IV-6 Forest Products

(1) Timber Production

1) General Conditions

The sawn timber production volumes for Kec. Kupang Tengah, Kec. Kupang Timur and Kec. Amarasi for the five year period between fiscal 1989 and fiscal 1993 are given in Table IV-12. Kec. Amarasi produced the largest volume of sawn timber of these three kecamatans and its total sawn timber production volume consisting of various species increased from 28 m^3 in fiscal 1989 to 75 m^3 in fiscal 1993. In the case of Kec. Kupang Timur, the increased volume of 32 m^3 in fiscal 1990 from 18 m^3 in fiscal 1989 continuously dropped thereafter to 29 m^3 in fiscal 1992. In fiscal 1993, however, the production recovered to 75 m^3. No sawn timber production was recorded for Kec. Kupang Tengah in this five year period. As such, timber production in these areas cannot be said to be active.

Table IV-13 shows the production volumes of sandalwood for these three kecamatans. Sandalwood is, in fact, produced in Kec. Kupang Timur and Kec. Amarasi. The former's production volume increased from 3,000 kg in fiscal 1989 to 13,425 kg in fiscal 1992, dropping to zero in fiscal 1993. In Kec. Amarasi, the production volume has continuously declined from 7,298 kg in fiscal 1989 to zero in fiscal 1993.

The number of surviving sandalwood trees in the three kecamatans is 6,472, consisting of 1,418 mature trees and 5,054 young trees. 2,303 trees are located in state forests while 4,169 trees are located outside state forests. Kec. Amarasi tops the league with 3,433 trees, followed by Kec. Kupang Timur (1,933 trees) and Kec. Kupang Tengah (1,106 trees) (Appendix D-5). Many trees classified as mature trees are, in fact, not very mature as the diameter of approximately 10 cm falls short of the felling criterion of 25 cm. As a result, there is little prospect of renewed production for some time to come.

Table IV-12 Sawn timber Production in Kec. Kupang Tengah, Kec. Kupang Timur and Kec. Amarasi

(Unit: m^3)

Fiscal Year	Kecamatan	Total Volume	Teak	Kayu Merah
1989	Kupang Tengah	-	-	-
	Kupang Timur	18	3	-
	Amarasi	28	1	-
1990	Kupang Tengah	-	-	-
	Kupang Timur	32	3	-
	Amarasi	63	-	-
1991	Kupang Tengah	-	-	-
	Kupang Timur	30	1	-
	Amarasi	68	3	-
1992	Kupang Tengah	-	-	-
	Kupang Timur	29	2	-
	Amarasi	52	5	-
1993	Kupang Tengah	-	-	-
	Kupang Timur	36	5	2
	Amarasi	75	9	-

Source: Cabang Dinas Kehutanan Kupang

Table IV-13 Sandalwood production in Kec. Kupang Tengah, Kec. Kupang Timur and Kec. Amarasi

(Unit: kg)

Kecamatan	1989	1990	1991	1992	1993
Kupang Tengah	-	-	-	-	-
Kupang Timur	3,000	5,420	10,445	13,425	-
Amarasi	7,298	6,788	4,690	1,096	-

Source: Cabang Dinas Kehutanan Kupang

2) Firewood and Charcoal Wood

The findings of the Local Inhabitants Survey on the question of firewood and charcoal wood are described below.

① Most households use firewood for cooking purposes and the species supplying firewood include kesambi, acacia spp., lamtoro, jati and various palm trees. Firewood collection may be as often as daily (37% of the respondents) or every 2 days (27%). 50% of the respondents stated that they collect firewood from far places. The reality of firewood collection (frequency per week, place and distance) for each watershed is given in Table IV-14 (only the top answers are included for the place of collection and distance).

Some 75% of the respondents currently find it more difficult to collect wood compared to the situation several years ago. The perceived causes of this growing difficulty are burning, shifting cultivation and climatic conditions, all of which degradate the forest and land conditions. A large majority (78%) of the respondents believe that the collection of wood will become more difficult in the near future.

Table IV-14 Collection of Wood/Firewood

Area	Frequency/Week		Distance		Type of Popular Site
	1 - 4 Times	5 Times - Daily	Opinion	Average	
Oebelo-Olio Watershed					
Upper Reaches	56%	44%	Far (77%)	2.8 km	Private Land (92%) Public Land (27%)
Middle Reaches	58%	42%	No Far/Far (28%)	2.1 km	Private Land (90%) Public Land (46%)
Lower Reaches	39%	61%	Far (53%)	2.2 km	Private Land (64%) Public Land (58%)
Oesao Watershed					
Upper Reaches	76%	27%	Far (45%)	3.0 km	Private Land (92%) State Forest Land (23%)
Middle Reaches	49%	52%	Far (45%)	2.1 km	Private Land (83%) Public Land (37%)
Lower Reaches	87%	11%	Far (49%)	3.3 km	Private Land (73%) Public Land (53%)

Notes

1) Surveyed Persons
Oebelo and Olio Watersheds: 48 for the upper reaches, 50 for the middle reaches and 118 for the lower reaches.
Oesao Watershed: 103 for the upper reaches, 86 for the middle reaches and 97 for the lower reaches.

2) The percentages are calculated vis-a-vis the total number of those interviewed in each watershed.

② Most of the respondents stated that the planting of trees may improve the situation but show little commitment to the planting of trees except lamtoro. This passive attitude can largely be explained by the lack of suitable planting sites due to the facts that privately owned farmland which is used as the main planting site lacks sufficient room for planting and that the species to be planted on public land cannot be decided even though the collection of wood is permitted.

③ The demand for firewood in the Study Area is estimated to be some 30,000 m^3/year (approximately 5 m^3/year per household) unless the level of dependence of wood as a fuel changes. Although this demand level is sustainable if some 6,000 ha of shrub land and sparse forests of palm trees, etc. do not rapidly disappear, the inhabitants of some areas expect that the firewood collection situation will become even more severe in the form of longer distances, etc. Feasible measures to improve the situation include the planting of such fodder trees as lamtoro nearer homes, the use of shrub branches which have so far been ignored and the joint production of firewood in state forests. In the case of the joint production of firewood, the lending of chainsaws should be considered in exceptional cases.

3) Demand for Housing (Construction) Timber

The average house maintenance and repair cost of the 62 people answering the relevant question in the Local Inhabitants Survey is 512,000 Rp. The work itself is presumably conducted by the house owner with the assistance of relatives and others and the purchase of timber is believed to account for approximately 95% of the cost. (The remainder is probably used for the purchase of cement to construct the foundations.) The average cost of standard construction timber is 5,000 Rp/battan (200 cm × 10 cm × 10 cm) and some 100 battans are required to construct a house. For the entire Study Area, an annual supply of some 3,000 m^3 of construction timber appears necessary. As many people are appealing for an adequate supply of construction timber, the restoration of forests is essential to enable the local supply of timber from state forests in the Study Area.

(2) Non-Timber Forest Products

The production volumes of non-timber forest products for the three kecamatans for the five year period between fiscal 1989 and fiscal 1993 show that neither Kec. Kupang Tengah nor Kec. Kupang Timur recorded any production of such items. Kec. Amarasi apparently produced tamarind, kemiri fruit and honey. The production of tamarind in

Kec. Amarasi of a record level of 12.5 tons in fiscal 1991 appeared rather unsteady as it dropped to zero in fiscal 1993. In contrast, the production volumes of kemiri fruit and honey showed steady increases from 3 tons and 20 litres respectively in fiscal 1989 to 12.4 tons and 80 litres respectively in fiscal 1993.

IV-7 Extension

(1) Extension Activities

The extension activities related to and guidance on reforestation, regreening, social forestry and soil and water conservation in the Study Area are conducted by 11 forestry extension workers (3 in Kec. Kupang Timur, 5 in Kec. Amarasi and 3 in Kec. Kupang Tengah) who are assigned to either the local offices of the Benain Noelmina Sub RLKT to conduct soil and water conservation work or the local forestry offices of the Dinas Kehutanan (Provincial Forestry Department) to conduct reforestation and regreening work.

As forestry extension work is often closely related to agricultural and stock raising activities, the forestry extension workers often work jointly with agricultural extension workers (14 in the three kecamatans) and stock raising extension workers (18 in the three kecamatans).

The main extension activities currently practiced are the management of village nurseries, guidance on nursery techniques, the supervision of and guidance on reforestation and regreening work and the promotion of technical understanding among local inhabitants. To be more precise, forestry extension workers are engaged in the management of demonstration plots, the provision of concrete guidance to promote agroforestry and to create private forests and public relations activities to enlighten the public on the importance of forests, forestry and soil and water conservation projects, etc. In addition, they provide local inhabitants with assistance to solve problems. Forestry extension workers act as a link between the local community and the provincial or kabupaten authorities for the introduction of official policies, new subsidy systems and new techniques, etc. via local leaders. At the same time, they also act as a channel to convey the opinions of local communities, as well as leaders, to the authorities.

(2) Extension Activities and Local Inhabitants

Local inhabitants generally understand the importance of forests and show much interest in the planting of trees. In areas with much gravel and shallow soil, people strongly feel the need for soil and water conservation and, therefore, many participate in government-

run demonstration plots and/or reforestation projects for the purpose of learning forestry techniques. Presumably because of both financial and time limitations, many of them stop short of planting trees themselves or are satisfied with the use of elementary techniques. In general, local inhabitants are afraid of taking risks and tend to have a passive attitude towards new ideas. Group leaders are believed to be quite influential in guiding local inhabitants in a particular direction. It is, therefore, desirable to emphasise extension work and training aimed at these leaders.

(3) Group Activities

The most popular type of group activity in the Study Area is apparently religious-based, followed by village meetings, family education and family planning. Production-related groups or those based on a local initiative include farmers' groups, KUDs (agricultural cooperatives) and weaving groups. In some cases, the same group is engaged in several different activities. Joint cultivation by group members to help repair a church and the creation of a mutual financing group (arisan) by a weaving group are cases in point. Activities related to forest products, such as group planting, often originate from other activities. There are examples of joint engagement by the same groups in water management and farming in the upper reaches, particularly in the Oebelo Watershed. In other areas, people generally participate in "gotong royong" (a traditional system of mutual assistance) and these goton royong groups appear to organise planting as part of their activities.

Although a clear cut distinction is difficult to establish, certain group production activities can be roughly associated with certain family members. To be more precise, the participation rate of husbands is high in the case of farmers' groups activities while the participation rate of wives is high in the case of weaving (tenun ikat) and other domestic life-related activities. As the participation of women is essential to vitalise and ensure the long life of any group activity, it is hoped that they will join in production-related group activities.

The size of a farmers' group appears to be an average of some 20 members in the Oesao Watershed although the existence of farmers' groups with a membership of several hundred is indicated in the middle and lower reaches of the Oebelo Watershed. The size of a mutual financing group (artisan) or weaving group (tenun ikat) is approximately 10 - 20 members.

In regard to the motivation for joining a group, many people state the necessity to share a common understanding with other members and to enjoy the benefits of more economical and faster joint work. In short, the farmers appear to make a spontaneous

decision to participate in various activities rather than being motivated by such direct external benefits as government assistance and subsidies. As the final decisions on group activities are made by the majority or by unanimous agreement, the decision-making process appears to be in the hands of the members rather than the leaders. Some 50% of the respondents are of the opinion that group activities are well managed and coordinated. Some of the respondents replied negatively with a shortage of funds being the most frequently given reason.

(4) Education and Training

As described earlier, the education and training of local inhabitants are conducted through extension activities in the form of on-site explanatory project meetings and village meetings, etc. More advanced and comprehensive education and training are systematically conducted at special training facilities.

The Kupang Forestry Training Centre located in Kupang acts as a forestry education and training facility for East Nusa Tinggara Province and 2 other provinces lying to the east of West Nusa Tinggara Province. It not only trains senior staff members but also provides 20 different education and training courses (in fiscal 1993) for extension workers and local inhabitants, particularly leaders. Of these training courses, those relating to reforestation, etc. are listed below.

① Nursery and Reforestation Techniques (for forestry staff members, such as extension workers; 35 provincial staff members on the course)

② Agroforestry Techniques (as above; 14 provincial staff members on the course)

③ Forest Survey, Geographical Survey and Drawing (as above; 23 provincial staff members on the course)

④ Nursery practices for Industrial Reforestation (HTI) (for local inhabitants; 25 people on the course)

⑤ Forest Conservation (as above; 31 people on the course)

⑥ Planting Techniques (as above; 26 people on the course)

One of the important objectives of education and training is to give the trainees the ability to accurately teach what they have learnt to others who have not received the same education and training. Some 200 local inhabitants receive education and training every year and the number is approximately 90 for 12 kabupatens in East Nusa Tenggara Province. The training period is rather short (5 - 10 days) and attendance is arranged via an extension worker under the control of the Centre. The cost of education and training is fully met by the central government

CHAPTER V

WATERSHED CONSERVATION

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V-1 Hydrological Conditions

The discharge of Oesao River in the Study Area is observed in several locations by the Proyek Pengembangan Data Sumber Air-NTT, Kanwil PU. Table V-1 shows the flow regime of Oesao River based on 1993 data of the Fatuteta Station. The specific discharge means the mean discharge per unit area in a watershed and is used to compare the discharge volumes of different watersheds with different land areas. The low figure recorded for Oesao River indicates a relatively large watershed area and a low mean discharge. Attention must be paid to the fact that the value of specific discharge can be affected by the state of land cover and other factors. The hydrograph for the Fatuteta Station is shown in Fig. V-1.

Table V-1 Flow Regime Characteristics of Oesao River

Observation Station	Upstream Catchment Area (km^2)	Specific Discharge (ℓ/sec/km^2)	Q. Max (m^3/sec)	Q. Min (m^3/sec)	Q. Mean (m^3/sec)	Annual Discharge ($x10^6m^3$)
Fatuteta (Automatic Water Level Recorder)	137.5	2.88	25.1	0.00	0.40	12.5

Source: Formulated using 1993 data provided by Proyek Pengenbangan Data Sumber Air-NTT, Kanwil PU

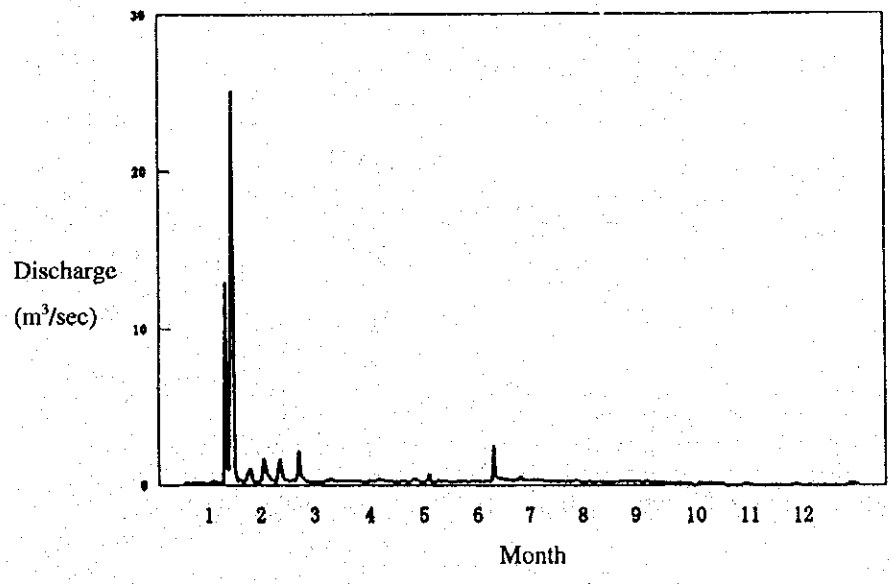


Fig. V-1 Hydrograph of Oesao River (Fatuteta Station: 1993)

In terms of the monthly discharge, January is the highest month, followed by February and then March. The discharge from mid-March to December is extremely low, indicating the long dry season. The high discharge recorded in June, 1993 was caused by torrential rain from the 15th to the 18th of the same month and should not be regarded as the normal state of river flow in the Study Area.

As the discharge is not observed at either Oebelo River or Olio River, the minimum flow was measured by the Study Team in November, 1994. The measured values were 0.04 m^3/sec for Oebelo River (some 500 m upstream of the Noelbaki intake weir) and 0.002 m^3/sec for Olio River at Bihonis in Desa Kotabes.

V-2 Water Resources and Water Utilisation

(1) Surface Water

1) River Water

Rivers in the Study Area are the main sources of irrigation water for farm lands and paddy fields. The competent provincial and kabupaten authorities in charge of irrigation have constructed a total of 9 (including those which are of a temporary nature) intake weirs in the Oesao Watershed and one each in the Oebelo Watershed and Olio Watershed. The irrigation areas supported by these 11 intake weirs which are located on flat land in the lower reaches are shown in Table V-2.

Table V-2 Irrigation Areas Supported by Intake Weirs in Study Area and its Vicinity

Watershed	No. of Intake Weirs	Irrigation Area (ha)		
		Technical Irrigation	Semi-Technical Irrigation	Traditional Irrigation
Oesao	9	-	1,458	-
Olio	1	-	-	222
Oebelo	1	-	285	-

Note: Technical Irrigation : water distribution is measured and controlled
Semi-Technical Irrigation : no measurement or control of the water distribution is conducted
Traditional Irrigation : direct use of river water (excluding paddy fields using rain water)
Sources: Sub-Dinas Pengairan, PU NTT, 1994 and Pengairan PU Kabupaten Kupang, 1994

2) Rain Water

Desa Tunbaun in the Study Area has 86 sites where rain water is stored for domestic use. These facilities have been constructed by a NGO since 1989. Rain water falling on the tin roof of a house during the rainy season is directed to a concrete water tank

(maximum storage capacity of 6.5 m^3) for its domestic use in the dry season together with well water.

3) Small Ponds (Dam Embung) and Earth Check Dams (Dam Pengendali)

The competent authority in charge of irrigation at the kabupaten level constructs embung for supplying local inhabitants with drinking water (main purpose), supply drinking water for animals and water for small domestic gardens. In the Study Area, one embung has been constructed in Desa Babau in F/Y 1990/1991 to supply water for 246 households (5 - 6 members/household). A dam site is usually selected in an area of clayey soil because of its relatively low permeability level and mechanical compaction work is conducted to further consolidate the dam body as well as the bottom of the reservoir. The water stored by the embung in November, 1994 (the month in which the lowest level of water storage is usually recorded) was estimated at the 51% level of the full capacity. "The Study on the Embung Development Project in East Nusa Tenggara and West Nusa Tenggara in The Republic of Indonesia" by JICA is in progress and embungs Oeltua and Bimoku under the study are located outside but close to the western border of the Study Area.

The main purpose of dam pengendali is to control sediment loss while also supplying drinking water for local inhabitants as well as domestic animals. The construction of dam pengendali is planned by the Sub-Balai RLKT and the actual construction is conducted by the kabupaten authority. These dams are manually constructed and no mechanical compaction is conducted. Dam pengendali are observed at 13 sites in the Study Area. When visited during the dry season, 9 were found to have dried up due to the high evaporation and seepage. The specifications and other details of embung and dam pengendali are given in Appendix E-1, E-2.

(2) Groundwater

1) Wells

Wells in the Study Area are classified as shallow wells and deep wells with a depth of 20 m comprising the dividing line. Shallow wells are mainly jointly dug by local inhabitants and are used to provide water for domestic purposes as well as for small domestic gardens in some cases. In general, one shallow well is shared by 6 - 15 households (5 - 6 family members each). The actual well depth considerably varies. According to the survey conducted in August, 1994 on 7 wells, the well depth ranged from 6 - 20 m. The local inhabitants testified that the water table drops by 1 - 2 m towards the end of the dry season.

Deep wells are constructed under the Groundwater Development Project implemented by an organization attached to the Ministry of Public Works. Most deep wells in the Study Area are found on flat land in the northern part. According to information provided by the provincial government, boring to a depth of 30 - 80 m was conducted at 20 sites in 6 desas (Noelbaki, Oebelo, Merdeka, Babau, Oesao and Tuapukan) from 1983 to 1991. Three sites produce salty water while 4 sites produce nothing or very little water. The flow rate at the remaining 13 sites ranges from a minimum of 0.2 litres/sec to a maximum of 41 litres/sec. The water is used for domestic and irrigation purposes. Provincial government data puts the irrigated area using water from deep wells in the Study Area at approximately 90 ha in 1994. Moreover, wells were constructed at 13 villages on the Oesao Plain, including at 5 villages in the Study Area, between 1992 and 1994 under the OECF's Small-Scale Irrigation Project to supply irrigation water for 600 ha of farmland.

2) Fountain Water and Ponds Created by Seepage River Water

Fountain water seldom dries up during the dry season, provides a source of the river's baseflow and is used for domestic water, drinking water for domestic animals and irrigation water. In this sense, fountain water is one of the most important water resources in the Study Area. For example, organizations related to the Ministry of Public Works and NGOs supply fountain water for domestic use and small domestic gardens via pipes using the gravity method. At Desa Oenoni, the Ministry has been supplying fountain water since 1989 to 3 dusuns out of 6 for domestic use. Solar cells are used to generate electricity to supply the water through pipes. In those villages where no water pipelines have been laid, the villagers are seen carrying the water from fountains in buckets. The observation results on the flow rate of fountain water by the Field Survey Team at 7 sites in November and December, 1994 show a large gap of between less than 1 litre/sec and 15 litres/sec depending on the actual fountain size.

In the dry season, fountain water in the upper reaches flows into a river to form the baseflow, infiltrates the ground through the riverbed with high permeability to form the sub-surface flow and frequently springs out several hundred meters downstream to create small ponds. Many such small ponds are found in the lower reaches of Oebelo River and Olio River. At several sites of alluvial deposits in the lower reaches of Obelo River, local inhabitants pump the water from the small ponds for irrigation purposes. According to the survey on these ponds conducted at the end of the dry season (8 sites, November and December, 1994), the stored water volume ranges from a low of 17 m^3 to a high of 644 m^3 with an average of 140 m^3.

V-3 Current Conditions of Degradation

(1) Hillside Degradation

1) Surface Erosion

In the case of open grassland, grassland with scattered trees and shrub and bush land, the loss of vegetation cover due to over-grazing and burning in the dry season lead to the creation of bare land in many places. With the commencement of the rainy season, under-storey vegetation begins to emerge to rehabilitate the land cover to a certain extent. However, strong rains in the area (reaching a maximum daily rainfall of 140 mm) can cause serious surface erosion, particularly at slopes. Grazing on steep slopes tends to create permanent animal paths and the surface soil of these paths is compacted and in some cases soil structure is destroyed. Small collapses tend to occur on the slopes at these sites, from which surface erosion and rill erosion start. At Dusun Oesu in Desa Tuapukan and Oeteum in Desa Nonbes, such mini landslides have occurred at slopes with a gradient of 25% or more. The scale of these mini landslides varies from 6 cm to 160 cm in width and from 30 cm to 230 cm in length.

The traditional farming system called the Amarasi Agroforestry System with the planting of lamtoro spp. is often observed at mixed gardens and dry crop fields. From October to November, lamtoro and other trees and plants are cut down and burning is conducted as land preparation for farming. Such crops as maize and cassava are then planted in lines (with a gap of some 50 cm between the lines) just before the beginning of the rainy season. The crops are harvested in March or April and, in the meantime, lamtoro, etc. is removed two or three times. At land where agroforestry is conducted, especially at steep slopes, surface erosion is likely to be caused by strong rain in the rainy season which lasts until March or April. The gradient of such areas, as measured in 5 locations in the Study Area, ranged from 15 to 30% (Appendix E-3).

2) Landslides

Landslides mainly occur at steep slopes in the upper reaches of Oebelo River and Olio River in the western part of the Study Area. In general, these sites consist of shale and marlstone. Some of the landslides are approximately 10 years old and revival of the vegetation can sometimes be observed. Five fairly large landslide sites were selected for the survey and the results are given in Appendix E-4. According to local inhabitants, the landslides in question caused damage to domestic animals, particularly to cattle and horses on the grazing land.

3) Gully Erosion

Gully erosion is observed at several sites in the Study Area. However, the site with a significant gully erosion is located in Naben of Desa Oelpuah where the farming of some 70 ha of land in the upper section of the area has been rendered impossible due to the severity of such erosion. At the same time, gully erosion is also threatening some 120 ha of rain fed paddy fields and the road passing through Desa Oelpuah, necessitating the introduction of soil conservation measures. The current conditions of this gully erosion are given in Appendix E-5.

(2) Bank Erosion

Bank erosion is widely observed in the Study Area along Oebelo River, Olio River, Oesao River and their tributaries. The distribution of the bank erosion sites was confirmed by aerial photograph interpretation (photo scale: 1/25,000) and field reconnaissance survey and the sites were divided into two groups, i.e. those with such conservation objects as mixed gardens, paddy fields and roads, etc. requiring direct protection in the vicinity and those with no direct conservation objects in the vicinity. The length of bank erosion at each site was estimated on the topographical map (scale: 1/10,000) and the findings are given in Appendix E-6. The total length of bank erosion sites on both banks accounts for 37% of the total length of the main channel and its tributaries for Oebelo River, 28% for Olio River and 22% for Oesao River. Bank erosion is generally said to be affected by the state of vegetation in the watershed, particularly vegetation along the river course, and the degree of torrent devastation. The low level of bank erosion of Oesao River appears to vindicate this general theory as the main channel and tributaries are lined with richer vegetation which is responsible for the lesser torrent devastation than Oebelo River and Olio River.

(3) Stream Erosion

The state of erosion was surveyed for the three main rivers and their tributaries and the findings are given in Appendix E-7. In general, few deposits of unstable sediment are observed. In contrast, bank erosion is rather noticeable in the Oebelo and Olio Watersheds. The water forming the baseflow is mainly transparent but the water forming small ponds in the river channel is mainly brown. According to local inhabitants, the storm flow during the rainy season is mainly muddy, presumably the result of soil erosion due to strong rain.

V-4 Soil Loss

(1) Soil Loss Measurement and Prediction Methods

Several methods have been suggested to estimate the volume of soil loss due to surface erosion in a watershed. It is necessary to select the most appropriate method based on the study objectives, data accuracy, related data availability, survey cost and survey period, etc. For the present Study, the method used is prediction of the soil loss in the Study Area by mainly measuring the sedimentation volume at check dams, taking the availability of related data and study period into consideration (Appendix E-8).

In fact, while the erosion Pins and Nails and Washers Method was used to measure and predict the soil loss, gathering of sufficiently reliable data was difficult due to the short survey period. The total volume of soil loss in the Study Area is, therefore, estimated by adding the soil loss due to gully erosion and river bank erosion, both of which are separately estimated, to the soil loss due to surface erosion.

(2) Sedimentation at Check Dams

The sediment resulting from soil erosion at hillsides in a watershed is partially deposited around such obstructions as stones and plants on the slopes and at sites of changing gradient while the rest is deposited in a river or dam reservoir (if there is a dam). In short, the amount of soil loss is the total sediment deposited on slopes and sediment deposited in a river or dam reservoir, etc. The ratio of sediment discharged to and deposited in a river or dam reservoir is calculated in the form of the sediment delivery ratio (SDR) which is said to be determined by such factors as the catchment basin area, the state of vegetation etc. in the watershed.

The following table gives the SDR calculation result for the four working areas in the Study Area based on the following formula (FAO Conservation Guide: Guidelines for Watershed Management, 1977, pages 53 - 79).

$$SDR = 36A^{-0.20*}$$

where, A: land area (km^2)

* The exponent in the formula to calculate the SDR based on the catchment area size. In general, the value is between -0.15 and -0.35, but that values cluster strongly around -0.20 over a wide range of watershed size.

Working Area	Land Area (km^2)	SDR (%)
Oesao East	106.60	14.15
Oesao West	96.32	14.44
Olio	45.12	16.80
Oebelo	83.76	14.85

The ratio of eroded soil on a slope (ESS) is given by subtracting the SDR from the total soil loss (100%).

$$ESS\ (\%) = 100\% - SDR\ (\%)$$

In order to estimate the actual soil loss in the Study Area, the deposited sediment was measured at 11 of the existing dam Pengendali from among the 13 dam Pengendali and one embung. Using the average sedimentation depth and the sedimentation area size at each check dam site located in the four working areas, the sedimentation volume was calculated. The sedimentation volume of the check dams in each working area was considered to represent the SDR ratio for that working area (classification of the Study Area into Working Areas is mentioned in Table VI-2 of Chapter VI). Based on the sedimentation volume for each check dam reservoir, the annual mean sedimentation volume of each dam and the annual sedimentation volume per ha were calculated. The volume of the remaining eroded soil on a slope was calculated by multiplying the sedimentation volume of each dam by the value of the ESS for the working area in which the dam in question is located and dividing the multiplication result by the SDR value for the same working area.

(3) Soil Loss by Working Area

1) Soil Loss by Surface Erosion

Using the sedimentation volumes for the check dams and slopes in the catchment area (as given in Appendix E-9), the annual soil loss by check dam as well as by per ha in each of the working areas was calculated as shown in Table V-3. It was assumed that the average annual soil loss per ha in each working area would be obtained by dividing the total volume of soil loss in a given working area by the number of check dams in the same working area. The results are given in Table V-4.

Table V-3 Soil Loss Caused by Surface Erosion by Check Dam and Working Area

Working Area	Check Dam No.	Reservoir Sedimentation Volume (tons/ha/year)	Slope Sedimentation Volume (tons/ha/year)	Total Soil Loss (tons/ha/year)
Oesao East	1	1.0	6.1	7.1
	2	2.2	13.3	15.5
	3	3.5	21.2	24.7
	4	0.4	2.4	2.8
	Total	7.1	43.0	50.1
Oesao West	5	5.0	29.6	34.6
	6	8.1	48.0	56.1
	9	2.7	16.0	18.7
	Total	15.8	93.6	109.4
Olio	11	8.1	40.1	48.2
	12	5.0	25.0	30.0
	Total	13.1	65.1	78.2
Oebelo	13	2.8	16.0	18.8
	14	3.1	17.8	20.9
	Total	5.9	33.8	39.7

Table V-4 Average Soil Loss from Surface Erosion by Working Area

Working Area	No. of Check Dams	Annual Soil Loss (tons/ha/year)	Average Soil Loss (tons/ha/year)
Oesao East	4	50.1	12.53
Oesao West	3	109.4	36.50
Olio	2	78.2	39.10
Oebelo	2	39.7	19.85

2) Soil Loss by Gully Erosion

As already described, major gully erosion is taking place at Naben in Desa Oelpuah in the Oebelo Working Area. The volume of sediment loss is estimated to be 123,000 m^3 and gully erosion is active at some 70% of the total length. According to local inhabitants this gully erosion was first noticed in the mid-1960's. Assuming that the gully erosion in question has been continuing for 30 years, the annual sediment loss is 2,870 m^3 (3,329 tons) which means that the annual sediment loss per ha in the Oebelo Working Area is 0.4 tons.

3) Soil Loss by Bank Erosion

Bank erosion is widely occurring in the Study Area along Oebelo River, Olio River, Oesao River and their tributaries. Based on the field survey findings, it is assumed that in one year bank erosion is taking place along some 20% of the entire length of the bank erosion sites. The average height and depth of the bank erosion are estimated at 2.5 m and 1.0 m respectively. Table V-5 shows the annual soil loss per ha due to bank erosion in each working area.

Table V-5 Soil Loss by Bank Erosion in Each Working Area

Working Area	Soil Loss		Annual Soil Loss (tons/year)	Annual Average Soil Loss in Each Working Area (tons/ha/year)
	(m^3)	(tons)		
Oesao East	7,500	8,700	1,740	0.2
Oesao West	43,750	50,750	10,150	1.1
Olio	26,250	30,450	6,090	1.3
Oebelo	42,000	48,720	9,744	1.2

Note: ① The weight of the soil loss (tons) is obtained by multiplying the volume (m^3) by bulk density of 1.16 for alluvial soil.
② For river bank erosion length refer to Appendix E-6.

4) Gross Soil Loss by Working Area

The gross soil loss is the sum of all types of soil loss occurring in a watershed. Soil loss in the Study Area is caused by surface erosion, landslides, gully erosion and bank erosion. It is difficult to estimate the annual soil loss at former landslide sites as many sites have been invaded by vegetation in the post-landslide years with the result of a certain amount of land stabilisation and also because the time of landslide occurrence is not clear at some sites. Table V-6 shows the soil loss by type of soil erosion and watershed in the Study Area. Based on average soil loss data, the situation appears particularly serious in the Olio and Oesao West Working Areas, presumably because of the vegetation (forest and others) conditions and topographical conditions in the Study Area. In the case of the Oesao East Working Area where the soil loss is relatively low, the forest ratio and ratio of steep slopes (25° or more) are approximately 14% and 25% respectively. The average of corresponding figures for the Oesao West Working Area and Olio Working Area with much soil erosion are around 2% and 36%.

Table V-6 Average Soil Loss by Type of Soil Erosion and Working Area and Gross Soil Loss

Working Area	Average Soil Loss (tons/ha/year)			Average Soil Loss (tons/ha/year)	Gross Soil Loss (tons/year)
	Surface Erosion	Gully Erosion	Bank Erosion		
Oesao East	12.53	-	0.2	12.7	135,000
Oesao West	36.50	-	1.1	37.6	362,000
Olio	39.10	-	1.3	40.4	182,000
Oebelo	19.85	0.4	1.2	21.4	179,000
Total	-	-	-	-	858,000

V-5 Existing Soil and Water Conservation Facilities

(1) Earth Check Dams (Dam Pengendali)

As part of the Regreening Programme, earth check dams are mainly constructed to control sedimentation. The purposes of check dams also include the supply of drinking water for local inhabitants and domestic animals and diffusion of the practice of soil and water conservation among the local community. A check dam construction project is planned by the Sub-Balai RLKT and the check dam is manually constructed by the competent office of the kabupaten. There are a total of 13 check dam sites in the Study Area (Appendix E-1). The Sub-Balai RLKT and Cabang RLKT adopt the following implementation criteria for an earth check dam (dam pengendali).

- The subject earth check dam should be constructed on private land outside a state forest (diluar kawasan hutan).
- Application for the construction of an earth check dam should be made by local inhabitants via an extension worker.
- The earth check dam should be constructed by local inhabitants based on the SWAKELOLA (self-management or community construction of public buildings) method.
- The subject earth check dam site must have a high level of soil erosion.
- The soil type of the proposed check dam site should be clay.
- The maximum and minimum catchment areas of the subject earth check dam shall be 250 ha and 150 ha respectively while the maximum area of the reservoir shall be 2.5 ha. The earth check dam height shall be between 6 m and 8 m.

After its construction, the kabupaten authorities hand the check dam over to the village authorities and the villagers are subsequently responsible for the management and maintenance of the dam.

(2) Gabions

A gabion is a wire mesh basket filled with stones and is used to control bank erosion, riverbed erosion and flooding. In the Study Area and its vicinity, typical examples of gabions are found both downstream and upstream of the Oebelo Bridge on the state road which are used to prevent bank erosion and riverbed erosion and along the left bank of Manikin River at Desa Tarus (located near the western boundary of the Study Area) which are used for flood control. The latter boast an approximate height and length of 8 m and 100 m respectively. Gabions are also found along Oebelo River, Oesao River and their tributaries. All these gabions were constructed by the Ministry of Public Works-related organizations and are generally in good condition even though the repair of broken mesh is required at some sites.

(3) Traditional Terracing System

Traditional terraces in the Study Area are often observed with mixed gardens around houses, particularly in Kec. Amarasi. These are basically constructed by family labour with no significant investment and appear to be suited to the local conditions to control soil erosion. The traditional terraces can be classified into two types in regard to their effectiveness in preventing soil erosion.

The structure of the Type A traditional terrace is rather simple. Stones are laid in single to triple file to a height of 35 - 50 cm above the ground and a width of 30 - 40 cm along the contour lines to create a 3 - 7 m wide terrace. (The actual terrace width varies depending on the gradient). Turi, Lamtoro spp., fruit trees and other trees are planted on the terrace at regular intervals with maize, cassava, beans and vegetables, etc. planted between the trees immediately before the start of the rainy season. The planting of grass and lamtoro, etc. immediately above or below the stone lines is seldom observed in the case of this type of terrace. Due to the relatively wide space between the stones laid along the contour lines, there is a likelihood of soil and/or water flowing out between these stones at the time of heavy rain, even to the point of breaking the stone wall.

In the case of the Type B traditional terrace, while the stone line height, terrace width and crops grown on the terrace, etc. are practically the same as those of a Type A terrace, it differs in that thick, parallel double lines of stones and gravel are constructed along the contour lines with soil filling the 20 - 30 cm opening between the stone lines. King grass

and lamtoro spp., etc. are planted above and below the stone lines at some 1 m intervals to reinforce the stone lines. Because of the narrower gap between the stones, eroded soil tends to be deposited inside the stone lines. In short, the Type B terrace appears to be more efficient in terms of soil erosion control than the Type A terrace.

(4) Soil Conservation Demonstration Plots of Regreening Programme

The UP-UPSA demonstration plots, established to diffuse the soil conservation-oriented farming method among farmers through the Regreening Programme, employ terracing for farming purposes. In principle, various types of terraces are constructed to suit four slope gradient categories of 0 - 8%, 8 - 15%, 15 - 25% and 25 - 45%. In some cases, both terracing and planting are conducted. Only planting is conducted for slopes of 45% or more. At a plot in Desa Ponain, Kec. Amarasi in the Study Area, stones are laid to a width of 30 - 35 cm and a height of 45 - 50 cm, creating terraces with a width of 3 - 5 m. Below the lines of stones, king grass or Lamtoro spp. is planted to provide fodder (the planting distance for Lamtoro spp. is 2 m by 2 m). Such useful trees as turi and orange are planted at 5 m intervals on the actual terraces with maize, cassava, beans and vegetables being cultivated between the trees.

The UP-UPM demonstration plots also comprise part of the Regreening Programme and are introduced to show and diffuse appropriate soil conservation and farming methods on relatively gentle slopes (0 - 25%) to facilitate the permanent settlement of farmers engaged in slash-and-burn agriculture. On sloping sections (2 - 5%), 10 - 12 m terraces are constructed using branches of Lamtoro spp. and turi as well as soil along the contour lines with ditches of 0.5 m in depth and 1 m in width to store rain water.

V-6 Past Disasters and Statutory Regulations

Two sediment disasters have occurred in the Study Area and its vicinity in the last 5 years (1990 - 1994) (Appndix E-10). Flooding has occurred at relatively flat land in the lower reaches, causing damage to farmland and houses, etc. No statutory regulations applicable to watershed conservation exist in the Study Area except those addressing protection forests.

CHAPTER VI

BASIC FRAMEWORK

CHAPTER VI BASIC FRAMEWORK

VI-1 Basic Principles

As described earlier, the soil productivity in the Study Area is generally poor and inappropriate land use, particularly in the form of grazing and slash-and-burn agriculture, has deteriorated the forest land, causing serious concern in regard to the further degradation of the soil productivity of farmland, as well as grassland, and also undesirable sedimentation and flooding in the lower reaches. Given the low income level, especially of farming households, in the Study Area, improvement of the standard of living through the promotion of local industries is highly desirable.

The formulation of a land rehabilitation plan designed to promote rational land use which is appropriate vis-a-vis the local characteristics is necessary to prevent the further degradation of the land and to promote socioeconomic development in the Study Area.

(1) Land Rehabilitation Plan and Land Use

1) In planning the land rehabilitation plan, land use improvement criteria will be determined for soil and water conservation in the Study Area, taking the zoning for national land conservation purposes, site classification to judge suitable land use, current land use conditions of the Study Area and opinions of local farmers, etc. into consideration. These criteria will then be used to formulate the said project which will reflect the local reality.

2) While it is desirable to control soil loss in the Study Area as much as possible, a realistic soil loss control target under the project will be established through examination of the possible cost and likely impacts of soil loss control measures on agriculture and stock raising, etc.

3) Surface erosion, the largest source of soil loss, will be addressed by such vegetative measures as reforestation, farmland improvement and grassland improvement together with civil engineering measures, including the creation or rehabilitation of terraces. Soil loss in streams will be dealt with by such civil engineering measures as earth check dams, small check dams, gully plugs and revetment works and also by the planting of trees on banks.

4) Forests in the Study Area have been extensively lost with the remaining forests accounting for only 7% of the total land area. Despite the overwhelming urgency to restore forests, the land rehabilitation plan will pay careful attention to the

prospective use of local land as farmland or grassland. In practice, forest use will be given the highest priority in protection zones and the intensity of land use for forests will be gradually lowered in buffer zones and further lowered in cultivation zones with a corresponding increase of the farming use of the land.

5) In those areas designated for farmland improvement, agroforestry practices, such as the cultivation of mixed gardens, will be actively encouraged to facilitate soil conservation and stable farming management.

6) Given the relative importance of stock raising in the Study Area, silvo-pastoral with the planting of grazing grasses and fodder trees, etc. will be employed to proceed with grassland improvement in order to increase the stock raising capacity in the Study Area with a view to mitigating the adverse impacts of reforestation on stock raising. Silvo-pastoral will also be actively employed in reforestation work to create fodder forests to increase fodder production. All these measures also aim at improving the practice of stock raising which has been partly responsible for the degradation of forests.

   With regard to the necessity to prevent forest fires caused by the practice of burning grassland, wide-ranging public awareness activities will be conducted together with more direct measures, such as the construction of fire-breaks and fire look-outs and the procurement of communication and fire-fighting equipment.

7) The seedlings required for the project will be supplied by the state nursery which is currently under construction by the assitance of Finland at a site adjacent to the Study Area. However, some of the fruit tree and fodder tree seedlings which are in strong demand by local inhabitants will be supplied by the village nurseries scattered around the Study Area. These village nurseries will act as the bases for planting.

8) The project details will be in line with the contents of the existing spatial plan for the Study Area.

(2) Local Development and Participation of Local Inhabitants

1) The land rehabilitation plan aims at achieving not only land rehabilitation, i.e. forest restoration, but also local development and improvement of the local standard of living. It must, therefore, be prepared from a long-term perspective. The plan's implementation with the active participation of local inhabitants from the viewpoint of diffusing the practice of social forestry is essential. It is also important to clearly

present the roles and benefits, etc. for local inhabitants and villages participating in the Plan prior to the Plan's implementation, particularly in state forests.

2) Local inhabitants do not yet appear to fully understand the importance of soil conservation and land rehabilitation. The land rehabilitation plan will clearly present incentives vis-a-vis local inhabitants. In addition, education and training on social forestry and soil conservation will be actively provided for extension workers and local inhabitants in addition to the new recruitment of extension workers to alleviate their shortage and the procurement of extension equipment. For these purposes, training facilities and demonstration plots will be established in view of systematic training.

3) The group activities of local inhabitants will be actively encouraged by means of promoting the establishment of groups, training of leaders and participation of women, etc. Close liaison with local NGOs should also be sought in this context.

4) The road conditions in the Study Area cannot be said to be excellent, hindering the transportation of agricultural products and transport access to local markets. The construction of new roads will be promoted to improve the village infrastructure in areas with an under-developed transport network. In addition, repair work will be conducted for poorly maintained existing roads which are causing soil loss.

5) The drilling of wells for drinking water and the creation of hedges, etc. will be planned as environmental conservation measures at a village level. Infiltration wells will also be planned to replenish the groundwater.

6) From the viewpoint of promoting local industries, the introduction of fruit trees, aromatic trees and apiculture, etc. will be considered.

7) In preparing the plan details, priority will be given to those technologies which are well established in the Study Area and readily accepted by local inhabitants. Efforts will also be made to procure as much labour, materials and equipment as possible locally. During the project implementation process, special care will be taken to coordinate with farming work, particularly to avoid competition for labour during the busy farming season.

(3) Consideration of Environmental Impacts

1) In order to implement the land rehabilitation plan with due consideration of the natural and socioeconomic environments of the Study Area, the local environmental conditions will be surveyed and the possible environmental impacts of the contents

of the project will be forecast and evaluated together with examination of the environmental issues to be addressed in the project's planning process.

2) The plan contents will favour environmental conservation and will also contribute to the development of the local socioeconomy as the project intends to increase opportunities for local inhabitants to improve their lives.

3) During the project implementation process, not only the environmental impacts but also all components of the plan will be monitored to evaluate the plan in order to identify problems and measures to solve them in view of modification of the plan contents for continual plan implementation.

(4) Consolidation of Plan Implementation System

1) As the role to be played by local inhabitants will increase at the plan implementation stage, the plan implementation system will emphasise the participation of local inhabitants in the project.

2) As the Study Area stretches over 3 kecamatans and involves a number of local administrative organizations, including those of the Ministry of Forestry, the project implementation system must be planned to ensure smooth coordination between different organizations and offices.

3) A plan management centre will be established in the Study Area to supervise the implementation, coordination and evaluation of the plan, to liaise with related organizations, to conduct both training and awareness activities for local inhabitants and to provide displays and guidance for the improvement of local life.

4) For the convenience of plan implementation, the Study Area will be divided into 4 working areas based on the local characteristics.

5) Although the early completion of the plan is highly desirable due to its urgency, a project period of 10 years is planned in view of the total volume of the required work, the likely efficiency of the project implementation system and the present conditions of the communal activities of local inhabitants, etc.

VI-2 Classification of Working Areas

For the convenience of project implementation, the Study Area is divided into four working areas, i.e. Oesao East, Oesao West, Olio and Oebelo, based on the catchment area, topographical conditions and area size (Fig. VI-1).

(1) The Oesao East Working Area

The Oesao East Working Area has a land area of 10,660 ha, consisting of 5,636 ha of state forest land, 1,144 ha of enclave and 3,880 ha of private land. According to the forestry zone map of the Kupang Forestry Office (scale: 1/100,000), state forest land in the Oesao East Working Area is categorised as limited production forest. In terms of the gradient class, 0 - 8% accounts for the largest area of 4,612 ha, followed by 8 - 15% (3,340 ha) and 15 - 25% (1,696 ha) with respective ratios of 43.3%, 31.3% and 15.9%. In terms of the soil type, chromic luvisols account for the largest area of 5,948 ha (55.8%), followed by humic cambisols with 3,524 ha (33.1%) and eutric cambisols - lithic leptosols complex with 736 ha (7.9%). In terms of the land use, grassland with palm trees accounts for the largest area of 3,264 ha (30.6%), followed by shrub land with 3,020 ha (28.3%) and natural/secondary forests with 1,264 ha (11.9%). The total forest area of 1,407 ha, consisting of natural/secondary forests, man-made forests, bamboo forests, mangrove forests and lowland forests except mangrove forests, means that the forest ratio is 13.2% which is the highest of the four working areas. (In fact, there are no mangrove forests or lowland forests in the Oesao East Working Area).

(2) The Oesao West Working Area

The Oesao West Working Area has a land area of 9,632 ha, consisting of 2,916 ha of state forest land and 6,716 ha of private forest land. The state forest land in this working area is categorised as either protection forest or limited production forest. The ratio of gently sloping areas is the highest in this working area with areas with a gradient of 0 - 8% accounting for 5,872 ha (61.0%), followed by 8 - 15% with 1,676 ha (17.4%) and 15 - 25% with 1,480 ha (15.4%). In terms of the soil type, eutric cambisols - lithic leptosols complex accounts for the largest area of 3,352 ha (34.8%), followed by eutric vertisols with 1,632 ha (16.9%) and paddy field soil with 1,512 ha (15.7%). In terms of the land use, grassland with palm trees again accounts for the largest area of 2,628 ha (27.3%), followed by paddy fields with 1,556 ha (16.2%) and shrub land with 1,180 ha (12.2%). The total forest area defined above in relation to the Oesao West Working Area is 252 ha (no man-made forests exist in this working area) and the forest ratio is 2.6%).

(3) The Olio Working Area

The Olio Working Area has a land area of 4,512 ha, consisting of 1,008 ha of state forest land, 660 ha of enclave and 2,844 ha of private land. The state forest land is categorised as either protection forest or limited production forest. In terms of the gradient class, 0 - 8% accounts for the largest area of 1,636 ha (36.3%), followed by 15 - 25% with 1,304 ha (28.9%) and 25 - 45% with 868 ha (19.2%). In terms of the soil type, humic

cambisols account for the largest area of 2,524 ha (55.9%), followed by eutric vertisols with 728 ha (16.1%) and chromic luvisols with 564 ha (12.5%). In terms of the land use, grassland with palm trees accounts for the largest area of 1,688 ha (37.4%), followed by shrub land with 708 ha (15.7%) and open grassland with 636 ha (14.1%). The forest area is 72 ha (no lowland forests except mangrove forests exist in this working area) and the forest ratio is a mere 1.6%.

(4) The Oebelo Working Area

The Oebelo Working Area has a land area of 8,376 ha, consisting of 3,264 ha of state forest land, 120 ha of enclave and 4,992 ha of private land. The state forest land in this working area is categorised as either protection forest or limited production forest. In terms of the gradient class, 0 - 8% accounts for the largest area of 3,608 ha (43.1%), followed by 15 - 25% with 2,144 ha (25.6%) and 8 - 15% with 1,764 ha (21.1%). In terms of the soil type, humic cambisols account for the largest area of 3,392 ha (40.5%), followed by chromic luvisols with 1,948 ha (23.3%) and eutric cambisols - lithic leptosols complex with 1,004 ha (12.0%). In terms of the land use, grassland with palm trees accounts for the largest area of 3,076 ha (36.7%), followed by grassland with trees other than palm trees with 1,092 ha (13.0%) and shrub land with 984 ha (11.7%). The total forest area (natural/secondary forest, man-made forest, bamboo grove etc.) is 576 ha and the forest ratio is 6.9%. (see Appendix B-1, F-1)

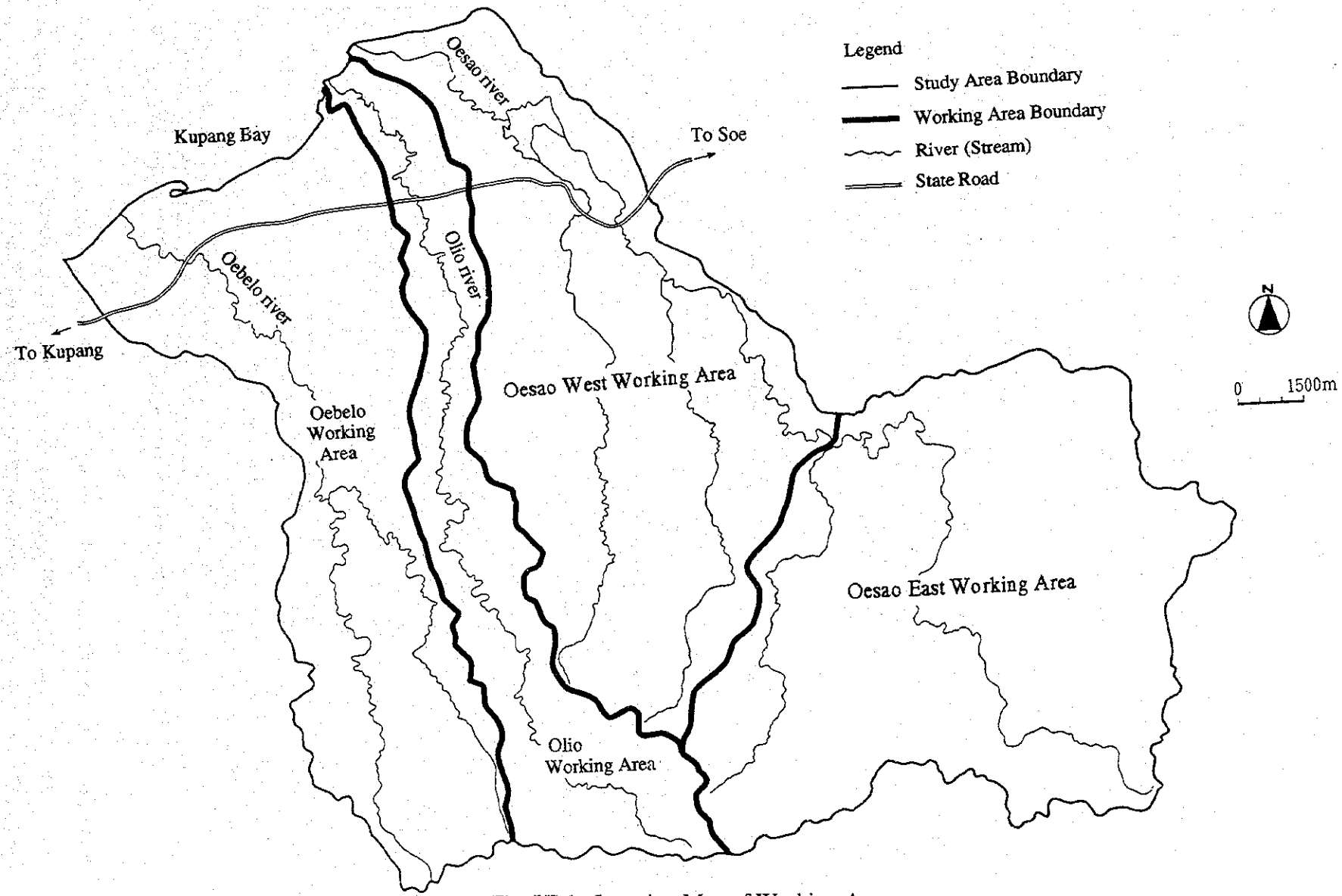


Fig. VI-1 Location Map of Working Areas

VI-3 Soil Loss Control Targets

For the sustained use of land as farmland, grassland or forest land, it is necessary for the rate of soil loss due to erosion to be lower than the rate of soil formation to preserve the soil fertility. Although it is difficult to accurately measure the rate of soil formation, the best estimate of soil scientists is that when disturbance, aeration, etc. are taken into consideration the creation of some 25 mm of top soil requires approximately 30 years (Norman Hudson: Soil Conservation, 1971, page 36). Assuming a bulk density of soil of 1.5, the rate of soil formation is approximately 12.5 tons/ha/year. This figure is often used as the maximum tolerable level for soil erosion. For example, this figure of around 12.5 tons/ha/year is employed as the soil loss tolerance in the case where a soil loss control measure is planned on the basis of the universal soil loss equation (USLE). The soil formation rate and soil loss tolerance (AT) of soils in Indonesia is classified into 7 categories based on such soil characteristics as the conditions of the parent material, permeability and soil depth as shown in Table VI-1.

Table VI-1 Tolerable Erosion Rate for Soils in Indonesia

No	Soil Properties	Soil Loss Tolerance (AT)	
		mm/year	tons/ha/year
1.	Soil on the bed rock, low depth	0.0	0.0
2.	Soil above Unconsolidated materials, low depth (unconsolidated materials)	0.4	4.8
3.	Soil above degraded parent material, low depth	0.8	9.6
4.	Soil above degraded parent material, average depth	1.2	14.4
5.	Soil with water resistant layer under in, above degraded substratum, high depth	1.6	19.2
6.	Soil with low permeability layer under in, above degraded sub stratum, high depth	2.0	24.0
7.	Soil with high permeability layer under in, above degraded substratum	2.5	30.0

Notes
1) Volume weight × 10 × AT (mm/year) = AT (tons/ha/year)
2) Average volume weight for soils in Indonesia: 1.2 g/cc
3) The soil loss tolerance in tons/ha/year was calculated using procedures and data as mentioned in 1) and 2).
Source: Ministry of Forestry, DG of Reforestation and Land Rehabilitation: Critical Land Evaluation at End of the Fifth Five-Years Development (including the System), Book I, the Main Report, 1993, page 10

In the case of an area like the Study Area which has a shallow soil and which experiences a long, severe dry season, the rate of soil formation is believed to be generally lower than usual. According to the soil survey findings, the prevailing soils in the Study Area can generally be

categorized as soils No. 2, 3 and 4 of Table VI-1. For the present soil and water conservation plan, an average AT figure of 9.6 tons/ha/year (average of soils No. 2 through No. 4) is assumed as the target ceiling for the control of soil loss. Taking into consideration its effects on plan cost, agriculture and stock raising in the area, the control of some 70~80% of the soil loss (target Ceiling for the Control of soil loss i.e. 541,000t/year) will be a realistic target. Using this target, measures to combat surface erosion, landslides, gully erosion and bank erosion, all of which are sources of soil loss, will be established.

Table VI-2 Rate of Soil Loss by Working Area

Working Area	Present		Target		
	Average Soil Loss (tons/ha/year)	Total Soil Loss (1,000 tons/year)	Average Soil Loss (tons/ha/year)	Total Soil Loss (1,000 tons/year)	Soil Loss to be Controlled (1,000 tons/year)
Oesao East	12.7	135	9.6	102	33
Oesao West	37.6	362	9.6	92	270
Olio	40.4	182	9.6	43	139
Oebelo	21.4	179	9.6	80	99
Total	-	858	-	-	541

VI-4 Zoning

In Indonesian the Ministry of Forestry applies a scoring method to classify land into protection zone, buffer zone, perennial crop cultivation zone and annual crop cultivation zone using the three factors affecting soil erosion, i.e. slope gradient, soil type and rainfall intensity and this classification is used when watershed conservation plans are prepared. Based on this official classification, the Study Area is also classified into these zones using the criteria shown in Table VI-3. To be more precise, the Study Area represented on the topographical map (scale: 1/10,000) is divided by square meshes (2 cm × 2 cm = 4 ha per mesh) and the said criteria are applied for each mesh to determine the prevailing feature (see frontispiece). The resulting land areas are 1,600 ha of protection zone, 10,272 ha of buffer zone and 21,308 ha of cultivation zone.

Table VI-3 Criteria for Zoning

Item		Category	Class	Score
Factors	Gradient	0 - 8%	1	20
		8 - 15%	2	40
		15 - 25%	3	60
		25 - 45%	4	80
		45% <	5	100
	Soil Type	L : Chromic Luvisols	3	45
		V : Eutric Vertisols	4	60
		C : Humic Cambisols	3	45
		C.L : Eutric Cambisols - Lithic Leptosols Complex	5	75
		F : Eutric Fluvisols	1	15
		P : Paddy Soils	1	15
		M.S: Mangrove Soil or Swamp Soil	5	75
		s.r : Sand, Stone or Rock	5	75
		ls : Landslide	5	75
	Average Daily Rainfall Intensity	0 - 13.6 mm/day	1	10
		13.6 - 20.7 mm/day	2	20
		20.7 - 27.7 mm/day	3	30
		27.7 - 34.8 mm/day	4	40
		34.8 mm/day <	5	50
Zones	Protection Zone	A site meeting any one of the following conditions is classified as a protection zone. ① The total score of the three factors is 175 or more. ② Any site of which the gradient is more than 40% ③ Any site with a soil type of C.L, M.s, s.r. or ls with a gradient of 15% or more		
	Buffer Zone	The total score of the three factors is between 125 and 174.		
	Cultivation Zone	The total score of the three factors is 124 or less.		

Note: Adjusted from data given in Pola Rehabilitasi Lahan Dan Konservasi Tanah, Wilayah Das Oesao, 1987

VI-5 Site Classification

In planning the Land Rehabilitation Plan, site classification based on the natural conditions must be established in order to establish criteria for appropriate land use.

(1) Land Capability Classification

The planned land use categories in the Study Area are cultivation land, forest land and grassland. Land will be classified into one of these categories based on its suitability. In practice, the suitability of land as cultivation land, forest land or grassland will be evaluated based on several factors which affect the land productivity. The results will constitute the land capability classification based on the natural conditions of the land in question.

1) Land Capability Classification Factors for Cultivation Land

Cultivability is judged by the difficulty of farming and degree of soil erosion prevention, both of which are determined by the gradient of the land in question. The growth potential is judged by the scope of restrictions on root growth and the capacity to retain the soil fertility and soil moisture, both of which are determined by the soil conditions of the land. The cultivation land suitability is then decided on the basis of cross reference of the cultivability and growth potential. Based on the cultivation land suitability, the land capability criteria are established to classify cultivation land into 4 categories, i.e. 3 classes of land suitable for farming and land unsuitable for farming.

2) Land Capability Classification Factors for Forest Land

The suitability for reforestation is judged by the difficulty of planting and tending work and the soil conservation potential, both of which are determined by the gradient of the land in question. The growth potential is judged by the scope of restrictions on root growth and scope of restrictions on the supply of nutrients and water, both of which are determined by the soil conditions of the land. The forest land suitability is then decided on the basis of cross reference of the above two factors. Based on the forest land suitability, the land capability criteria are established to classify forest land into 4 categories, i.e. 3 classes of land suitable as forest land and land unsuitable as forest land.

3) Land Capability Classification Factors for Grassland

The suitability for grassland use is judged by the difficulty of grassland management and the degree of soil erosion control, both of which are determined by the scope of restrictions on root growth and scope of restrictions on the supply of nutrients and water, both of which are determined by the soil conditions of the land in question. The grassland suitability is then decided on the basis of cross reference of the above two factors. Based on the grassland suitability, the land capability criteria are established to classify grassland into 4 categories, i.e. 3 classes of land suitable as grassland and land unsuitable as grassland.

4) Land Capability Classification

In view of the use of the soil conditions and land gradient for the land capability classification, Table VI-4 shows the land area by different soil types as well as by different grades of gradient in the Study Area. It is logical to conduct the land capability classification on the basis of viable combinations of soil type and gradient grade observed in the Study Area. Having integrated the above-mentioned land capability criteria for cultivation land, forest land and grassland, the general land capability is established as shown in Table VI-5. Mangrove forests, swamps and paddy fields are excluded from this classification as they are not planned to be used as cultivation land, forest land or grassland under the plan.

(2) Site Classification

Six combinations of the cultivation land, forest land and grassland categories are observed in the Study Area, i.e. $C_1F_1G_1$, $C_2F_1G_1$, $C_3F_2G_2$, $C_xF_3G_3$, $C_xF_3G_x$ and $C_xF_xG_x$ (C = cultivation land, F = forest land and G - grassland). The subscripts classify the land from level 1 to 3 with 1 representing the most suitable land and 3 the least. An x means not suitable. These are used as the site categories as described below.

Type I : Suitable for use as cultivation land, forest land or grassland ($C_1F_1G_1$)

Type II : Suitable for use as either forest land or grassland but may be used as cultivation land depending on the location ($C_2F_1G_1$)

Type III : Desirable for use as either forest land or grassland but its use as cultivation land may be feasible depending on the location ($C_3F_2G_2$)

Type IV : Feasible for use as either forest land or grassland ($C_xF_3G_3$)

Type V : Feasible for use as forest land ($C_xF_3G_x$)

Type VI : Unsuitable for use as cultivation land, forest land or grassland ($C_xF_xG_x$)

The results of the site classification for the Study Area are shown in Appendix F-1. Type III accounts for the largest area of 16,680 ha, followed by Type IV and Type I.

Table VI-4 Land Area by Soil Type and Gradient in Study Area

(Unit: ha)

Soil Type	Gradient (%)					
	0 - 8	8 - 15	15 - 25	25 - 45	45 -	Total
L : Chromic Luvisols	5,972	2,936	244	8	0	9,160
V : Eutric Vertisols	3,176	48	0	0	0	3,224
C : Humic Cambisols	352	2,216	5,224	3,020	84	10,896
C.L : Eutric Cambisols, Lithic Leptosols Complex	1,956	1,948	1,096	168	0	5,168
F : Eutric Fluvisols	1,000	84	4	4	0	1,092
M.S : Mangrove Soil or Swamp Soil	1,008	4	0	0	0	1,012
P : Paddy Soil	2,204	240	44	4	0	2,492
s.r : Sand, Stone or Rock	60	4	8	52	4	128
ls : Landslide	0	0	4	4	0	8
Total	15,728	7,480	6,624	3,260	88	33,180

Note: Land area is the sum of meshes (1 mesh equivalent to 4 ha)

Table VI-5 General Land Capability Criteria for Cultivation Land, Forest Land and Grassland

Soil Type	Use Category	Gradient Class (%)				
		0 - 8	8 - 15	15 - 25	25 - 45	45 -
L	Cultivation Land	3	3	3	×	
	Forest Land	2	2	2	3	
	Grassland	2	2	2	3	
V	Cultivation Land	1	2			
	Forest Land	1	1			
	Grassland	1	1			
C	Cultivation Land	2	3	3	×	×
	Forest Land	1	2	2	3	3
	Grassland	1	2	2	3	×
C.L	Cultivation Land	×	×	×	×	
	Forest Land	3	3	3	3	
	Grassland	3	3	3	3	
F	Cultivation Land	2	3	3	×	
	Forest Land	1	2	2	3	
	Grassland	1	2	2	3	
s.r	Cultivation Land	×	×	×	×	
	Forest Land	×	×	×	×	
	Grassland	×	×	×	×	
l.s	Cultivation Land			×	×	
	Forest Land			×	×	
	Grassland			×	×	

Notes

1) L : Chromic Luvisols
   V : Eutric Vertisols
   C : Humic Cambisols
   C.L : Eutric Cambisols, Lithic Leptosols Complex
   F : Eutric Fluvisols
   M.S : Mangrove or Swamp Soils
   P : Paddy Soils
   s.r : Sand, Stone or Rock
   l.s : Landslide
2) The number given in the table corresponds to the land capability category (Class 1 - Class 3). A small number indicates a higher degree of suitability. The symbol x indicates that the subject land is unsuitable for any intended use.

VI-6 Land Use Criteria

The land use criteria given in Table VI-6 are prepared based on the zoning results (VI-4), site classification results (VI-5) and current land use. In protection zone, forest use is given the highest priority with a declining degree of forest use priority for buffer zones and cultivation zones. In contrast, farming use is given the highest priority in cultivation zones with a declining degree of priority for buffer zone and protection zone. The land use criteria for each zone are explained below.

(1) Protection Zone

The current land use in protection zone consists of open grassland, grassland with palm trees, grassland with trees other than palm trees, shrub land, bamboo grove, natural/secondary forests, paddy fields, dry crop fields and landslide sites. A change of the land use is planned for open grassland, grassland with palm trees, grassland with trees other than palm trees, shrub land and dry crop fields based on the site classification results. In these areas, the highest priority is given to forest use and active efforts will be made to create forests.

In the case of open grassland, all-out reforestation will be conducted. Reforestation will also be conducted for grassland with palm trees or trees other than palm trees while keeping the existing trees. At shrub land, efforts will be made to improve the physiognomy through the planting of trees. Dry crop fields of the Type I or Type II site category will be used as crop cultivation sites together with the introduction of fruit and other trees. Dry crop fields of the Type III through Type VI site categories will be used as mixed gardens with fruit and other trees.

(2) Buffer Zone

The current land use in buffer zone consists of open grassland, grassland with palm trees, grassland with trees other than palm trees, shrub land, bamboo grove, natural/secondary forests, man-made forests, paddy fields and dry crop fields, mixed gardens, seasonal swamps and settlements. A change of the land use is planned for all types of grassland, shrub land, dry crop fields and mixed gardens with a crown density of less than 70% based on the site classification results.

In this zone, while provision is made for the farming use of the land, forest use is also encouraged by increasing the green coverage ratio through the planting of fruit and other trees. Grassland improvement will be conducted for grassland of the Type I through Type III site categories. In the case of grassland of the Type IV through Type VI site categories, all-out reforestation will be conducted. For other types of grassland, grassland improvement will be conducted for those sites of the Type I through Type III

site categories and reforestation will be conducted for those of the Type IV through Type VI site categories while keeping the existing trees. Shrub land of the Type I through Type IV site categories will be used as mixed gardens with fruit and other trees and that of the Type V or Type VI site category will undergo improvement of the physiognomy through planting. Dry crop fields of the Type I or Type II site category will be permitted to continue while those of the Type III or Type IV site category will be used as crop cultivation sites with the introduction of fruit and other trees. Dry crop fields of the Type V or Type VI site category will be used as mixed gardens with fruit and other trees. Mixed gardens with a crown density of less than 70% which are of the Type I or Type II site category will be permitted to continue while those of the Type III through Type VI site categories will be subject to the planting of fruit and other trees to increase the crown density.

(3) Cultivation Zone

The current land use in cultivation zone consists of mangrove forests, lowland forests other than mangrove forests, open grassland, grassland with palm trees, grassland with trees other than palm trees, shrub land, bamboo groves, natural/secondary forests, man-made forests, paddy fields, dry crop fields, mixed gardens, salt fields, industrial sites, seasonal swamps, ponds/lakes/dams, rivers, roads and settlements. A change of the land use is planned for all types of grassland, shrub land, dry crop fields and mixed gardens based on the site classification results. In these areas, priority is given to the farming use of the land while the planting of fruit and other trees will be conducted to improve the green coverage ratio.

Grassland improvement will be conducted for grassland of the Type I through Type IV site categories. That of the Type V or Type VI site category will be subject to all-out reforestation. In grassland with palm trees and in grassland with trees other than palm trees of type I through IV grassland improvement will be conducted. Type V through VI will be subject to reforestation while keeping the existing trees. Shrub land of the Type I or Type II site category will be used as crop cultivation sites with fruit and other trees being planted. That of the Type III or Type IV site category will be used as mixed gardens with fruit and other trees while that of the Type V or Type VI site category will undergo improvement of the physiognomy through planting. Dry crop fields of the Type I through Type III site categories will be permitted to continue with those of the Type IV through Type VI site categories will be used as crop cultivation sites with the introduction of fruit and other trees. Mixed gardens with a crown density of less than 70% and of the Type I through Type III site categories will be permitted to continue while those of the Type IV through Type VI site categories will be subject to the planting of fruit and other trees to increase the crown density.

Moreover, the following sites of which the specific land use has been identified on the land use map prepared under the Study are excluded form the scope of the Plan and their present use will continue because it is unlikely that severe soil erosion takes place at these sites.

① Lowland Forests

Most of these are located on coastal flat land. As they are well covered by vegetation, serious soil loss is unlikely to occur.

② Bamboo Groves, Natural Forests/Secondary Forest (with a crown density of 70% or more)

Although the land gradient varies from site to site, the surface soil is generally covered by vegetation. As litter on the forest bed slows the flowing speed of the surface water and facilitates its infiltration into the ground, serious soil loss is unlikely to occur.

③ Paddy Fields

Most of these are located on flat alluvial plains. As those located on sloping land in the southern mountain ranges are terraced, serious soil loss is unlikely to occur.

Table VI-6 Land Use Criteria

Zone	Land Use Prior to Plan Implementation	Site category Type					
		I	II	III	IV	V	VI
Protection Zone	Mangrove Forests	-	-	-	-	-	-
	Lowland Forests (except Mangrove Forests)	-	-	-	-	-	-
	Open Grassland	F1	F1	F1	F1	F1	F1
	Grassland with Palm Trees	F2	F2	F2	F2	F2	F2
	Grassland with Trees other than Palm Trees	F2	F2	F2	F2	F2	F2
	Shrub Land	F3	F3	F3	F3	F3	F3
	Bamboo Groves	-	-	-	-	-	-
	Natural/Secondary Forests	-	-	-	-	-	-
	Man-Made Forests	-	-	-	-	-	-
	Paddy Fields	-	-	-	-	-	-
	Dry Crop Fields	FI1	FI1	FI2	FI2	FI2	FI2
	Mixed Gardens (crown density < 70%)	FI2	FI2	FI2	FI2	FI2	FI2
	Mixed Gardens (crown density > 70%)	-	-	-	-	-	-
	Others	-	-	-	-	-	-
Buffer Zone	Mangrove Forests	-	-	-	-	-	-
	Lowland Forests (except Mangrove Forests)	-	-	-	-	-	-
	Open Grassland	GI1,2	GI1,2	-	F1	F1	F1
	Grassland with Palm Trees	GI1,2	GI1,2	-	F2	F2	F2
	Grassland with Trees other than Palm Trees	GI1,2	GI1,2	-	F2	F2	F2
	Shrub Land	FI2	FI2	FI2	FI2	F3	F3
	Bamboo Groves	-	-	-	-	-	-
	Natural/Secondary Forests	-	-	-	-	-	-
	Man-Made Forests	-	-	-	-	-	-
	Paddy Fields	-	-	-	-	-	-
	Dry Crop Fields	-	-	FI1	FI1	FI2	FI2
	Mixed Gardens (crown density < 70%)	-	-	FI2	FI2	FI2	FI2
	Mixed Gardens (crown density > 70%)	-	-	-	-	-	-
	Others	-	-	-	-	-	-
Cultivation Zone	Mangrove Forests	-	-	-	-	-	-
	Lowland Forests (except Mangrove Forests)	-	-	-	-	-	-
	Open Grassland	GI1,2	GI1,2	GI2	-	F1	F1
	Grassland with Palm Trees	GI1,2	GI1,2	-	-	F2	F2
	Grassland with Trees other than Palm Trees	GI1,2	GI1,2	GI2	-	F2	F2
	Shrub Land	FI1	FI1	FI2	FI2	F3	F3
	Bamboo Groves	-	-	-	-	-	-
	Natural/Secondary Forests	-	-	-	-	-	-
	Man-Made Forests	-	-	-	-	-	-
	Paddy Fields	-	-	-	-	-	-
	Dry Crop Fields	-	-	-	FI1	FI1	FI1
	Mixed Gardens (crown density < 70%)	-	-	-	FI2	FI2	FI2
	Mixed Gardens (crown density > 70%)	-	-	-	-	-	-
	Others	-	-	-	-	-	-

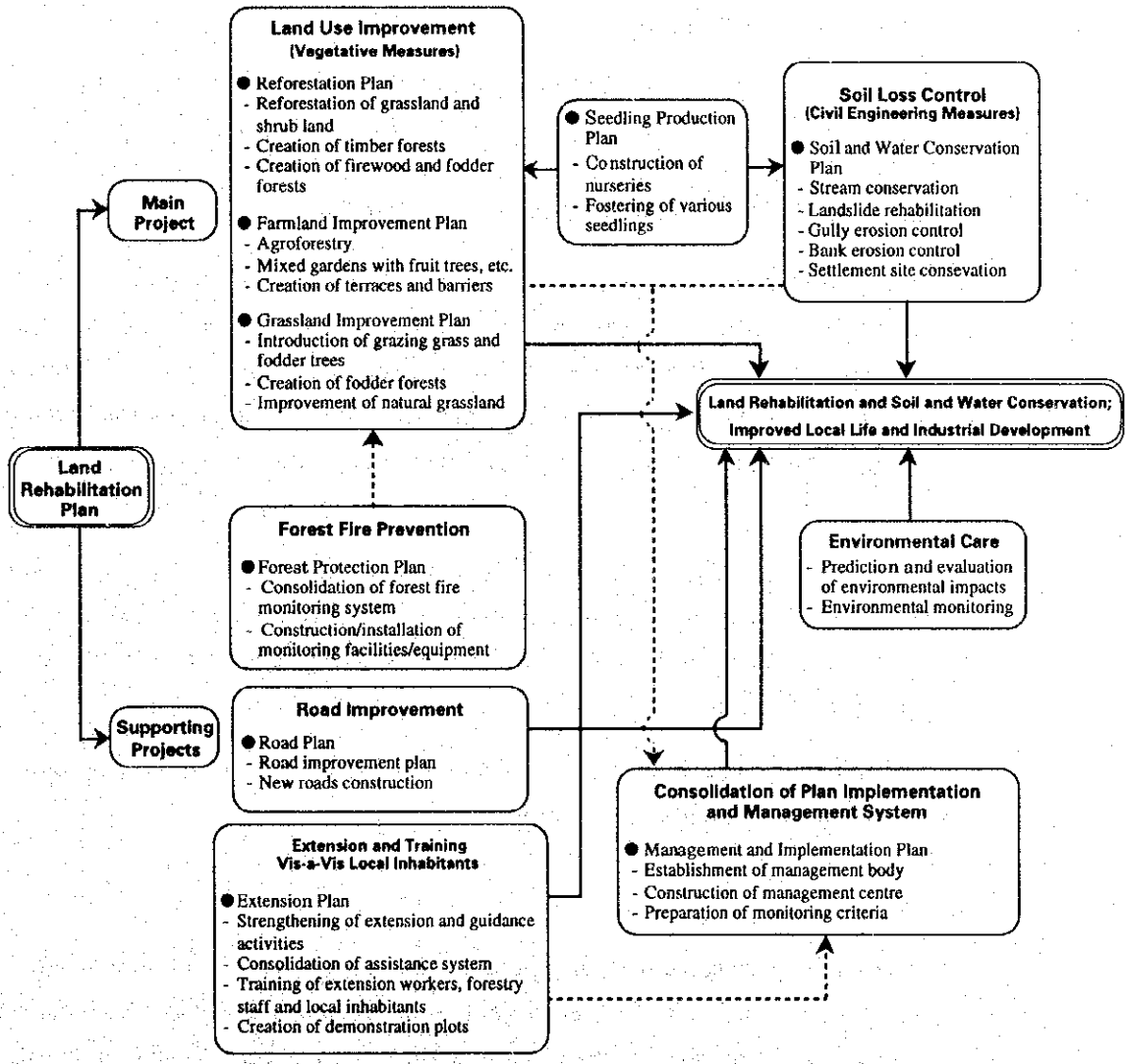
Notes
F1 (Reforestation Type 1) : All-out reforestation
F2 (Reforestation Type 2) : Intensive planting
F3 (Reforestation Type 3) : Less intensive planting
FI1 (Farmland Improvement Type 1) : Crop cultivation with the introduction of fruit and other trees
FI2 (Farmland Improvement Type 2) : Mixed gardens of fruit and other trees
GI1 (Grassland Improvement Type 1) : Introduction of grazing grass and fodder trees
GI2 (Grassland Improvement Type 2) : Establishment of fodder trees
— : Continuation of the existing land use

CHAPTER VII

LAND REHABILITATION PLAN (DRAFT)

CHAPTER VII LAND REHABILITATION PLAN

The main objective of this plan is land rehabilitation mainly through forest establishment and through the necessary farmland improvement, grassland improvement, terracing, etc. all of which will contribute to control of land degradation, the main cause of soil loss and sedimentation. Also proper attention will be paid to the promotion of agriculture and stock raising in the Study Area. The components of the plan and their mutual relationship are shown in the following table.



VII-1 Forest Establishment Plan

Forest establishment work (reforestation) will be conducted at those sites requiring special care from the viewpoint of soil conservation and in sites with low land productivity in such areas as open grassland, grassland with palm or other trees and shrub land.

(1) Reforestation Type 1: All-out Reforestation

Reforestation will be conducted over the entire area due to the importance and urgency of the soil conservation of existing grassland which is classified as F1 in Table VII-1.

1) State Forest Land

① Selection of Tree Species

In the case of production forests, reforestation will be conducted, mainly by the planting of useful species, to partly create firewood forests. The species to be selected will be jati, mahoni, johar, kayu merah, kemiri, jambu mente, kapok, kesambi, *Gmelina arborea*, lamtoro and gamal, etc.

Fast growing species will be planted for protection forests in order to assist the quick recovery of the vegetation. Indigenous species and other suitable species will also be introduced to create forests of diversity. The planted species will include *Acacia auriculiformis*, duri putih, *Casuarina junghuhniana*, kabesak, asam, kayu putih and nitas, etc. in addition to those species listed for production forests.

As land with eutric cambisols or lithic leptosols has been used as poor grazing land due to the gravel-infested shallow soil layer, the introduction of soil improving trees will be conducted together with the main species to improve the land productivity.

The planting of such species as jati and mahoni to produce timber should avoid those sites with poor soil conditions.

② Planting Method

The planting distance will, in principle, be 2 m by 3 m at those sites where crop cultivation is difficult. The same planting distance will apply to sites where crop cultivation is possible and the cultivation of crops between the lines of the planted trees will be conducted for approximately three years after the initial planting based on the tumpangsari system. The standard planting density will be 1,666 trees/ha.

Planting holes with minimum dimensions of 30 cm by 30 cm by 30 cm each will be dug during the second half of the dry season. These holes will be refilled when the bottom becomes sufficiently wet with the commencement of the rainy season. Actual planting will be conducted when the soil which refills these holes has absorbed plenty of water after further rain.

The seedlings to be planted are those which have undergone the hardening process. In the case of potted seedlings, these will be removed from the pot immediately before planting to minimise any disturbance of the root system.

Mulching will be applied around the roots of the planted seedlings using cut grass to suppress water evaporation from the ground's surface.

If the survival rate of the planted seedlings is less than 80%, supplementary planting will be conducted. At present, the Kupang BPK is experimenting with planting assisted by water retaining materials and the further continuation of this experimental research is desirable to improve the performance of local reforestation work.

The crops to be used for the tumpangsari agroforestry are king grass, maize, soybeans, kacang hijau, kacang tanah, dry field rice and green gram, etc.

③ Tending Method

Weeding can be omitted under the tumpangsari system. If the tumpangsari system is not adopted, weeding in strips will be conducted along the contour lines for three years. Thinning will be conducted when deemed appropriate and thinned material will be used as firewood. Depending on soil condition, the crops will receive mixed chemical fertilisers and barnyard manure or compost with emphasis on organic fertilisers. The spraying of agrochemicals and weeding will also be conducted if necessary.

Reforestation sites will be fenced to prevent the invasion of animals. The size of each fenced site should be approximately 50 ha. In the erection of fencing, special care should be paid to ensuring the blockage of animals using the fencing adopted for industrial reforestation sites as an example. Gamal or other species with a strong sprouting performance will be used as the stakes for fencing. Depending on the growth condition of planted trees, the fences around a reforestation site should last 5 years and the necessary maintenance must be conducted. Grazing during dry season, use of such plants as fodder trees and

fruit trees inside forest will be allowed by the community groups etc. who took part in reforestation activities.

Table VII-1 Selection of Subject Sites for Reforestation Plan

Zoning	Protection Zone						Buffer Zone						Cultivation Zone					
Site Category / Existing Land Use	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Grassland	F1									F1							F1	
Grassland with Palm Trees	F2									F2							F2	
Grassland with Trees other than Palm Trees																		
Shrub Land	F3										F3						F3	

Note
F1 : Reforestation Type 1
F2 : Reforestation Type 2
F3 : Reforestation Type 3

2) Enclaves and Private Land

① Selection of Species

In the case of enclaves and private land, a mixture of forest trees and fruit trees will be planted in an effort to provide land coverage by trees. While the preferences of local inhabitants will be respected in the selection of the species, those species capable of contributing to fodder production will be selected for areas where stock raising is popular. The likely species to be selected are jati, kemiri, mahoni, jambu mente, lamtoro, gamal, turi, nitas, cendana and kesambi etc. The likely fruit species are mangga (mango), kelapa (coconut palm), nangka, papaya, sirsak, jeruk manis, apokat (avocado) and sukun, etc.

② Planting Method

All the planting principles described for state forest land will apply to enclaves and private forests except for the standard planting distance which will be 3 m by 4 m with a planting density of approximately 833 trees/ha.

③ Tending Method

All the tending principles described for state forest land will apply here but thinning will not be conducted for fruit trees and those trees of which the fruit will be used.

(2) Reforestation Type 2: Intensive Planting

Reforestation using forest trees will be conducted for grassland with palm or other trees which is classified as F2 in Table VII-1. The selection of species, planting method and tending method for state forest land, enclaves and private land will follow those described in (1) Reforestation Type 1 except for the standard planting density which will be 1,300 trees/ha for state forest land and 700 trees/ha for enclaves and private land because of the preservation of the existing trees. Fodder trees should be actively selected for areas where beef cattle production is popular.

(3) Reforestation Type 3: Less Intensive Planting

In the case of present shrub land which is classified as F3 in Table VII-1, less intensive planting will be conducted to create firewood forests or fodder forests. The species to be planted are *Gmelina arborea*, duri putih, turi, gamal, lamtoro and *Acacia auriculiformis*, etc. The line planting method will be employed with 2 m wide felling strips, a 10 m wide reserved belt and a planting distance of 2 m. The planting density will be 416 trees/ha. The timing of the planting and planting holes will follow the description given for Reforestation Type 1. Weeding in strips will be conducted for the first two years and no thinning will be made. The reforestation sites will be fenced off as in the case of Reforestation Type 1 but the fences will only be maintained for three years instead of 5 years.

Natural regeneration will be encouraged for existing natural/secondary forests with a crown density of less than 70%.

Table VII-2 shows the planned reforestation work by working area. The total land size of the subject sites is 788 ha for Reforestation Type 1, 3,684 ha for Reforestation Type 2 or 200 ha for Reforestation Type 3.