, but general tendencies can be seen as shown in Fig. III-2 and Table III-8. The Study Area is, in fact, listed as one of the 15 priority areas in the province and comprehensive local development is planned with emphasis on farming, plantation, stock raising and tourism. Moreover, emphasis is also placed on the construction and rehabilitation of irrigation facilities and the necessity to control soil erosion and landslides. Also, some 20% of the Study Area has been classified as Reserved Area and, therefore, it is safe to assume that the provincial plan indicates the general direction for development.

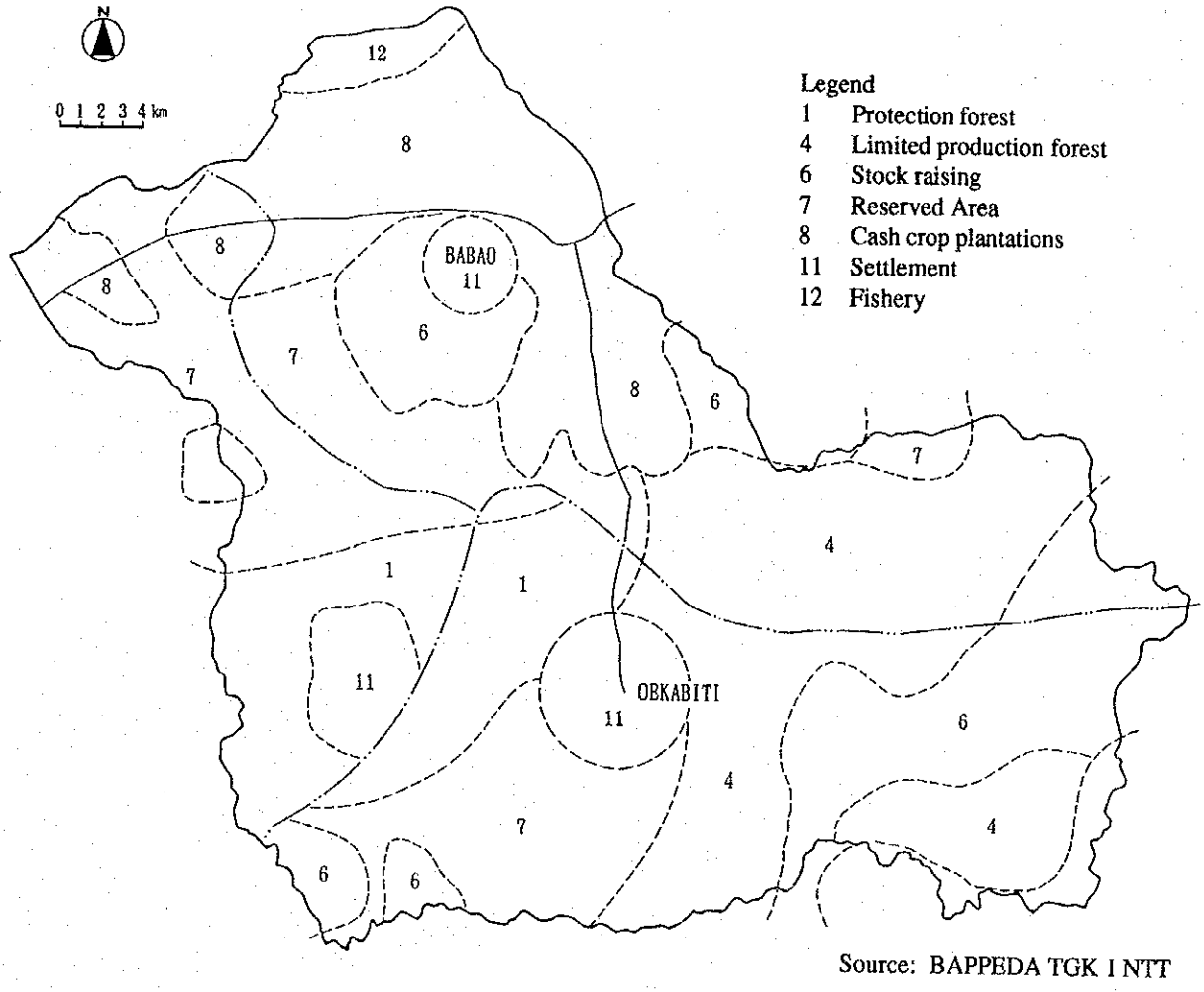


Fig. III-2 Spatial Plan Map of Study Area (with minor adjustments)

Table III-7 Planned Land Use Areas based on the spatial plan map in Study Area (Rough Estimate)

Land Use	Planned Area (ha)	Remarks
Protection Forest	4,200	
Limited Production Forest	7,850	
Stock Raising	5,800	Currently the designated areas contain paddy fields, settlements and others.
Reserved Area	7,000	This is an area where the land use is not yet clearly decided and is currently used as a settlement, paddy field, dry farming field or natural grassland, etc.
Cash Crop/Plantation	5,800	Currently this includes paddy fields and settlements, etc.
Settlements	2,100	Only settlements such as Babau, Oekabiti and Bokong are listed.
Fishery	430	
Total	33,180	

CHAPTER IV

FORESTRY

CHAPTER IV FORESTRY

IV-1 Outline of Forestry

(1) Forestry Policies and Forestry Development Programmes

In its 2nd Long-Term National Forestry Development Plan (1994 - 2018), the Government of Indonesia sets the overall target of creating forest resources capable of achieving the maximum performance of multiple functions and identifies such priority issues as (i) forest control and management in accordance with the land use types, including protection forests, production forests and nature reserves, (ii) fostering and recruitment of excellent manpower, (iii) establishment of a highly efficient management organization and (iv) introduction of advanced forestry techniques and technologies suitable for the local conditions.

Based on this long-term target, the 6th 5-Year National Development Plan which commenced in 1994 puts forward such administrative objectives as (i) consolidation of forest boundaries and land use classification, (ii) creation of new employment opportunities for people living near forests through the development of social forestry, (iii) realisation of sustainable forest management with emphasis on environmental conservation through the promotion of local communities and (iv) preservation and development of protection forests characterised by a high level of soil conservation and water preservation functions as listed in Table IV-1 and Table IV-2.

The deterioration and disappearance of forests are the result of slash-and-burn (shifting) cultivation, grazing and illegal felling, etc., causing nationwide concern in regard to soil erosion and flooding. These forest conditions have made the restoration of forest land productivity and reforestation particularly important and high priority is given to measures aimed at controlling soil erosion, improving the water yield and preventing floods. The situation is exactly the same in East Nusa Tenggara Province where the reforestation and restoration of various forest functions are considered priority issues.

Table IV-1 Main Programmes of 6th 5 Year National Development Plan

Title of Programme	Description
1. Forest Boundary Consolidation and Natural Forest Productivity Improvement	Consolidation of forest boundaries, improvement of natural forests, promotion of popular use of forestry by-products, promotion of participation of local inhabitants in forestry, development of sustainable forest management
2. New Forest Plantation Development	Establishment of seed and seedling centres, precise categorisation of soil and climatic conditions for reforestation, identification of non-productive land, creation of pilot reforestation sites
3. Forest Development	Strengthening of planning and implementation organizations for regional forest development, establishment of nurseries, training for forestry extension, financing of forestry funds, bee-keeping and natural sericulture, establishment of cinnamon nurseries
4. Forest Product Processing Development	Training for sericulture and honey processing, feasibility study on home industries using forestry by-products, production of local forest products, consolidation of sales facilities, provision of loans
5. Inventory and Evaluation of Natural Resources and Environment	Identification of natural resources and environmental factors, arrangement of data and mapping
6. Forest, Soil and Water Preservation	Establishment of conservation criteria for natural environment, evaluation of protected areas facing landslides and degradation, establishment of an ideal model, study and designation of national parks
7. Critical Land Rehabilitation	Reforestation of protection forests and nature conservation forests, regreening and soil conservation (including establishment of nurseries for regreening purposes, civil engineering work and further loans for highland agriculture) around forests, strengthening of biophysical and socioeconomic analysis of technologies, watershed conservation, establishment of a model pattern for rehabilitation projects
8. Coastal Area Development	Creation of mangrove forests, development of marine national parks, establishment of conservation projects for protected sea zones

Source: Ministry of Forestry: Draft Sixth Five-Year Forestry Development Plan (Material for National Meeting) March, 1994

Table IV-2 Supporting Programmes of 6th 5 Year National Development Plan

Title of Programme	Description
1. Spatial Programme	Coordination with spatial programmes of central, provincial and kabupaten governments for efficient land use
2. Agrarian Affairs	Clarification of legal backing for communal forests, solution for disputed land, clarification of conversion forest boundaries, clarification of legal backing for mangrove forests
3. Environmental Development and Management	Harmonisation between quarrying activities and living environment, training for forestry workers, implementation of projects which abide by laws and regulations relating to environmental conservation
4. Mobilisation and Guidance on Transmigration and Forest Encroachment	Identification of shifting cultivators and illegal forest invaders, confirmation and evaluation of destinations for transmigration, assistance for migrants' preparations
5. Tourism Development	Identification of tourism spots for enjoyment of natural environment, development of new tourism resorts and facilities to encourage tourism
6. Community Development (Promotion of Small Businesses)	Consolidation of data, provision of training and technological innovations for processing of rattan, leather/fur and forest by-products and their marketing in cooperation with NGOs
7. Forestry Research and Development/Applied Research	Development of applied technologies in such areas as machine processing of by-products, forest rehabilitation and forest improvement for soil conservation, etc.
8. Education and Training	Improvement of educational standards, training of government and non-government staff members and forestry high school teachers, consolidation of training organizations/centres
9. Control and Efficiency of Government Apparatus	Adoption of appropriate recruitment, work assessment, promotion and reward/punishment policies to improve work morale and quality of staff members, simplification of administrative procedures
10. Guidance and Education for Younger Generation	Education, guidance and displays on conservation of forests and natural environment, flora and fauna for younger generation
11. Promotion of Women's Roles	Encouragement of women to play an increasing role in protection and utilisation of forest resources through photograph displays, etc. and other methods

Source: Ministry of Forestry: Draft Sixth Five-Year Forestry Development Plan (Materials for National Meeting) March, 1994

As of 11th January, 1994, forestry administration is organised as shown in Fig. 4-1. Further, local administrative organisations may possibly be reorganised, along with the trend of decentralisation and the establishment of more effective management organisations.

(2) Forest Size and Forest Management Types

Forests in Indonesia are classified as nature protection forests, protection forests, production forests and conversion forests based on their functions. Nature protection forests provide habitat for rare flora and fauna and are very valuable tourism resources. Protection forests fulfil land conservation functions, including water preservation. Production forests are mainly used to produce timber and are further classified as either regular production forests or limited production forests. Conversion forests can be converted for different land use purposes, be it farmland or residential land. As far as forestry activities are concerned, felling is prohibited in both nature protection forests and protection forests. In the case of production forests, a combination of selective felling and natural regeneration is, in principle, employed for natural forests. In contrast, a combination of clear felling and afforestation is employed for man-made forests, afforestation sites on bare land or grassland and natural forests with low productivity (stand volume of less than 25 m^3 per ha). Those trees of which felling is permitted must have a minimum diameter of 50 cm and 60 cm in the case of a regular production forest and limited production forest respectively. Clear felling is employed at conversion forests.

The total size of forest zones in East Nusa Tenggara Province is approximately 1,689,000 ha, accounting for 35.6% of the province's total land area, while the total size of forest zones in Kab. Kupang of 243,114 ha accounts for 33.1% of the kabupaten's total land area. The ratio of forest zones in Kab. Kupang is, therefore, slightly lower than that in East Nusa Tenggara Province. In terms of forest functions in East Nusa Tenggara Province, protection forests have the largest combined area of 623,641 ha (36.9% of the province's total forest area), followed by limited production forests (330,280 ha, 19.5%) and regular production forests (230,198 ha, 13.6%). In the case of Kab. Kupang, protection forests have the largest combined area of 104,719 ha (43.1% of the kabupaten's total forest area), followed by limited production forests (55,906 ha, 23.0%) and regular production forests (48,824 ha, 20.1%). The total ratio of these three types of forests of 86% in Kab. Kupang is larger than the corresponding figure for the province as in the case of the ratio of each of these three types of forests (Table IV-3).

Forests in the Study Area consist of either protection forests or limited production forests and the total size of forests of 12,824 ha accounts for 38.6% of the Study Area's total land area, exceeding the corresponding figure for both East Nusa Tenggara Province and Kab. Kupang. A forest area is a classification category for national land to be managed as a forest for the purpose of national land conservation. As such, it does not mean that the entire zone is actually covered by forest vegetation. The real forest size in the Study Area, combining natural forests, secondary forests, bamboo grove, man-made forests and

lowland forests, is 2,336 ha, a mere 7.0% of the total land area. This is because many of the areas designated as forests have become grassland due to grazing and other causes.

As these forest areas are believed to be owned by the government and are controlled by the Ministry of Forestry, they are referred to as state forest land hereinafter for the purpose of convenience.

Various forestry projects are in progress in East Nusa Tenggara Province, including reforestation projects on state forest land, private forest development projects, model units for natural resources conservation projects, model units for settled agriculture promotion projects and regreening projects involving the construction of check dams, etc. in areas other than state forest land. Some of these projects are being conducted in the Study Area. While the timber produced in East Nusa Tenggara Province mainly consists of jati (teak), kayu merah and *shorea* spp., no timber production is conducted in the Study Area except on a very small scale for domestic consumption and other purposes. Because of the area's characteristics, forestry activities in the Study Area are mainly reforestation and regreening with emphasis on soil and water conservation. Industrial reforestation activities are also observed in some parts.

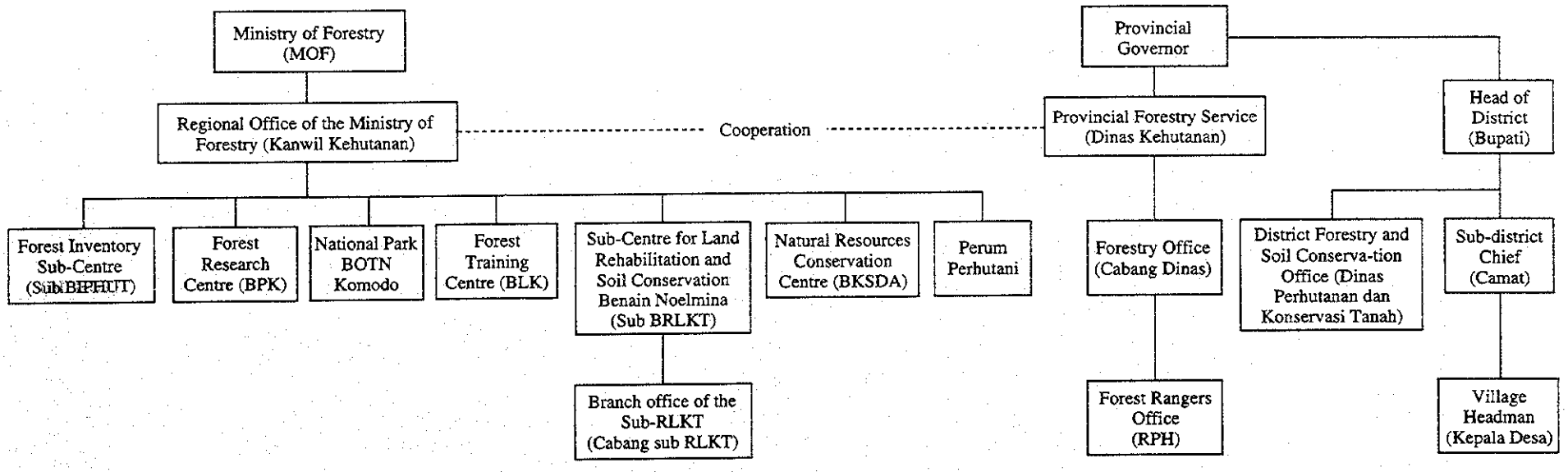
The administrative structure relating to forestry in East Nusa Tenggara Province as of January 11, 1994 is shown in Fig. IV-1. The local administrative structure may be subject to reorganization in the future due to the process of decentralisation and the move to establish an efficient control structure.

Table IV-3 Size of Forest Zones by Forest Function in Kab. Kupang and East Nusa Tenggara Province

(Unit: ha)

Item		Kab. Kupang	East Nusa Tenggara Province
Total Land Area		733,860	4,738,920
Forest Zone	Protection Forest	104,719	623,641
	Regular Production Forest	48,824	230,198
	Limited Production Forest	55,906	330,280
	Conversion Forest	3,000	172,679
	Nature Protection Forest	-	69,961
	Wild life Protection Forest	3,000	18,098
	Hunting Forest	-	595
	Resort Forest	783	14,783
	Reserved Area	26,882	229,188
	Total	243,114	1,689,423

Source: Statistik Kehutanan Propinsi Nusa Tenggara Timur, 1993/1994



Objectives, etc., of organisations

- Regional Office of the Ministry of Forestry (Kanwil Kehutanan):
  All planning and implementation coordination relating to forestry in the province.
- Provincial Forestry Service (Dinas Kehutanan):
  Under the direct jurisdiction of the provincial governor, and responsible for implementation and coordination.
- Forest Research Centre (BPK):
  In NTT province, research into sandalwood and social forestry is of particular interest.
- Forest Training Centre (BLK):
  Training is conducted within NTT province and in Bali, Nusa Tenggara Barat (NB) , South Sulawesi, and East Timur Provinces.
- Sub-Centre for Land Rehabilitation and Soil Conservation Benain Noelmina (Sub Balai RLKT Benain Noelmina):
  Within NTT province, the sub-centre, which has 12 branch offices under its jurisdiction, is responsible for the planning and evaluation of activities relating to soil and water conservation and rehabilitation of degraded lands, and is under the jurisdiction of the Representative Office of the Ministry of Forestry. In line with moves towards decentralisation, partial authority was delegated to the local areas (5th March, 1994), and in each district, departments of forest and soil conservation were created, with responsibility for forestry and regreening affairs.
- Forestry Office (CABANG Dinas):
  One Cabang Dinas exists in each district.
- Forest Rangers Office (RPH):
  One RPH office exists in each sub-district and is responsible for extension activities.
- Forest Inventory Centre (BIPHUT):
  Conducts forest inventory and mapping of forested areas.
- Sub-District Chief (Camat):
  Marks the end of the government chain of command. Below this person is the village headman, a public official.

Fig. IV-1 Organisational Chart of Forestry Administration

IV-2 Reforestation, Industrial Afforestation, Regreening and Nurseries

(1) Reforestation (Reboisasi)

Reforestation projects involve the actual planting of trees and the construction of infrastructure for planting, such as nurseries to supply seedlings, etc. The purposes of such projects include the rehabilitation of forests, creation of new employment opportunities for local inhabitants, mitigation of soil erosion, flood control and the conservation of natural resources in such areas as designated hazard zones in national forests, protection forests and forest reserves in important watersheds or selected sub-watersheds and abandoned former shifting cultivation sites, etc.

Table IV-4 shows the annual reforestation performance in East Nusa Tenggara Province and Kab. Kupang. The total reforestation area in the province fluctuated between 1,300 ha and 3,900 ha in the period between fiscal 1984 and fiscal 1989, increased to 5,000 ha in fiscal 1990, passed the 10,000 ha mark in the two consecutive years of fiscal 1991 (10,150 ha) and fiscal 1992 (14,162 ha) and then dropped to 8,000 ha in fiscal 1993.

In the case of Kab. Kupang, the total reforestation area in fiscal 1984 was 985 ha which then fluctuated between zero and 600 ha upto fiscal 1990, passed the 1,000 ha mark in the two consecutive years of fiscal 1991 (1,300 ha) and fiscal 1992 (1,500 ha) and dropped to 800 ha in fiscal 1993. In the 10 year period between fiscal 1984 and fiscal 1993, the ratio of the total reforestation area in Kab. Kupang in the total reforestation area in East Nusa Tenggara Province was 11.3%.

According to a survey conducted by the Kupang Forestry Office on reforestation sites in Kab. Kupang created in the period prior to the commencement of the 1st 5-Year Development Plan to the 5th 5-Year Development Plan, 3,027 ha of reforested land of the surveyed reforested land of 14,898 ha (20.3%) failed to achieve satisfactory results, mainly because of forest fires and damage caused by the grazing of livestock (Table IV-5). The species used for reforestation are mainly jati and johor (together accounting for some 70% of the reforestation areas, including those sites of mixed planting with other species). Other frequently planted species are *Acacia auriculiformis*, *Swietenia macrophylla* (mahoni), *Gmelina arborea* and *Aleurites moluccana* (kemiri). Small sites of *Eucalyptus urophylla*, *Ceiba pentandra* (kapok), *Santalum album* (cendana), and *Tamarindus indica* (asam) are also observed. *Acacia auriculiformis*, *Gmelina arborea* and *Ceiba pentandra* (kapok) are often planted together with other species. Fruit trees are also subject to mixed planting.

Table IV-4 Annual Reforestation Area in East Nusa Tenggara Province and Kab. Kupang

Fiscal Year	East Nusa Tenggara Province ①	Kab. Kupang ②	② / ①
1984	3,085 ha	985 ha	31.9%
1985	1,835	100	5.4
1986	2,516	200	7.9
1987	3,650	350	9.6
1988	3,900	-	0.0
1989	1,300	200	15.4
1990	5,000	600	12.0
1991	10,150	1,300	12.8
1992	14,162	1,500	10.6
1993	8,000	800	10.0
Total	53,598	6,035	11.3

Source: Adjusted from Statistik Kehutanan Propinsi Nusa Tenggara Timur 1988/89, 1989/90, 1990/91, 1991/92, 1992/93 and 1993/94

Table IV-5 Reforestation Performance in Kab. Kupang

Period	Planted Area	Good Result	Poor Result	Failure Ratio
Prior to 5-Year Plans	681 ha	681 ha	- ha	0.0%
1st 5-Year Plan (1969 - 1973)	359	349	10	2.8
2nd 5-Year Plan (1974 - 1978)	2,805	2,295	510	18.2
3rd 5-Year Plan (1979 - 1983)	5,313	4,070	1,243	23.4
4th 5-Year Plan (1984 - 1988)	1,300	1,078	222	17.1
5th 5-Year Plan (1989 - 1993)	4,440	3,398	1,042	23.5
Total	14,898	11,871	3,027	20.3

Source: Data Tanaman Reboisasi Sebelum Replita s/d Replita V Di Wilayah Kerja Cabang Dinas Kehutanan Kupang, 1994

Table IV-6 lists the actual reforestation activities completed in the period between fiscal 1984 and fiscal 1993 in the Study Area. A total of 800 ha of land was planted but the results for approximately 70% of this land were poor. The planted species were *Acacia auriculiformis*, *Cassia siamia* (johar), *Celba pentandra* (kapok), *Tectona grandis* (jati), *Aleurites moluccana* (kemiri) and *Anacardium occidentale* (jambu mente: cashew), etc. Successful reforestation sites in the Study Area are concentrated in the upper reaches of the Oesao Watershed at an elevation of some 400 m or higher. Many of the trees at other reforestation sites have died or have been destroyed by fire, necessitating repeated reforestation efforts.

Reforestation is conducted on the basis of either the tumpangsari or jalur system. The former is agroforestry with inter-cropping between the trees being permitted for the first 3 years after planting, removing the necessity for weeding during this period. The trees are planted in December at a planting distance of 2 m by 3 m in planting holes of 30 cm in width, 30 cm in length and 30 cm in depth. The crops for inter-cropping are maize, peanuts, kidney beans, dry field rice and cassava, etc.

The jalur system is employed in those places which are unsuitable for inter-cropping due to the high mixture of gravel in the soil. The land is prepared in a stripped fashion from the top of the slope downwards from June to November and holes of 30 cm in width, 30 cm in length and 30 cm in depth are dug. The most popular planting distance is 2 m by 3 m and planting is conducted in December. Strip weeding of a width of 1 m is conducted for the first 3 years in February.

The findings of the field survey on reforestation sites in the Study Area and its surrounding areas are given in Appendix D-1. Kec. Amarasi has reforestation sites of teak, johar, kemiri and mahoni, etc. One reforestation site is 15 - 100 ha in size with stand ages varying from 17 to 28 years. Prior to planting, these sites were grassland or shrub land. While the direct seeding method was used in the case of kemiri, seedlings were planted in the case of other species. The original planting distance was 2 m by 3 m for teak and johar, 3 m by 4 m for kemiri and 3 m by 1 m for mahoni. The tumpangsari system was employed at all the sites, involving maize, peanuts, kidney beans and/or cassava, etc. Supplementary planting was conducted once a year at all the sites for the first 2 years. The supplementary planting ratios were 20 - 40% for the first year and 10 - 35% for the second year. Weeding was also conducted once a year in March for the first 3 years. No thinning was conducted, following the common practice in East Nusa Tenggara Province.

An inventory was conducted at each of the reforestation sites by establishing rectangular survey plots of 40 m by 25 m. The findings in the case of a teak stand of 26 years of age

are an average tree height of 17 m, an average DBH of 32 cm and a standing tree density of 596 trees/ha. In the case of a teak stand of 17 years of age, the findings are an average tree height of 19 m, an average DBH of 25 cm and a standing tree density of 400 trees/ha, indicating possible growth gaps between the stands. A kemiri stand of 20 years of age shows an average tree height of 21 m, an average DBH of 32 cm and a standing tree density of 380 trees/ha. A 28 years of age johar stand shows an average tree height of 17 m, an average DBH of 16 cm and a standing tree density of 710 trees/ha while a mahoni stand of 22 years of age shows an average tree height of 17 m, an average DBH of 21 cm and a standing tree density of 1,310 trees/ha.

Table IV-6 State of Reforestation Activities in Study Area

Site Location			Planted Fiscal Year	Planted Area (ha)	Main Planted Species	Result	System
Kecamatan	Desa	Site					
Amarasi	Tesbatan	Oehara	1990	100	Johar, fruit trees	Poor	T
		Taenbira	1991	100	Johar, Mahoni, Kemiri, Gmelina arborea	Poor	T
	Nonbes	Oetium	1991	100	Johar, Mahoni, Kemiri, Gmelina arborea	Poor	J
			1992	200	Johar, Gmelina arborea	Poor	J
	Apren	Apren	1990	100	Johar, Mahoni, Gmelina arborea	Good	
Kupang Tengah	Oelpuah	Oelpuah	1992	100	Johar, Gmelina arborea	Good (54 ha)	T: 25% J: 75%
	Oelpuah	Nefosmeni	1993	100	Johar, Mahoni, Gmelina arborea	Good	T

Notes
1. Those listed are actual efforts made in the period between fiscal 1984 and fiscal 1993.
2. T: tumpangari system, J: Jalur system
Source: Sub Balai RLKT Benain Noelmina and Cabang Dinas Kehutanan Kupang

(2) Industrial Reforestation (Hutan Tanaman Industri: HTI)
(Renamed Social Forestry in Fiscal 1994)

Industrial reforestation has diverse objectives, including (i) a stable supply of crude wood from production forests for the timber industry, (ii) increase of government revenue, (iii) assistance for increased timber exports and timber supply to meet the domestic demand, (iv) promotion of regional development and economic growth, (v) increase of employment opportunities, (vi) promotion of the transfer of forestry technologies/techniques, (vii) increased energy supply for industrial and domestic use and (viii) improved harmony and balance with the natural environment.

Industrial reforestation (renamed Social Forestry in Fiscal 1994) commenced in East Nusa Tenggara Province in fiscal 1987 by the State Forestry Corporation (Perum Perhutani) and some 18,000 ha were covered by fiscal 1993 (Table IV-7). The main species planted are teak, mahoni, johar, *Pterocarpus indicus*, *Gmelina arborea*, *Eucalyptus urophylla*, *Enterolobium seclocarpum* (Sengon butto) and sandalwood. The normal planting distance is 3 m by 4 m with a planting hole size of 30 cm in width, length and depth. *Acacia catechu* and others are planted at a planting distance of 0.5 m by 0.5 m to grow as hedges.

Planting follows the tumpangsari system except in places which are unsuitable for farming. It is hoped that shifting cultivation will be replaced by permanent farming in the course of project implementation. Such seasonal crops as maize, dry field rice, peanuts and soybeans, etc. are cultivated between the lines of the main trees. In addition, Lamtoro spp. and turi, etc. are planted for fodder production, improved soil fertility and erosion control. The commercial crops planted along the block perimeters include such fruit trees as kemiri, *Syzygium jambos* and nangka. Turi, gamal and *Spondias pinnata* (Kedongdong), etc. are planted as stakes along the reforestation site perimeters.

Under an industrial reforestation project, the farmers receive fertiliser and the seeds of such fruit trees as mango, orange, coconut palm, nangka, kemiri, coffee and *Syzygium jambos*, such seasonal crops as maize, soybean, *Phaseolus radiatus* and medicinal herbs, such fodders as king grass and Lamtoro spp. and such hedge trees as kapok and gamal. The Perum Perhutani also conducts the construction of water tanks, wells and toilets, the repair of churches and other work to encourage the participation of local communities in the project.

An industrial reforestation project was implemented in the Study Area at shrub land of 245 ha located in Desa Fatuknutu in fiscal 1993. Of this subject land area of 245 ha, 177 ha were actually planted with *Gmelina arborea* (113 ha and 29 ha) and sandalwood (25 ha). Five hectares were used for experimental planting while the remaining 5 ha were earmarked as a provenance test site. The planting distance adopted was 3 m by 4 m. Pot-grown seedlings were used and the height of the seedlings (above ground height) at the time of planting was approximately 30 cm and approximately 40 cm in the case of *Gmelina arborea* and sandalwood respectively. The tumpangsari system was employed to mix the two main species with such fruit trees as nangka, mango and sukun and such trees as kemiri, Lamtoro spp. and turi. Maize, dry field rice, peanuts, soybeans and green gram were cultivated between the lines of fruit trees. The planting distance was 12 m by 12 m for fruit trees and kemiri. Lamtoro spp. was planted in a single line at 50 cm intervals. The fruit trees were fertilised using NPK at the rate of 3:3:1. The amount of

fertiliser used was 30 g/plant in the first year and 60 g/plant in the second year. Supplementary planting was conducted to replace 10% of the *Gmelina arborea* and 50% of the sandalwood trees which had died. No specific diseases or insect damage have been reported. A total of 170 farming households participated in this tumpangsari project. It is said that crop production will last for 3 - 5 years at the sandalwood site and 3 years at the *Gmelina arborea* site. The Perum Perhutani supplied the farmers with seedlings and seeds of the fruit trees free of charge together with maize and bean seeds which were provided once at no charge.

Table IV-7 Annual Planting Area by Species of Industrial Reforestation Scheme in East Nusa Tenggara Province

(Unit: ha)

Species	Fiscal Year							Total
	1987	1988	1989	1990	1991	1992	1993	
Teak	425	572	582	745	433	600	1,384	4,741
Sandalwood	-	49	20	20	100	100	138	427
Johar	-	204.5	234	993	987	1,100	866	4,384.5
Mahoni	-	323	162	200	184	200	88	1,157
Kayu merah	-	0.25	-	-	-	-	-	0.25
Eucalyptus utophylla	75	3.25	-	-	16	55	44	193.25
Experimental Planting/Agroforestry	-	-	1	10	5	5	6	27
Provenance Test	-	-	1	1	5	5	6	18
Gamal	-	-	-	20	258	530	-	808
Gmelina arborea	-	-	-	6	1,112	2,405	2,968	6,491
Total	500	1,152	1,000	1,995	3,100	5,000	5,500	18,247

(3) Regreening (Penghijauan)

Regreening projects involve the establishment of demonstration plots, private forests, check dams, gully control and nurseries in such areas as designated critical lands outside state forests and selected sub-watersheds in important watersheds. The purposes of regreening projects include improved commitment to the conservation of natural resources on the part of farmers, forest rehabilitation in hazard zones, improvement of soil fertility and soil productivity, increase of farmers' income, mitigation of soil erosion and flood control. Subsidies are provided along with official activities to achieve the stated purposes as an incentive for local inhabitants to participate in such projects.

Table IV-8 shows the major regreening projects implemented in East Nusa Tenggara Province and Kab. Kupang in the period between fiscal 1989 and fiscal 1993. The total area of regreening projects in East Nusa Tenggara Province in fiscal 1993 was 7,700 ha, an increase of 97.9% on the previous year, reaching the highest level since fiscal 1990. In comparison, the total area of regreening projects in Kab. Kupang in the same fiscal year was 400 ha, a decrease of 33.3% on the previous year. In the case of model units for natural resources conservation projects (UP-UPSAs) and model units for permanent settlement and farming projects (UP-UPMs), the total number in East Nusa Tenggara Province in fiscal 1993 dropped by 27 on the previous year to 77 sites. The corresponding number in Kab. Kupang also dropped by 10 to 6 in fiscal 1993. In the case of check dams, the number of sites in the province dropped by 4 on the previous year to 35 sites in fiscal 1993 while the corresponding number in Kab. Kupang also dropped by one on the previous year to 4 in fiscal 1993. The ratio of the regreening area in Kab. Kupang in the total regreening area in East Nusa Tenggara province was 9% for the creation of private forests, 12.1% for UP-UPSA and UP-UPM model units and 11.4% for the construction of check dams for the three year period between fiscal 1991 and fiscal 1993.

Various regreening projects involving demonstration plots, check dams, private forests and nurseries are in progress in the Study Area.

Table IV-8 Regreening Intensity by Year in East Nusa Tenggara Province and Kab. Kupang

Area		Unit	1989	1990	1991	1992	1993
① East Nusa Tenggara Province	Hutan Rakyat (Private Forest)	ha	n.a.	1,273	5,775	3,890	7,700
	UP-UPSA and UP-UPM	site	8	20	25	104	77
	Dam Pengendali (Check Dam)	site	n.a.	n.a.	31	39	35
② Kab. Kupang	Hutan Rakyat	ha	n.a.	100	570	600	400
	UP-UPSA and UP-UPM	site	2	3	3	16	6
	Dam Pengendali	site	n.a.	n.a.	3	5	4
②/①	Hutan Rakyat	%	-	7.9	9.9	15.4	5.2
	UP-UPSA and UP-UPM	%	25.0	15.0	12.0	15.4	7.8
	Dam Pengendali	%	-	-	9.7	12.8	11.4

Source: Adjusted from data found in Statistik Kehutanan Propinsi Nusa Tenggara Timur 1988/89, 1989/90, 1990/91, 1991/92, 1992/93 and 1993/94

1) Demonstration Plots

There are two categories of demonstration plots, i.e. model units for natural resources conservation projects (UP-UPSAs) and model units for permanent settlement and farming projects (UP-UPMs). The former (UP-UPSAs) demonstrate a farming method emphasising soil conservation and each unit involves 10 ha of land and 10 households. The latter (UP-UPMs) are designed to facilitate the permanent settlement of farmers engaged in shifting cultivation and each unit involves 20 ha of land and 20 households. The present conditions of the demonstration plots in the Study Area are shown in Table IV-9. There are 4 UP-UPSAs (40 ha) and one UP-UPM (19 ha).

A fact-finding survey was conducted on 3 UP-UPSAs in the Study Area and the findings are given in Appendix D-2. The project sites are all located on private land with a slope gradient of 2 - 20% and comprised grassland or shrub land prior to the project. The land area per site is 10 ha and the number of participating households per site ranges from 20 to 40. The distance from home to the site is within 1 km. The actual work involved varies from terracing, farming, the planting of trees, including fruit trees, and the construction of a workshop. In general, crops are grown between trees but no farming is conducted at sites with many stones and gravel. The crops commonly grown are maize, peanuts, kecang turis, green gram, pumpkins and cassava. Popular species for planting are gamal, turi, lamtoro, acacia, mahoni and teak, etc. The planting method used is line planting for the stump seedlings of gamal and for seeds of turi and lamtoro In the case of acacia, mahoni and teak, pot-grown seedlings are planted at intervals of 2 m by 3 m. Most of these have since died except the lamtoro and turi. Most of the fruit trees, such as tangerine, papaya, mango, nangka, avocado, banana, cashew and coconut palm planted at intervals of 5 m by 5 m or 5 m by 3 m have also died. The government has assisted the projects through the supply of fruit tree seedlings and seeds, crop seeds and fertiliser, etc. At the beginning of the projects, terracing work was conducted to create terraces (teras kredit, teras gulud) together with contour lines where some 30 cm high ridges of gravel and soil were made at 5 - 10 m intervals or stepped terraces (teras bangku) where 0.5 - 1.5 m tall steps were made at 5 - 10 m intervals. The line planting of gamal, turi and lamtoro was conducted immediately below each terrace while fruit trees were planted or crops grown on land between the terraces. While the teras bangku method was employed in East Nusa Tenggara Province before fiscal 1986/87, it is no longer used today because it tends to cause substantial soil erosion.

A fact-finding survey was also conducted at the sole UP-UPM model unit in the Study Area. The subject site is 19 ha of private land located in Desa Tesbatan in Kec. Amarasi and 40 households are participating in the project. Ridge-like terraces using gravel have been created at 10 m intervals and the line planting of lamtoro, gamal and turi, etc. is observed at 0.5 - 1 m intervals along the terraces. Cashew trees are planted at intervals of 7 m by 7 m between the terraces and such crops as maize and beans are also cultivated.

Table IV-9 Implementation of UP-UPSA and UP-UPM Model Units in Study Area

Location		UPSA or UPM	Fiscal Year	Area (ha)	Main Species Planted	Result
Kecamatan	Desa					
Kupang Timur	Tuatuka	UPSA	1987	10	Gamal, Lamtoro, etc.	Poor
Amarasi	Ponain	UPSA	1991	10	Jati, Kemiri, Nangka, Jambu mente, etc.	Good
	Tesbatan	UPM	1985	19	Lamtoro, Gamal, etc.	Good
	Nonbes	UPSA	1984	10	*Acacia auriculiformis*, Lamtoro, etc.	Poor
Kupang Tengah	Bokong	UPSA	1984	10	*Acacia auriculiformis*, Lamtoro, etc.	Poor

Note : UPSA - Natural Resources Conservation Project Model Unit
UPM - Permanent Settlement and Farming Project Model Unit
Source: Benain Noelmina sub RLKT

2) Check Dams

The check dams constructed in the Study Area are described in Chapter on Soil and Water Conservation.

3) Private Forests (Hutan Rakyat)

Private forest projects are regreening projects aimed at achieving soil conservation, improving soil fertility and providing new cash income opportunities for local farmers by means of planting trees and fruit trees on degraded land. The subject sites include slopes with a gradient of 40% or more, sites unsuitable for annual crops, abandoned sites and non-productive sites, water conservation areas incorporating fountains and ponds, landslide sites and shallow top soil sites. The main idea is to get those farmers owning small areas of private land together to create tree cover over a sizable area.

The state of implementation of private forest projects in the Study Area in the period between fiscal 1984 and fiscal 1992 is shown in table IV-10. Private forest projects

have been implemented at a total of 14 sites, totalling 625 ha, with the size of a single site ranging from 25 ha to 100 ha.

A fact-finding survey was conducted at 3 private forest sites in the Study Area and the findings are given in Appendix D-3. The year of project implementation at these 3 sites was fiscal 1989, fiscal 1991 and fiscal 1992. The size of the subject land varies from 25 ha to 50 ha with a slope gradient of 14 - 20%. The land was either owned by the desa or privately owned prior to project implementation. The distance from home to the site varies from 50 m to 4 km. In the case of the site being owned by the desa, the desa authorities have ownership rights to the planted trees. In the case of private land, the owner farmer also owns the trees. The observed planting methods are the mono-planting of teak at a planting distance of 3 m by 3 m and the mixed planting of teak and kemiri at a planting distance of 2 m by 3 m. In both cases, weeding was conducted once. While the pot-grown seedlings of teak were planted, the direct seeding method was employed for kemiri. All the planted trees at the fiscal 1989 project site have since died due to drought. Supplementary planting was conducted once at the other sites and maize, beans and cassava, etc. are cultivated as the undergrowth of the planted trees. The government provided project assistance in the form of tree seeds and seedlings.

4) Village Nurseries (Kebun Bibit Desa)

A village nursery project uses a minimum land area of 0.25 ha to grow those seedlings required for a regreening project to suit the local requirements. The seedlings for a private forest project or a demonstration plot project are supplied by a village nursery. This type of project is conducted by a farmers' group and lasts for one year although the group is allowed to maintain the nursery in subsequent years.

Table IV-10 Implementation of Private Forest Projects in Study Area

Location		Planting Year	Planted Area (ha)	Planted Species	Result
Kecamatan	Desa				
Kupang Timur	Merdeka	1986	75	n.a.	Poor
		1986	25	n.a.	Poor
	Oefafi	1986	50	n.a.	Poor
		1988	25	Jati, Mahoni	Partly lost due to fire
	Babau	1986	50	n.a.	Poor
Amarasi	Tesbatan	1986	50	n.a.	Poor
		1990	25	Johar, Jambu mente	Poor
		1991	25	Jati, Mahoni, Johar	Poor
		1992	50	Jati, Kemiri	Poor
	Kotabes	1990	25	Johar, Jambu mente	Poor
		1991	50	Jati, Jambu mente, Kemiri	Poor
		1992	100	Jati, Kemiri	Poor
	Nonbes	1992	25	Jati, Kemiri	Poor
Kupang Tengah	Bokong	1991	50	Jati, Kemiri, Jambu mente	Poor

Source: Benain Noelmina Sub RLKT

5) Fires at Planted Sites

Fires occur every year at some of the planted sites of reforestation and regreening projects, hindering the progress of these projects. Nevertheless, official data on fire damage is unavailable. The causes of fire are believed to be burning for grazing and slash-and-burn agriculture purposes and the throwing away of cigarettes.

The existence of burning in the Study Area was confirmed by the questionnaire survey. The most popular reasons for burning are "to clear the area for new land for cultivation", "it is a fast and economical method of weeding and clearing the land", "to provide young, new grass for grazing cattle" and "to improve the soil fertility". The burning season is from June to November and August, September and October are particularly popular months. It is conducted once a year, mainly on private land but also on land owned by public bodies.

6) Planting Problems

In general, the performance of reforestation and regreening projects has been poor, mainly because of fire, drought, damage by animals and inferior seedlings, etc. The severe dry season in the Study Area lasts for some 6 months, from May to October, and burning is widely conducted between June and November, resulting in adverse natural (drought) and social (burning) conditions for the planted trees. In fact, double damage to the planted trees during the single dry season is not unusual. As described earlier, fires at reforestation and regreening project sites can be mainly attributed to burning for grazing or farming purposes and other man-made causes. In particular, burning for grazing purposes appears to be the most damaging vis-a-vis the planted trees.

Some reforestation sites are protected by barbed wire fences to keep out grazing animals. However, many of these fences have been left unrepaired after being damaged by fire. Those which are undamaged are not strong enough to deter animals from entering the sites. The Study Team members witnessed goats entering the sites through openings in the fences.

The nurseries created for reforestation or regreening projects are often located under the cover of trees, hardening treatment is laking in the nurseries and daily watering until the day of planting makes them vulnerable to direct sunlight and the dry climate. Many of the poorly grown seedlings provided by nurseries have proven to be weak against drought and the level of sprouting following a fire is low. Pot-grown seedlings have been planted at many sites with holes at the bottom of the pot and the seedlings have not been removed from the pot, presumably hindering development of the root system.

An interview at the Forest Ranger Office (RPH Kupang Tengah) revealed that directly seeded trees had a better survival rate than pot-grown seedlings. The reasons for this can be assumed to be the weak resistance of pot-grown seedlings to strong sunlight and dry weather as mentioned earlier.

In contrast, industrial reforestation generally achieves better results than other types of reforestation work. This may be explained by the facts that the site usually enjoys excellent topographical and soil conditions, that maintenance is conducted by a full-time keeper (s), that the perimeter fence is much stronger to deter the possible invasion by animals and that such fire prevention facilities as fire-breaks and fire look-outs are established.

(4) Nurseries

A field survey was conducted to examine the conditions of village nurseries (KBD), nurseries run by the provincial forestry department and a nursery run by the Perum Perhutani located in the Study Area and its surrounding areas (Appendix D-4).

Two village nurseries were surveyed, one located in Desa Fatuteta which was established in fiscal 1990 and one located in Desa Tesbatan which was established in fiscal 1991. Each nursery has a land area of 0.5 ha and the land is owned by farmers. The production of seedlings lasted for one year and 10 - 12 workers were involved. Pot-grown and stump seedlings of teak, kemiri, cashew, gamal, mahoni, lamtoro, citrus fruit, nangka and mango trees, etc. were grown and were shipped to demonstration plots and private forest sites.

The two surveyed nurseries run by Dinas Kehutanan are located in Desa Fatuknutu (established in fiscal 1991) and Desa Oelpuah (established in fiscal 1993). Each nursery has a land area of 0.1 ha. The production of seedlings is continuing, using Desa land or government land. The pot-grown and stump seedlings produced are those of johar, mahoni and *Gmelina arborea*, etc. and are supplied for various reforestation projects.

The nursery run by the Perum Perhutani is located in Desa Fatuknutu (established in fiscal 1993) and has a land area of 1.5 ha. The land is owned by the government and the production of seedlings is continuing with 18 workers. The pot-grown and stump seedlings produced are those of sandalwood, teak, johar, *Gmelina arborea*, Sengon butto, cashew, kapok and kemiri, etc. and are supplied for industrial reforestation sites. The target production volumes for fiscal 1994 and the current number of seedlings growing at the site are given in Table IV-11, indicating an achievement rate of some 90%.

Also, Perum Perhutani has nurseries for the industrial reforestation of Nevoneak, in Kupang District, and is raising teak, mahoni, gmelina, sandalwood, *Acasia mangium*, etc.

Adjacent to the nursery at Nevonaek, is a 4 ha nursery, being constructed by Finland, a part of a Central Nursery Construction Plan. Under the plan, 8 central nurseries and 7 satellite nurseries will be constructed throughout Indonesia. At Nevoneak, seed beds, road construction, germinating rooms, water supply facilities, compost processing sites, administrative offices, training facilities, and guesthouses, etc., are planned.

Table IV-11 Seedling Production Targets and Current Number of Seedlings at Perum Perhutani Nursery Located in Desa Fatukanutu

(Unit: seedlings)

Species	Production Target	Number of Growing Seedlings
Sandalwood	20,356	19,351
Teak	722,296	651,929
Johar	87,661	86,134
Gmelina arborea	824,737	701,653
Sengon buto	2,945	2,945
Cashew	9,461	9,501
Kapok	1,527	1,527
Kemiri	4,943	4,960

IV-3 Social Forestry

(1) Principles of Social Forestry

Deterioration and the disappearance of forests has been taking place in the Study Area due to grazing, burning and the expansion of farmland under a semi-arid climate as described earlier, causing serious problems from the viewpoint of soil and water conservation in the relevant watersheds. This decline of forest resources has also caused a supply shortage of construction timber, firewood and agricultural timber for local use. While there is no doubt that forests play important roles in terms of improving the current situation, it is also essential that any effort to rehabilitate and/or conserve forests focuses on the lives and awareness of the local inhabitants so that they can voluntarily play a role of protecting the forests. In other words, forestry activities should be oriented to improving the lives of local inhabitants in addition to restoring forest functions. The concept of social forestry is a forestry activity, for example the planting of trees, which is, in principle, promoted with the participation of local inhabitants in the form of individuals, a group, settlement or desa and which aims at stabilising the lives and contributing to the welfare of local inhabitants.

In reality, social forestry takes various forms depending on the actual conditions of a country and/or local community. The traditional concept of community forestry is indeed a type of social forestry. Based on the understanding that local inhabitants living near a forest should conduct their own forestry activities to develop and maintain the forest in order to improve their own living conditions while enjoying its benefits, the Ministry of Forestry has established a committee with the participation of 7 other related ministries

and agencies and has been sponsoring various projects to promote social forestry. These projects have a wide scope, ranging from timber production to the production of various forest products, the growing of rattan, apiculture and sericulture. Social forestry is considered to be the main pillar of the 6th 5-Year Forestry Development Plan, the targets of which include the establishment of 830 local resident groups, the training of 4,800 group leaders, the promotion of apiculture and sericulture and the growing of cinnamon and rattan.

(2) Realities of Social Forestry

Most of the forestry activities in the Study Area are conducted based on the concept of social forestry. While agroforestry based on the tumpangsari system is widely practiced in state forests, industrial reforestation projects (renamed Social Forestry in Fiscal 1994) sometimes assist the refurbishment of churches, the drilling of wells and the distribution of cattle, etc. to gain the understanding, as well as cooperation, of local inhabitants vis-a-vis the projects. In some cases, kemiri, which is a popular species for planting among local inhabitants, is selected and those local inhabitants which have participated in the reforestation work are allowed to conduct farming between the lines of the planted trees and to harvest the fruit. In the case of private forest regreening projects, such popular species as jati and kemiri are often selected and those local inhabitants which have participated in the planting work are allowed to conduct farming between the lines of the planted trees and to harvest the fruit. In the case of demonstration plots on private land, agroforestry involving fodder trees and fruit trees is frequently observed. Despite the progress of these projects based on the concept of social forestry, it is still premature to say that social forestry is firmly rooted in the Study Area. A mixed garden, which is a common feature around the settlements in the Study Area, is a traditional form of agroforestry in the tropics, combining the planting of perennial trees and/or fruit trees with the cultivation of crops to stabilise the financial basis and to ensure soil conservation. This practice is well-developed in areas at a relatively advanced stage of agriculture in the Study Area.

The traditional farming method called the amarasi system is another traditional form of agroforestry. This method involves the alternate growing of lamtoro and crops. A stand of lamtoro spp, which are fodder trees, is regularly felled after 2 - 3 years and crops are cultivated in the cut-over areas. When the soil productivity deteriorates due to farming, lamtoro are again planted. This method was established after the introduction of lamtoro in the 1930's and, as well as crops, fruit trees or such forest trees as kemiri, jati and mahoni are occasionally planted.

Another form of agroforestry is silvopastoral which combines forestry and stock raising. In general, silvopastoral includes such activities as the creation of shelter woods on grassland, the creation of fodder forests to produce fodder, the creation of hedges using fodder trees to act as perimeter fencing and the use of plants growing on forest land, etc. These variations of agroforestry are not practiced in the Study Area except in partial form. As stock raising has important implications in the Study Area as a local industry and also from the viewpoint of environmental conservation, the urgent development of the practice of silvopastoral is deemed necessary through the creation of grassland improvement and woodland pasture.

(3) Awareness of Social Forestry Among Local Inhabitants

Excluding shrub land with such fodder trees as lamtoro and others, some 50 ha of Jati have been planted at the initiative of local inhabitants in the Study Area. Most of the planting was conducted some time ago and sites of recent planting are few. Almost all the owners intend to replant after felling in the future, indicating their satisfaction of having forest land as a substantial asset and their awareness of the importance of forestry. However, the findings of the Local Inhabitants Survey suggest that the level of awareness of the importance of forestry, as well as planting, as a first step is generally low, presumably because they lack sufficient land, enough money and time for forestry. Among those people living in the upper reaches where there is more forest land than in other areas, the learning of forestry techniques is a more popular reason than an increased crop production volume due to the tumpangsari system or increased cash income for participation in government-run forest restoration projects and others, indicating willingness on the part of those living in the upper reaches to learn more about forests and forestry in preparation for their own forestry activities in the future when the conditions are ripe. Among those people living in the lower reaches, an improved crop production volume using tumpangsari method is the most popular reason. Some of the local inhabitants stated that the heavy physical work involved in a reforestation or regreening project is the reason for their non-participation.

(4) Selection of Species

Regardless of the type of forest to be developed the selection of appropriate species vis-a-vis the subject site is essential to ensure successful growth and to avoid adverse impacts on the local ecosystem. In the case of social forestry, the wishes of local inhabitants must also be met.

1) Timber Trees and Firewood Trees

Suitable species for timber production in the Study Area are jati (teak) and mahoni. These species have long produced housing timber, the reliability of which is well established. Kesambi, generally regarded as an ideal material for the production of charcoal, should in fact have a long felling period and because of its hardness is used for various wood working. Kesambi is used in East Java as the host for insects to obtain insect gall which is used as a raw material for paint. In view of the possibility of Kesambi producing forestry by-products in the future, it is preferable to plant this species on a trial basis using the results of Kesambi plantings in other parts of Indonesia despite the fact that no artificial planting of Kesambi has ever been conducted in the Study Area. Species used as fodder trees or soil improving trees are used to obtain firewood.

2) Fodder Trees and Soil Improving Trees

Locally established fodder trees or soil improving trees with fast growth in the Study Area include the Hawaian variety of lamtoro, turi and gamal. It is necessary to plant a mixture of 2 - 3 species instead of a single species in view of the likely damage caused by jumping lice.

3) Cash Crops

Kemiri produces oil from its fruit which is used as a raw material for varnish, candles, soap and cosmetics. Due to its high economic value, Kemiri is the source of great expectations on the part of local inhabitants. Jambu mente (cashew) is promoted as a horticultural crop by the competent agency which provides seedlings as well as subsidising the planting cost. Jambu mente was planted in the Study Area on 50 ha of land in Desa Oelpuah in fiscal 1994 and small plots are also observed in other villages. The competent agency bases its recommendation of the favourable performance of a jambu mente forest which was developed 33 years ago near a suburb of Kupang and which continues to produce a good yield today. While it is difficult to use a jambu mente forest for multiple purposes, including the introduction of crop cultivation between the trees, the fact that a jambu mente forest can produce a profit roughly rivalling that of paddy rice cultivation without much labour except the initial planting is attracting the attention of local inhabitants.

4) Aromatic Trees

Sandalwood is an aromatic trees which is the native of Timor Island and its resources today are scarce due to its export over many years. Efforts have been

made to develop reliable planting techniques and experimental plots with a size of approximately 100 ha have been tried with little success. Given the fact that some local inhabitants have successfully planted sandalwood, it may be an idea to create small experimental plots around dry farming fields located in relatively cool areas to find suitable sites.

5) Useful Species for Apiculture

The collection of natural honey in Kec. Amarasi yielded 20 litres in fiscal 1989, followed by a gradual increase to 80 litres in fiscal 1993. This probably reflects the increase of kemiri and coffee trees in addition to the traditional coconut palm plantations. Due to the prospect of the increased planting of kemiri and fruit trees as well as the cultivation of leguminous grass at grassland, apiculture, which provides a more stable supply of honey than reliance on the collection of natural honey, may be considered a promising venture.

IV-4 Forest Protection

(1) Diseases and Insect Damage

In 1930, *Leucaena leucocephala* (lamtoro) was planted in Sikka and Amarasi areas in East Nusa Tenggara Province. In Amarasi area, it was intended to prevent the spread of the weed *Lantana camara* which is detrimental to stock raising and planting was also widely conducted in the Study Area.

In 1986, however, East Nusa Tenggara Province experienced an onslaught by (jumping lice) *Heteropsylla cubana* which caused extensive damage to lamtoro. By the end of August, 1986, the estimated area of damage has reached some 50% of the lamtoro planted area. This in turn has caused a decline of the stock and crop production. For example, the number of cattle raised annually per household has declined from 5 - 7 heads in the pre-disaster period to 2 - 3 heads. The rearing period has also lengthened. Several measures have been adopted in the fight against jumping lice, including the trimming and burning of branches, both ground and aerial spraying of insecticide and the introduction of a natural enemy.

The attack by jumping lice had almost ceased by the end of 1992 and no major damage has since been reported although farmers say that minor damage to lamtoro is still occasionally occurring during the rainy season. At present, the introduction of a lamtoro variety with a high resistance to jumping lice and mixed planting with other fodder trees are in progress.

(2) Fire Prevention Facilities

According to the Dinas Kehutanan, the main fire-fighting facility in the Study Area is 20 m wide fire-break constructed in man-made forests. The combustible grass and plants growing in this area are cut during the dry season every year. The Dinas Kehutanan employs inspectors (pengawas) to prevent forest fires, illegal grazing and illegal cutting. If a fire breaks out in a national forest area, the KRPH (Kepala Resort Polici Hutan: Forest Ranger Office) in the kecamatan concerned is informed by an inspector. Assisted by the kecamatan authorities, the KRPH mobilises the local inhabitants and the fire is extinguished using spades and cut branches, etc. In addition to the above, Perum Perhutani has the following facilities at its industrial reforestation sites.

① Each planting block has a 5 - 10 m wide fire-break. Combustible grass, etc. is removed at the beginning of the dry season.

② Each planting block of some 400 - 500 ha has a fire look-out with communication facilities. There is a total of 21 fire look-outs in East Nusa Tenggara Province. Organizations concerned are informed of the outbreak of a fire by the watchmen which are posted at these look-outs.

③ A portable fire extinguisher is provided for each 200 ha of planting land.

VI-5 Forest Roads

There is a one km-long 3m wide forest road constructed by Dinas Kehutanan in the Study Area which was manually constructed at a reforestation site (100 ha) at Desa Tesbatan in the Oesao East Working Area in fiscal 1991. The surface is covered by a 20 cm thickness of stones and gravel and the road has 50 cm wide and 30 cm deep drainage ditches. No surface erosion is observed. In addition to this forest road, there are two types of forest roads serving the industrial reforestation conducted by the Perum Perhutani.

① Spur roads (jalan pemeriksaan) : 2.5 m wide, located at reforestation sites and regularly repaired

② Access roads (jalan cabang) : 3 m wide, linking reforestation sites with trunk roads and regularly repaired

Both road types are manually constructed before the start of the rainy season so that they can also be used as fire-breaks. The total length of completed access roads to industrial reforestation sites in the Study Area is only several hundred meters.