

**THE STUDY
ON
CRITICAL LAND AND PROTECTION FOREST REHABILITATION
AT TONDANO WATERSHED**

SUMMARY

Part I GENERAL INFORMATION AND BACKGROUND

I-1 INTRODUCTION

1 Authority

This Final Report was prepared in accordance with the Scope of Work for the Study agreed between the Japan International Cooperation Agency (JICA) and the Directorate General of Land Rehabilitation and Social Forestry, Ministry of Forestry and Estate Crops (presently renamed Ministry of Forestry), the Republic of Indonesia (DGLRSF) on September 20, 1999.

2 Background of the Study

In order to mitigate the soil erosion in Tondano watershed and to prevent much sedimentation in Lake Tondano, the Government of Indonesia (GOI) requested the Government of Japan (GOJ) to extend technical assistance for the Study on Critical Land and Protection Forest Rehabilitation at Tondano watershed in October 1997. In reply to this request, the Minutes of Meeting for the Scope of Work for the Study were made between JICA and DGLRSF on September 20, 1999.

3 Subject Areas

There are the two objective areas in this Study. One is the Study Area for the Master Plan Study, which is the 54,755 ha Tondano watershed located in North Sulawesi Province in Indonesia. The other is the Intensive Area for the Feasibility Study, which is selected from the area directly influencing the sedimentation of Lake Tondano, through the Master Plan Study.

4 Objectives of the Study

The objectives of the Study are to a) execute the Master Plan Study for the Study Area, aiming at reviewing and recommending existing land use plans, b) conduct the Feasibility Study on the critical land and protection forest rehabilitation for the Intensive

Area identified through the Master Plan Study for Tondano watershed, aiming at alleviation of risks of watershed degradation by sustainable land use in Tondano watershed, and also to provide technology transfer to the counterparts during the Study period.

I-2 ECONOMY AND FORESTRY POLICIES

5 National and Regional Economy

- (1) Indonesian economy had steadily grown with an average annual growth rate of about 7% since 1969. But, the sudden emergence of a currency crisis in July 1997 had dramatically changed its economic situation, so that the economic growth rate has severely dropped to -13.6 % in 1998. In order to reconstruct such deteriorated economy, GOI has prepared the General Guideline for the National Development, and has launched toward improvement of economic situation. As a result, the economic growth rate in the first quarter of 2000 has reached 2 %.
- (2) The average economic growth rate of the North Sulawesi in 1994 to 1998 reached 5.6%. The growth rate for 3 years from 1994 to 1996 was higher than the average one. After 1996, however it has gradually declined, and has come to -2.4% in 1998 due to the said economic crisis. The contribution of the Forestry Sector to GRDP of North Sulawesi has increased yearly from 2.3 % in 1993 to 3.7 % in 1999.

6 Forest Sector in Indonesia

The Ministry of Forestry and Estate Crops (MOFEC) has developed strategies so that working and development investment should move in the direction of increasing community institution capacity, efficiency of use of resources, fair distribution of benefits, and sustainability of development, and has prepared 7 core policies and 12 operational policies. Major policies are to develop forestry and estate for people, and to improve the quality and productivity of national forest areas, private forest, community forest and estate. Quantitative targets are 200,000 ha for forest/critical land rehabilitation and 110,000 ha for development of private forest. These strategies and policies except for the estate crops, are currently followed by the Ministry of Forestry (MOF), so renamed in November 2000. In accordance with the policies, local Forestry Offices have prepared respective working plans for the watershed rehabilitation, greening, and reforestation. For this Study Area, the same strategies and policies are applied.

7 Latest Policy and Laws Concerned

- (1) GOI has been keen in executing the decentralization of public administration in the country. Under the Law 22 and 25 in 1999, the regional governments, especially at the district level will have greater autonomy and responsibilities in the public administration, which in turn will reduce the departmental influence from the Jakarta bureaucracy to the regions. The administrative decentralization implies that the institutional development of regional apparatus (i.e., *Dinas*) is a must for the effective provision of public services.
- (2) GOI passed a new forestry law in 1999 (Law 41/99). The new law describes the guidelines for protecting and utilizing forest in detail. The new forestry law also elaborates the community's rights over the forest, which complements the stipulation of the agrarian law whereby the customary land rights are recognized. Thus, the community plays a very important role for protection of forests, and the sustainability of watershed conservation in the Study Area.

Part II MASTER PLAN STUDY FOR THE STUDY AREA

II-1 Location and Administration

8 Present Conditions of the Study Area

The Study Area lies within the geographical tract between 1°07'~1°31' North latitude and 124°45'~125°02' East Longitude. More specifically, the Study Area includes southern part of Manado City, the capital of North Sulawesi Province. Administratively, the Study Area belongs to the Manado Municipality consisting of 4 Sub-districts, and Minahasa consisting of 11 Sub-districts and 146 Villages, in North Sulawesi Province.

9 Topography, Geology, Meteorology and Hydrology

- (1) The Study Area has an undulated topography with the area of 54,755 ha, including 4,638 ha of the area of Lake Tondano. Elevations of the Study Area ranges from sea level to 1,990 m. Lake Tondano is located in the southern part of the Area. About one-quarter of the Area is steeper than 25% slope. The Study Area is composed of four main geologic formations, namely: Lacustrine and Fluvial deposits (Qs), Young volcanic rocks (Qv), Tondano Tuff (QTv), and Older volcanic rocks (Tmv).
- (2) The mean annual rainfall is 2,738 mm in the lower part and 1,442 to 2,364 mm around the lake. Monthly mean temperature ranges 21.9°C to 22.5°C at Tondano. Monthly humidity varies from 85 to 91% at Tondano. Monthly discharge of the Tondano river range from 5 to 22 m³/sec at Kairagi gauge station. Monthly discharge from Lake Tondano ranges 5 to 12 m³/sec. The runoff coefficient of the Tondano river is 45 % in the

lower reaches. The lake water surface varied between El.681.3 m and El.684.0 m in the last 20 years.

10 Soils and Vegetation

- (1) The Study Area is covered with four soil units, which are Andosols, Glumsols, Latosols, and Regosols. These soils are moderately fine to fine textured, and are, in general, not highly erodible from the soil texture viewpoint.
- (2) More than 60% of the Area is covered with tree-vegetation, and most of the remaining with herbaceous plants-vegetation. It can be said that the Study Area has a good vegetation covers, which would lead to prevention of soil erosion.

11 Socio-Economic Setting

- (1) In 2000, the total population of the Study Area was approximately 338,000 (195,000 in the Minahasa District part and 143,000 in Manado Municipality part). The population around Lake Tondano has been steady during the last few decades, showing a minimum sign of population pressure in the Area. In respect of labor force, over 60% of the population in the 11 Subdistricts of Minahasa District is engaged in agriculture. In Minahasa District as a whole, the Agriculture Sector contributed one-third of its total GRDP. Over 90% of population in Minahasa is Christian with a high literacy rate and education level in general. The level of poverty differs from one Sub-district to the other.
- (2) The land tenure system in the Area has dual dimensions: modern and traditional. The modern land rights have been promoted, which resulted in the expansion of formal land registration at the National Land Agency. But the customary arrangement of land, which is governed by customary law (*adat*), is still apparent in the Area. Customary land rights leave a large portion of private land unregistered in the Study Area.

12 Land Use

- (1) Categories for the present land use have been decided considering the existing legal classification and the actual land use distribution in the Study Area, and are based on the “Baslem and Buurman classification” which is used by MOF.
- (2) A present land use map has been prepared at a scale of 1:50,000 from interpretation of aerial photographs, topographic maps, and field survey. Areas of each land use category have been measured using this present land use map as shown below.

- (3) A slope gradient map has been prepared on the basis of topographic maps at a scale of 1:50,000. Comparison of the land use map and the slope gradient map shows that most of the steep areas would be covered with natural/semi-natural and secondary forests.

Area of Each Land Use

No.	Land Use	Area (ha)	Ratio (%)
1	Natural/Semi-natural Forest	3,745	6.8
2	Secondary Forest	1,238	2.3
3	Planted Forest	71	0.1
4	Estate	22,267	40.6
5	Mixture of Estate and Arable Upland	8,067	14.7
6	Arable Upland	5,562	10.2
7	Pasture	82	0.2
8	Paddy Field	5,960	10.9
9	Swamp	267	0.5
10	Water Body	4,684	8.6
11	Settlement and Others	2,812	5.1
Total		54,755	100.0

13 Forestry

- (1) Approximate area of the protection forest in the Study Area is 3,207 ha which corresponds to 5.6% of the Study Area. Latest planting activities of reforestation (*reboisai*) was carried out in the fiscal year of 1998/99. The planted area was 100 ha.
- (2) The results of greening program in Tondano watershed in the fiscal year of 1998/99 were 40 sites for private forest (*Hutan/Kebun Rakyat*), 6 village nurseries (*Kebun Bibit Desa, KBD*), and 3 demonstration plots of conservation of natural resources (*Unit Percontohan Usaha Pelestarian Sumberdaya Alam, UP-UPSA*). In addition, 5 check dams were constructed.
- (3) Community forest (*Hutan Kemasyarakatan, HKM*) has not been established in Tondano watershed because of the limited distribution of protection forest.
- (4) The Study Area has no permanent GOI nursery. A temporary nursery is prepared in a place close to the planting site for each planting program.
- (5) Forest fire occurred in and around Tondano watershed in 1997 and burned an area of 3,511 ha. Although cause of the forest fire could not be definitely identified, it is assumed that the most possible cause would have been escape from farming land being prepared for crop planting.
- (6) Distribution of forests in the Study Area is very limited, mostly located on top of the mountains with steep slopes, and most of them are designated as protection forests. There is no extensive timber plantation in the Area. Small plantations or individual planting among farming land have been commonly found. Cempaka (*Elmerrillia spp.*) is the most preferred species. In the Study Area, there are some industry consuming forest products although most of them are relatively small enterprises. These are housing factories, furniture factories, pottery makers, brick makers, etc.

14 Agriculture

- (1) From statistics on farm area and number of farm household by the related Sub-districts, an average land holding size is estimated at 1.26 ha, composed of 0.15 ha of lowland, 0.57 ha of arable upland and 0.54 ha of estate land. Out of average farm, 64% is own land, 19% is hired and 17% is cultivated jointly by some persons.
- (2) Agricultural land in the Study Area is estimated at 42,000 ha. Fifty-five percent of the total agricultural land is used for estate crop. Upland and mixed area (mixture of upland and estate land) accounts for 31% of total. In the estate crop area and mixed area, several types of agroforestry system have been practiced. Paddy field occupies 14% of total agricultural land, mainly located around Lake Tondano.
- (3) Major estate crops are coconut, clove and coffee. Out of upland crops (*palawija*), maize is predominant and the remaining are groundnuts, cassava, sweet potatoes, etc. Maize occupies 97% of total *palawija* area. The double cropping of paddy cultivation has been carried out in 60% of total paddy field. Yield of crops in the Study Area is relatively high compared with the average yield of North Sulawesi Province and Indonesia.
- (4) Reflecting local custom, the pig population is remarkably high. Most cattle are used as draft animals for cultivation and a considerable number of horses serve as transportation in town areas. The trend of animal population in recent years shows a little increase for cattle, horse and chicken for meat, while population of goat, local chicken and chicken for egg have remained steady or shown slightly decrease.
- (5) Fishery in the Study Area is carried out mainly in Lake Tondano. In addition, small scale fishery is also carried out at some reservoirs, rivers, small fishponds and paddy fields. Recently, fish production by traditional method has decreased year by year.
- (6) Out of farm income in average farm household, agricultural income is 58% and non-agricultural income is 42%, while living expenditure is 85% and farm cost is 15% of total expenditure respectively. Besides, farmers consume some 40 kg of fuel wood per week on average.
- (7) The marketing of agricultural products is dominantly undertaken through local collectors. In the case of paddy, most products are first transported to a rice mill by a local collector, then polished rice is sold at market. Maize is mostly sold through collectors and partly sold directly. Clove is first collected by local collectors and sent to local factories or Jakarta through the collector and/ or trader.
- (8) The total number of agricultural extension workers of Minahasa District is 451 and for related Sub-district areas, 161 persons are working. Extension service is mainly carried out by door to door service, classes at extension office and group discussion. However,

their activities such as door-to-door extension service is insufficient in frequency. In the related Sub-districts, there are 56 village-level cooperatives (*KUD*), however these cooperatives hardly function for local farmers.

- (9) Narrative histories suggest that clove cultivation was introduced to the sloped area around Lake Tondano in the 1970s and the 1980s, which brought about serious soil erosion throughout the area. Most farmers interviewed reported that there was serious soil erosion at the sloped area around Lake Tondano at that time due to the clean cultivation of clove. From the end of 1980 to the 1990s, soil erosion settled down because of farmers' loss of interest in intensive management of clove cultivation due to the fall of clove price. However they intend to cultivate clove again if its price rises in the future.

15 Agroforestry

- (1) In the Study Area, mono-culture of estate crop is very limited, and agroforestry systems would account for more than 60% of arable land area. However, these agroforestry systems are mostly rudimentary and should be improved for more productivity.
- (2) Types of agroforestry system in the Study Area could be classified into three categories: “Tree Crop Dominant Agroforestry System”, “Herbaceous Crop Dominant Agroforestry System” and “Inter-cropping System of Herbaceous Crops and Tree Crops. These are further classified into 10 types, according to crops and their plant density in the identical field.
- (3) In the old coconut (clove) garden where coconut was randomly planted in the 1950s to 1960s, there are some difficulties for herbaceous crop cultivation such as irregular shape of land for herbaceous crop and very small area for one plot. On the other hand, herbaceous crop cultivation can be effectively carried out where trees are planted in a regular arrangement.
- (4) Each agroforestry system is characterized by evaluation on resistance to soil erosion, the productivity of each crop category, and possibility of applying new cultural practices. Multi-story tree complex systems are very resistant to soil erosion.

16 Present Conditions and Effects of Soil Erosion

- (1) The Study Area suffered from very severe soil erosion in the past. In order to clarify the present soil erosion condition and sediment condition at Lake Tondano, soil loss and sediment have been studied. The estimated soil loss by USLE is 24 t/ha/year on an average, and also predicted annual sediment yield ranges from 6,400 to 7,538 t (0.1 mm thick sedimentation on the Lake bottom annually) in this decade owing to soil erosion

control effort by farmers themselves and low prices of clove.

- (2) The comparison of sounding (bathymetry) results by *PLN* in 1994 and the JICA Study Team has showed no definite increase in sediment condition at Lake Tondano. From this, it could be concluded that there have been no severe sediment deliveries to Lake Tondano for 6 years, from 1994 to 2000 at least.
- (3) In lower reaches of Tondano river, flood damage has occurred on low-lying land due to the bottlenecks by channel meander and unregulated expansion of residential area. The northern and southern parts of Lake Tondano are also inundated during higher water surface period. The inundation at the northern parts of Lake Tondano is mainly due to lower topographic condition close to water level of Lake Tondano and insufficient flow capacity at outlet channel. That at the southern parts is due to riverbed raising by sedimentation at intake weir and narrowed flow section by bridges.
- (4) According to the water quality test at this time, water quality of the lake is deteriorating, and the lake condition is declining to eutrophic. COD, which was measured at 26.7 mg/lit. in 1998, is decreased to 20.1 mg/lit. at present, but still shows a high value.
- (5) It has been confirmed that hydropower generation by the existing hydropower stations located downstream from Lake Tondano, has hardly been influenced by sedimentation in the lake based on the fact that the position of the outlet is higher than the lake bottom. The power generation would therefore depend only on the water level of the lake, directly relating to rainfall.

17 Watershed Management

- (1) Deteriorated watershed results in reducing available water, increased flood flows, concentrated runoff duration, high turbidity of runoff, deterioration of eco-system, and low soil fertility. In the watershed, possibilities on erosion hazard, extensive land use, water pollution, etc. have been found.
- (2) The Study Area is covered with perrious volcanic soils leading to high water retarding ability. There is a sign of revival for improper land use, which leads to the fertile soil loss and disruption of the hydrological regime. Some of the estates are practiced only to increase crop yield without considering soil conservation.
- (3) Lake Tondano and Tondano river serve as important water resources for irrigation, drinking, hydropower generation, inland fisheries, and also function as recreation sites for inhabitants. However, proper management has not been conducted for them. For example, water level of the lake is controlled only for hydropower generation, in spite of increase of flooding area around the Lake. Water of Lake Tondano has very high *COD* value which indicates that the lake is eutrophic, despite it being presently used as

drinking water.

18 Environment

The development activities require the environmental impact assessment (*EIA*), based on *AMDAL*. Regarding the Study Area, *EIA* has been undertaken by *PU* for possible projects around Lake Tondano, and they indicated loss of natural habitat by the projects will be fairly small since most of the areas have already been converted from natural habitat to agricultural land or urban area.

19 Related Government Agencies, Community Organization and NGOs

- (1) According to the current decentralization policy, the Minahasa District Forestry Services Office would be responsible for the project implementation. If this Office becomes the agency responsible for executing the watershed conservation plan, it is essential to apply capacity building.
- (2) GOI initiated several programs to formulate community organizations in every village. In the Study Area, almost all villages have government-initiated community organizations, and these organizations are known for top-down management. There are critics that these organizations are established as an avenue to increase political influence over villagers. There are some community-led organizations, mostly religious organizations, but they suffer from weak institutional foundations in general.
- (3) In North Sulawesi, a number of *NGOs* exist, but their activeness and reliability as an organization vary. They often lack operational funds and management capability.

II-2 Basic Approach to the Master Plan Study

20 Findings through Survey and Investigation

The Study shows there is currently no severe soil erosion in the Study Area nor sedimentation in Lake Tondano, but there is vulnerability to soil erosion due to steep topography, development possibility/risks and expansion of improper farming practice. Taking into due consideration these findings, the basic approach taken in the Master Plan Study is to gain control over potential critical land by analyzing potential hazard area, present land use, and present land condition, then to conduct a zoning for the Study Area. In succession, a basic watershed conservation plan is formulated for respective zones, and an Intensive Area is identified using identification criteria.

21 Basic Approach to the Master Plan Study

The Master Plan Study for the Study Area is executed in the following procedures: (1)

Preliminary examination of soil erosion and sedimentation, (2) Evaluation of present soil erosion and sedimentation condition, (3) Research on natural conditions, (4) Identification of area with potential for critical soil degradation, (5) Present land use, (6) Criteria for acceptable land use, (7) Evaluation of present land condition, (8) Preparation of basic concept for the Master Plan Study, (9) Zoning guidelines, (10) Zoning, (11) PCM work shop, (12) Examination of soil erosion and sedimentation, (13) Preparation of basic strategies for watershed conservation plan for each zone, (14) Watershed conservation plan for each zone, (15) Preparation of watershed conservation basic plan map, (16) Identification criteria, and (17) Identification of Intensive Area.

II-3 Basic Watershed Conservation Plan for the Study Area

22 Basic Concept for Watershed Conservation Plan

- (1) The Study has confirmed the importance and uniqueness of Tondano watershed area. Watershed degradation, when it occurs in the Area, results in a marked change in hydrological behavior, accelerated ecological degradation, and decline of the fertility of land.
- (2) The JICA Study Team has elaborated a concept of “Watershed Conservation through Sustainable Land Use (WACSLU)”, consisting of five elements, being “People-Oriented”, “Technically Sound”, “Economically Sound”, “Multi-Sectoral”, and “Environmentally Friendly”. These form the banner of Master Plan with an emphasis on comprehensive measures to enhance the hydrological function of watershed and to prevent further environmental degradation.

23 Zoning of the Study Area

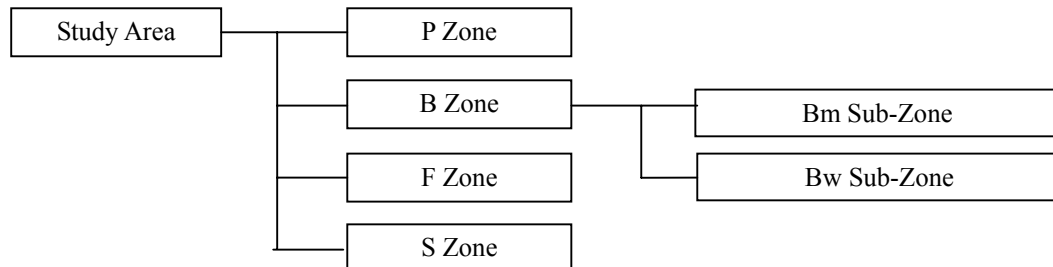
- (1) Zoning of the Study Area is carried out under the concept of “sustainable land use” by preventing the creation of critical land. To support the “sustainable land use”, the following has been taken into consideration:

Proposed Zoning Guidelines and Method

Main elements	Criteria for Zoning	Standard for Each Criteria
Sound hydrological Condition	Sensitivity of hydrological cycle	Distribution of sensitive area on hydrological cycle
Sound ecosystem	Fragileness of ecosystem	Distribution of fragileness of ecosystem
Fertility of soil	Potential for soil degradation	Distribution of potential critical area for soil degradation

- (2) Zoning of the Study Area has been performed using the three maps : Present Land Use

Map, Area with Potential for Critical Soil Degradation, and Sensitive Area on Hydrological Cycle, and also by taking into account land continuity, the present boundary of protection forest, etc. As a result, the following classification has been made for the Study Area:



P Zone : Protection is the main consideration. Slope gradient is more than 40%. Mainly covered with forest vegetation.

Bm Zone : Agricultural use with care for land conservation is acceptable. Slope gradient between 8 % and 40 %. Mainly used for agroforestry and agriculture.

Bw Zone : Conservation for a waterfront is main consideration. Shore of Lake Tondano and river banks are included.

F Zone : Intensive agriculture is acceptable. Slope gradient is less than 8%. Mainly used for cultivation.

24 Strategies for Basic Watershed Conservation Plan

- (1) Zoning of the Study Area is carried out under the concept of “sustainable land use” by preventing the creation of critical land. To support the “sustainable land use”, the following has been taken into consideration:
- (2) Under the concept of WACSLU, the following strategies have been worked out for respective zones made for the Study Area, based on the results of experts’ studies and PCM workshop.

- 1) **P Zone**

- Strategy 1: Conservation and rehabilitation of protection forest,

- 2) **B Zone** consisting of Bm Sub-zone and Bw Sub-zone

- Strategy 2: Conservation of riversides and lakeshores,
- Strategy 3: Reduction of potential critical land,

- 3) **F Zone**

- Strategy 3: Reduction of potential critical land,

and Strategy 4: Institutional development and Strategy 5: Community empowerment will

be applied for all Zones, to fulfill Strategies 1 to 3 effectively.

25 Basic Plan for Watershed Conservation Measures

- (1) As a tolerance limit of soil loss, the following figures are applied, which have been estimated for Indonesia soils:

Guide for Determining Tolerable Soil Loss for Indonesian Soils

No.	Soil Properties and Substratum	TSL*	
		(mm/year)	(ton/ha/year)
1	Very shallow soil overlying rock	0	0
2	Shallow soil overlying rock	no data	
3	Very shallow soil overlying weathered rock (unconsolidated)	0.4	5.2
4	Deep soil overlying rock	no data	
5	Shallow soil overlying weathered rock	0.8	10.4
6	Moderately deep soil overlying weathered rock	1.2	15.6
7	Deep soil with impermeable subsoil overlying weathered substrata	1.4	18.2
8	Deep soil with low permeable subsoil overlying weathered substrata	1.6	20.8
9	Deep soil with moderate permeable subsoil overlying weathered substrata	2.0	26.0
10	Deep soil with permeable subsoil overlying weathered substrata	2.5	32.5

*: Tolerable Soil Loss

The estimated soil loss for the Study Area should be reduced to satisfy the tolerable soil loss limits of 15.6 t/ha/year. for 80 % of the Study Area and 32.5 t/ha/year. for the remaining 20 %.

- (2) Application of physical measures is recommended to increase the effectiveness of soil conservation in combination with non-structural ones. In application of physical measures, consideration should be given to the use locally procurable materials considering cost-saving and O&M work by people concerned.
- (3) Suitable conservation measures have been worked out based on the surface slope under vegetation of annual crop farm land, and estate and pasture. The employed categories of surface slope are <8%, 8-15%, 15-25%, 25-40% and >40%.
- (4) There would be high potential of soil erosion unless appropriate land use and proper farming practices are employed. It is therefore necessary to establish a sustainable land use plan for each zone. An agroforestry system is one of the most effective systems for soil conservation and effective use of land resources.
- (5) The suitable type of agroforestry system should be determined based on the combination of the physical condition, social condition and the characteristics of each type of agroforestry system. The recommended agroforestry systems are divided into 3 categories and 10 types. In the determination of an applicable agroforestry system, the farmers and communities requirement should be considered.

26 Basic Watershed Conservation Plan for P Zone

- (1) Most of the existing protection forest is included in this zone. Although this protection forest in the Study Area is limited to small areas, it is important to revitalize the existing ones and prevent further deforestation. Thus from the outset, the JICA Study Team emphasizes the conservation and rehabilitation of protection forest as a crucial strategy for sustainable land use.
- (2) Reforestation, prevention of deforestation, and community forest are recommended for this Zone. Agroforestry is one of the measures for re-expansion of protection forest and prevention of further destruction of forest.

27 Basic Watershed Conservation Plan for Bm Zone

- (1) Agroforestry, proper farming practices, planting with people's participation like private forest are possible strategy.
- (2) Regreening and private forest are effective for sustainable land use. The Regreening Programme by GOI is very helpful for promotion of these activities.
- (3) This Sub-Zone is divided into three areas based on the present land use and topographic condition; right forest area, sloped area and the area around Protection Zone, and gently sloped and flat area. Multi-story tree garden is a suitable common agroforestry system for this Sub-Zone to supply fuel wood, organic carbon to soil, and to provide protection from soil erosion.
- (4) There are various recommended physical measures against soil erosion. These include infiltration trenches, grassed waterways, diversion ditches, contour dikes, intercepting ditches, terracing drains, and low stone masonry walls, to avoid soil loss from estate and arable upland, and slope failure. In particular, slope failure should require the extension service for farmers on prevention of cultivation on road shoulder.

28 Basic Watershed Conservation Plan for Bw Zone

- (1) Green belt, planting with people's participation like private forest and agroforestry, are possible strategies for the Waterfront Buffer Sub-Zone which extends along riversides and lakeshores.
- (2) Green belt and agroforestry should be introduced considering topography and width of basin. The recommended agroforestry system is a tree/tree crop dominant agroforestry system.
- (3) Since the water quality of Lake Tondano is deteriorating, increasing cage cultivation should be controlled, to avoid further contamination.

- (4) River bank protection works, river bed protection works, and check dam are recommended for protection of river banks and river beds.

29 Basic Watershed Conservation Plan for F Zone

- (1) Intensive farming is acceptable but promoting proper farming practices such as contour farming is a possible strategy. Agroforestry system is also applicable, but careful consideration should be given to higher productivity to gain farmers' acceptance, since farming activities are presently conducted.
- (2) Herbaceous crop dominant type and non-dominant crop type are recommended as suitable agroforestry system in the flat area. Considering the fuel wood consumption and maintaining soil fertility, hedgerow cropping of leguminous trees is proposed. In the sloped area, non-dominant crop agroforestry system and tree/tree crop dominant agroforestry system are recommended.
- (3) Intensive farming practice like contour cultivation and hedgerow cropping is recommended although any type of land use is possible. Especially, multipurpose *Leguminosae* trees are recommended to increase of soil fertility.

30 Basic Plan of Institutional Development

- (1) Institutional development is essential for effective execution of the watershed conservation plan. Institutional development means improvement of organizational and inter-organizational capability to identify problems, design programs, implement projects, monitor progress and evaluate achievement.
- (2) Institutional development requires structural development, policymaking, legal re-arranging and capacity building including training, managerial reengineering and financial restructuring. These developments need to be achieved not only within one specific organization, but also a cross-sectoral mechanism consisting of several organizations and stakeholders.

31 Basic Plan of Community Empowerment

- (1) Community empowerment is indispensable for fulfilling the zoning strategies in Protection, Buffer, Farming Zones since local population and groups should own and manage the potential critical land in Tondano watershed.
- (2) Community empowerment should contain some sub-components such as the organization of watershed conservation groups, micro planning for sustainable land use, environmental education and awareness raising, and gender and conservation, aiming to realize a bottom-up approach.

32 Monitoring and Evaluation

- (1) In order to predict and prevent heavy soil erosion and further deterioration of water quality of Lake Tondano, it is essential to establish a monitoring and evaluation system in the Study Area.
- (2) The minimum items required for monitoring are as follows:
 - 1) Hydrology:
Flow rate of in-flow rivers to the Lake, Sediment concentration in the rivers, Rainfall distribution, and Sedimentation in exiting check dams
 - 2) Water quality:
Temperature, TSS, Transparency, pH, Dissolved Oxygen, Total-CO₂, Total-N, and Total-P.

33 Basic Considerations for Implementation Plan

Various conservation measures will be executed in three priority orders in implementation: high, medium, and low. Of these, the measures to be urgently executed, which might be made by GOI itself are: a) establishment of community forest, b) extension service of proper clove cultivation to farmers, c) extension service of proper upland crop farming practice to farmers, d) establishment of working committee for watershed management, and e) establishment of monitoring and evaluation system.

II-4 Identification of Intensive Area

34 Criteria on Identification of Intensive Area

Taking into consideration the fragile characteristic of the Study Area to soil erosion due to steep and undulated topography and the basic approach to the Master Plan Study adopted hereby, it is proposed to employ the following criteria to identify the Intensive Area. It must have:

- 1) Steep topographic condition,
- 2) Development possibility/risks,
- 3) Possibility of improper farming practice, and
- 4) High potential of conservation work.

35 Identification of Intensive Area

The Intensive Area should be selected from the catchment area of Lake Tondano, as agreed with MOF and Working Committee based on the results of study by the JICA

Study Team. The Intensive Area was roughly selected from Bm Sub-zone in the east, west and south sides of Lake Tondano, and then identified based on the criteria mentioned above.

36 Confirmation of Intensive Area Boundary on 1/10,000 Maps

The boundary of the Intensive Area has been confirmed using the detailed topographic maps of 1/10,000 scale, and largely based on the hydrological boundaries and nearby clear features like roads. The total area of the Intensive Area confirmed was estimated at 11,885 ha as shown below:

Area and Administration of Intensive Area

Location	Area (ha)	Administration (Sub-districts)
East Area	3,339	Toulimanbot, Eris, Kakas- East,
South Area	3,400	Lamgowan, Tompasso
West Area	5,146	Kawangkoan, Kakas-West, Remboken, Tondano
Total	11,885	

Part III FEASIBILITY STUDY FOR THE INTENSIVE AREA

III-1 Present Conditions

37 Natural Conditions

- (1) The Intensive Area is about 120 km² around Lake Tondano. It is divided into three areas, namely East Area, South Area and West Area, by geographical points of view. The East Area (33 km²) with 29% average slope, is characterised by steep slopes composed of highly weathered old volcanic rocks (mostly tuff breccia and tuff) of the Miocene. The steep slopes are used as clove plantations. The South Area (34 km²) with 25% average slope gradient features young Quaternary volcanoes, including the still active Mt. Soputan. Volcanoes create the piedmont plain consisting of volcanic sandy soil, which is used for agriculture. The two major rivers flowing into Lake Tondano, Panasen, and Saluwangko, originate from the area. The West Area (51 km²) with 19% average slope is characterized by lava flow plateaus composed of young volcanic rocks of Quaternary. The gentle slopes on lava have been cultivated.
- (2) Soils are composed of weathered volcanic ash and volcanic rocks. Soils are sandy and have low plasticity in the south, but are clayey and highly plastic in the East and West Areas. Infiltration rate, one of the important characteristics affecting erosion, is very high over the area. In the South Area, it is at least 20 cm/hr, because of sandy soils. It is also very high in the East and West Areas, even though the soil is clayey, because it has good blocky and many cracks.

38 Socio-Economy

- (1) The population of the Intensive Area in 2000 was approximately 58,000 with 17,300 households. The average rate of annual population growth was 0.72 % between 1990 and 2000. The population density was 331 per km².
- (2) The level of human development is relatively high in the community. Also, the area still embraces abundant natural resources. However, people lack economic capital and agro-economic stability to develop the area. Urbanization with the consequences such as pollution and deterioration of morals is apparent. Many local people expressed that the gap between rich and poor has been widening rapidly even though the gap seems to be relatively small at present. On top of these, the richness of natural resources is facing a high potential of degradation due to the lack of adoption and promotion of conservation and management. Local people in general do not possess sophisticated problem-solving skills, thus strategic planning for the future is a foreign concept to them.
- (3) Community-based groups and organizations, such as farmer's groups, church congregations and informal gatherings are vital for the progress of community, though the success of those groups are arbitrary.
- (4) Male population dominates the public sphere of community life while the female population plays a key role in a private sphere. Women's participation in conservation activities is minimal. Women in general lack awareness towards natural resource conservation.

39 Land Use

- (1) Present land use for the Intensive Area has been examined using aerial photograph, topographic map and field survey, and then classified into 14 categories: 1) Natural/Semi-natural forest, 2) Secondary forest, 3) Planted forest (Timber), 4) Planted forest (Fuel wood), 5) Bush, 6) Estate (Clove), 7) estate (Others), 8) Mixture of estate and arable upland, 9) Arable upland, 10) Pasture, 11) Paddy field, 12) Swamp, 13) Water body, and 14) Settlement and

Area of Each Land Use

No.	Legend	Area (ha)	Ratio (%)
1	Natural/Semi-natural forest	1,128	9.5
2	Secondary forest	600	5.0
3	Planted forest (Timber)	24	0.2
4	Planted forest (Fuel wood)	448	3.8
5	Bush	242	2.0
6	Estate (Clove)	950	8.0
7	Estate (Others)	2,444	20.6
8	Mixture of estate and arable upland	1,821	15.3
9	Arable upland	3,122	26.3
10	Pasture	36	0.3
11	Paddy field	638	5.4
12	Swamp	20	0.2
13	Water body	6	0.0
14	Settlement and others	406	3.4
Total		11,885	100.0

others.

- (2) The East Area is dominantly used by “Estate (Clove)” and “Estate (Other tree crops or mixture of various tree species)”. Forestry still remains in the upper slopes. “Arable upland” is sporadic among the estates. The South Area is largely divided into upper part and lower part from a land use viewpoint. The upper part is covered with “Natural/Semi-natural forest” and “Secondary forest”. “Arable land” and “Planted forest (Timber)” are sporadically observed among “Secondary forest”. The lower part is covered with “Mixture of estate and arable upland” and “Arable upland” in mosaic. The West Area is characterized as land use of “Arable Upland” for gentle slope and “Estate (Others)” for surrounding slopes. “Natural/Semi-natural forest” is confined on upper slopes of mountains.

40 Forestry

- (1) Six protection forests are in the Intensive Area. The boundary of these protection forest areas had been mostly established before World War II. The boundary maps for respective protection forest areas are available, but their scale varies from 1/2,500 to 1/50,000 and no contours are indicated. The protection boundary areas were estimated using these maps, interpretation of aerial photos and field visits.
- (2) There are some 30 ha of areas that have been encroached by illegal clearing and cultivation in the Soputan Protection Forest. The encroached area is roughly classified into 3 parts in terms of cultivation activities: The lower part permanently used for tomato, maize and beans cultivation. The upper part is more or less temporarily used, and the middle part in between the two. The encroachers involve about 40 people, administratively belonging to Ampreng, Tumaratas and Raringis villages. To grasp details on encroachment and to explore possibilities of establishing of community forestry, a socio-economic approach has been made by the JICA Study Team. As a result, it has been deemed that they would be positive to involvement in a participatory forestry program if their right for cultivation is admitted.
- (3) Illegal logging has often been observed in eastern edge of the Soputan Protection Forest and around dividing ridge in the Lembean Protection Forest where good forest stands still exist. The main issues concerning this illegal logging are sustainability of timber resources and bio-diversity of the forests.
- (4) Forests in private lands are mostly fuel wood plantation. Main species are kaliandara and gamar. Some timber plantations of pine trees are observed in south to Kakas village of the East Area. Small plantations or individual planting among arable uplands or estates are commonly performed, where cempaka is planted.

- (5) There are 64 forest extension workers in Minahasa District. These workers do not seem to be active, because many village people pointed out their rare visits.
- (6) There are 3 nursery systems: government nursery, community or farmers' group nursery and private nursery. Generally nursery supply systems seem to be well established in the Intensive Area. However, some farmers claim there are no available nurseries. Establishment of additional nurseries would be worthwhile to settle this claim. Publicizing how to obtain material from existing nurseries is also essential.

41 Agriculture

- (1) The farm size in Intensive Area is estimated at 1.30 ha which is composed of 1.62 ha in the East Area, 1.09 ha in the South and 1.20 ha in the West.
- (2) The present agricultural land use can also be classified into five categories considering agricultural practices, cultivated crops and trees. These are AGF-I which is tree/tree crop dominant agroforestry system, AGF-II, which is herbaceous crops dominant agroforestry system, AGF-III, which is inter-cropping agroforestry system, Upland herbaceous crop farming (trees and tree crops area are less than 5% of total field area, UF) and Lowland farming (LF).
- (3) In the Intensive Area, the major tree crop is clove. Clove gardens are relatively concentrated in the East Area. Coffee, cocoa and vanilla are planted in small scale, and scattered mainly in sloped area. Coconut garden area is very limited and mainly planted in the hilly area and residential areas. Fruit trees are mainly planted in home garden and close to residential areas. Some timber trees, fuel woods and multipurpose trees are observed in agricultural land. Maize is the dominant crop and is cultivated under mono-cropping in flat and gentle slope area and under inter-cropping with tree crops in sloped area. Pulses such as groundnuts and cowpeas are cultivated as rotation crops. Vegetables such as tomato, leaf onion and chili are observed mainly in flat area.
- (4) On the flat or gentle sloped areas, improved farming practices are employed. The cropping intensity is under 150 %. Mechanization of farming is minimal, and most farming practices are carried out by man power and draught animal power even in flat area. On moderate to steep sloped areas, the majority of farmers employ an rudimentary agroforestry system. In a part of these areas, farmers employ soil conservation technology such as contour ridge farming, mulching, terracing, and no-tillage cultivation for herbaceous crops.
- (5) Main livestock in Intensive Area is cattle, pig and chicken. About 90% of cattle are used for draught and 10% for beef production. Generally cattle is fed with concentrate and grass that mainly grows on temporary fallow fields and roadsides. Pig and chicken are

reared in local residential area. This Area is also the center of duck rearing in Minahasa District.

- (6) In recent years, natural fish resources have declined due to over fishing and a deterioration in the water quality of Lake Tondano, and fishermen have begun to change from traditional fishing to fish cultivation by net cage. In Lake Tondano, currently about 482 fisherman households are carrying out fish cultivation with a total of about 5,000-6,000 net cages. The provincial government recognizes water quality deterioration of Lake Tondano, but understands that it does not pose a serious threat for fish cultivation at present. There are no regulations based in government law for carry ing out fish cultivation in the lake.
- (7) Agricultural extension service is carried out by Agricultural Information and Extension Service (BIPP) and forestry extension service by District Forestry Service. BIPP has 17 specialists and 234 extension workers (PPL) for food crop and horticultural crop sub-sector, 2 specialists and 114 PPLs for estate crop sub-sector, 5 specialist and 63 extension workers for animal husbandry sub-sector, 4 specialists and 68 extension workers for fishery sub-sector. However, because of the lack of mobilization, on-site extension service is insufficient and this is one of the source of farmers' discontent.

42 Agroforestry

- (1) There are three categories of agroforestry in the Intensive Area: "Tree/Tree Crop dominant Agroforestry System (AGF-I)", "Herbaceous Crop Dominant Agroforestry System (AGF-II)" and "Inter-cropping System of Herbaceous Crop with Tree Crop". Agroforestry system presently covers some 80% of agricultural upland. AGF-I is manly applied fon steep sloped and moderate sloped areas. AGF-II for gentle sloped to flat areas. AGF-III is mainly practiced on moderate sloped areas and upland farming on flat areas.
- (2) For present agroforestry systems, clove is the dominant species and other estate crop areas are very limited. Major fruit trees are durian, mango, langsat, avocado, jackfruit, citrus, and papaya, which are mainly planted in home garden and fields close to dwelling areas. Trees used for agroforestry system in the Intensive Area are cempaka, albizia, trema, mahoni, Nyatou, calliandra and gliricidia. Ficus and piper, which are autogenesis plants, have been found throughout the Intensive Area. Most agroforestry systems are applied in a rudimentary manner.
- (3) The extension service system for agroforestry is very poor at present, only few PPL work for extension of agroforestry. It is thus essential to strengthen the extension service system for agroforestry to improve existing rudimentary agroforestry system.

43 Present Erosion Condition

- (1) In the Intensive Area, sheet erosion and rill erosion were found in several areas of agricultural land, where crops were still small and no conservation practices have been applied. In the East, minor side-slope failures along the road, slope failures and landslide were found in parts composed of highly weathered volcanic rocks. Bank erosion and riverbed erosion were identified in several rivers.
- (2) Average soil loss over the Intensive Area is computed at about 19 t/ha/year. This amount is not so high, however, estimated soil loss is above tolerable level over a considerable area, including are 45% of the area in the East, 28% in the South and 9% in the West.
- (3) There is no critical land in the Intensive Area. However, potential critical land, which is defined as land with a high possibility of severe erosion in future but no severe erosion at present, consists of 2,200 ha of agricultural lands and several sites of slope failure and river erosion.
- (4) Heavy rainfall from November 29 to December 1 totalled more than 200 mm. The areas in Manado along the Tondano river were inundated for a few days by 0.5 m to 2 m of water. In the Intensive Area, residential area and paddy fields were inundated for 2 days with 1 to 2 m deep water in Remboken. The causes of the flood in Manado were presumed to be the meandered channel and expanded residential area on the flood plain in the lower reaches which exacerbated the heavy rainfall.

44 Existing Soil Erosion Control Facilities

- (1) The Intensive Area was provided with many erosion control facilities such as a) check dams, b) soil erosion control facilities, c) river bank protection works, d) slope protection works for hillside, and e) slope protection works for road. But new facilities are required to keep the Tondano watershed in good condition. Out of the 17 existing check dams, 4 check dams are presently damaged and will need rehabilitation works for recovering their proper functions.
- (2) Using the existing check dams, a sediment delivery ratio was developed using the estimated soil erosion quantity, and sediment volume and catchment area of 4 existing check dams. The estimated ratio was 70% for the catchment area of 30 ha, and 20 % for the catchment area of 100 ha.

45 Institutional Condition

- (1) The Minahasa District Office of Forestry Services consists of a main office and around 25 lower level regional branch offices. The current institutional capacity is generally weak, and would require significant investment to bring it up to a reliable standard for

forestry management.

- (2) The current institutional capacity of North Sulawesi Province Forestry Services Office is generally good in some departments, and the leadership and work practices in general reflect a reasonable amount of planning and good management practices. This office would be the ideal unit to which the district office should be attached in a counterpart role.
- (3) Under the decentralization policy, the role of the central government will be minimized in the regions, and gradually absorbed by the regional government. Decentralization has raised the concept of community empowerment to a high priority. It is expected that the community will play a much greater role in the management of government affairs.
- (4) An integrated watershed management function operates through *PTPA* or Water Regulation Committee. *PTPA* is a province level institution and assisted by a number of *PPTPA*, that operate at the watershed level. *PTPA* and *PPTPA* are concerned mainly with water distribution, and conservation is not necessarily a priority. There needs to be a committee driven by conservation.
- (5) Efforts to strengthen watershed conservation will need to ensure that there is a coordinated approach to rehabilitation and land and soil conservation and the community have a more prominent role in conservation. Ultimately, management decisions must include all stakeholders. A watershed conservation committee would ideally operate in close cooperation with *BAPPEDA* because strategic planning is the best approach to conservation.
- (6) General Government institutional problems include low salary, inadequate routine operational budget, routine/project budget balance, staff mobility, Government-Community communications, underdeveloped information systems, the need to separate technical government services from general administration, and the form of extension services.
- (7) General Non Government Institutional Problems include low levels of community awareness, apathy and lack of watershed management coordination.

46 Environment

- (1) The forest areas are too small and fragmented, and they may disappear altogether if subjected to any further pressure. The biggest threat and pressure on the natural vegetation is activities by human being. There are more than 21 species of major plant community in each of 4 forests and 16 species of the major bird community structure in the Intensive Area. There is one threatened species of bird.

- (2) The plant communities of agro-ecosystem consist of cultivated plants such as clove trees in the estate, dry land crops, and paddy plants. Several wild animal species are found in the Intensive Area. Domestic animals in the Intensive Area are pigs, cows, chicken, etc. A typical disease that infects plants is clove leaf fall.
- (3) In Lake Tondano except near Eris, plankton and benthos possesses high diversity, but non-cultured fish has decreased. Water hyacinths grow densely mainly around the area of fixed net fish culture.

III-2 Watershed Conservation Plan for the Intensive Area

47 Need of Watershed Conservation

- (1) In the Intensive Area, there are natural/semi-natural forest and secondary forest. These forests function to prevent intensification of soil erosion from steep slopes and possibly play an important roll in stabilizing water flow. However, there has been illegal logging and encroachment in the protection forests. If these devastating activities continue, the important forest functions mentioned above might be easily lost in near future. To keep the forest function for proper watershed conservation in the Intensive Area it is essential to establish an effective and integrated watershed conservation plan putting emphasis on forest function.
- (2) About 80% of the Intensive Area is located at undulated and sloped area of more than 8% slope angle. Such topographic condition requires careful land use to maintain soil conservation and soil fertility. A well-designed agroforestry system is one of the most effective system for soil conservation and increase of soil fertility. In the Intensive Area, agroforestry systems have already been introduced, but most are rudimentary. It is necessary to improve agroforestry systems and farming practices for effective soil conservation, and to increase soil fertility and crop production.
- (3) In the Intensive Area, sheet and rill erosion in several farmlands exceeds tolerable levels in considerable area, and needs improving measures to decrease the soil loss. Slope failure at Mt. Maimbeng, roadside slope failure in Eris, and three cases of torrent erosion need corrective measures. Available scientific data on the present condition are limited despite the fact that Lake Tondano is the only stable water source in the region. Collection of scientific data is a fundamental need for proper management of the lake and watershed.
- (4) Good management of the watershed involves a collective coordinated approach to monitor the overall conditions and ensure that the resource is maintained in good condition. Concurrently, it is essential to increase role of community in the watershed

conservation. Thus, institutional development for government is required for the strengthening of the coordination, and overall planning and management function of the Province Forestry Services Office, the District Forestry Services Office, the Office of Sub-district Head, and the Forestry Branch Offices. Institutional development for community include development of a village cadre extension worker system, development of a training capacity for cadres, strengthening of NGOs and shifting the project identification, planning and implementation function from government to community level. In addition, technical development on agroforestry and watershed conservation should be executed by local universities. Furthermore, it is necessary to prepare laws and/or regulations to clarify the roles of related government agencies. At present, such requirements for proper watershed conservation are totally lacking. The institutional development is thus essential for the Tondano watershed.

- (5) From the community viewpoint, there are several problems and constraints that impede local people from contributing to the watershed conservation. Those are: a) Inappropriate awareness and knowledge on conservation, b) Absence of long-term conservation perspectives, c) Inappropriate socio-economic environment to support community-based groups, d) Pessimism towards government, e) Improper collective initiatives for conservation, f) Economic instability and inadequate social safety net, g) Insufficient farming capital, h) Lack of women's empowerment. To settle these problems and constraints, and to realize proper watershed condition, it is essential to undertake the community empowerment.
- (6) It has been confirmed that Tondano watershed plays important roles for economic activities and inhabitant life in and around the Study Area. These are electricity supply, drinking water supply, and irrigation water supply. Lake Tondano also highly contributes to regional economic development through inland fishery, peak-cut of floods, and tourism. In addition, it has been recognized that these are large expectations for Tondano watershed as hinterland area for supporting the industry development plan (*KABIMA*) by supply of industry water. From these roles, it is essential to prevent Tondano watershed from any degradation.

48 Basic Approach to Watershed Conservation for Intensive Area

The watershed conservation plan for the Intensive Area should be worked out based on the strategies and the basic concept of WACSLU, which was elaborated through the Master Plan Study. In preparation of the watershed conservation plan, an important point is that the proper watershed conservation could not be successfully fulfilled without institutional development and community empowerment.

49 Zoning of Intensive Area

- (1) The zoning of the Intensive Area has been made using a simple scoring method. The employed indicators are slope gradient, rainfall, soil and geology and present land use to evaluate sensitivity of the hydrological cycle, fragileness of ecosystem and potential for soil degradation under the basic concept of sustainable land use. Government regulation for protected area has been also taken into account.

- (2) The Intensive Area has been classified into 7 zones; P Zone, Bm1 Zone, Bm2 Zone Bm3 Zone, Bw Zone, F Zone, and S Zone.

P, Bm1, Bm2, Bm3, and Bw Zones have been selected on the basis of the evaluation maps and other factors such as present land use map, slope distribution map, rainfall map, soil map and government regulation. The areas of the various zones for the Intensive Area are shown in the above table.

Area of Each Zone

Zone	Area (ha)	Ratio (%)	Zoning in Master Plan Study
P Zone	1460	12.3	P Zone
Bm1 Zone	1,985	16.7	Bm Sub-Zone
Bm2 Zone	4,306	36.1	Bm Sub-Zone
Bm3 Zone	1,696	14.3	Bm Sub-Zone
Bw Zone	94	0.8	Bw Sub-Zone
F Zone	2,075	17.5	F Zone
S Zone	270	2.3	S Zone
Total	11,885	100.0	

50 Physical Watershed Conservation Measures

Forestry Management and Rehabilitation Plan

- (1) There are three basic approach to the forestry development plan. Those are 1) to maintain present forest and to improve forest condition for P Zone and 2) to decrease deforestation by supplying new resources outside of forest and to contribute to land conservation by planting trees for Bm1, Bm2, and Bm3 Zones, and 3) to provide green belt with agroforestry systems for Bw Zone.
- (2) The forestry management and rehabilitation plan consists of 7 components, i.e. a) boundary survey of protection forests, b) community forestry, c) reforestation, d) forest patrol, e) research for non-wood forest products, f) fuel wood planting, and g) timber tree planting. The a) to e) components are applied for P Zone, and the remaining f) and g) components for Bm1 and Bm2 Zones.

Agriculture and Agroforestry Improvement Plan

- (1) The improvement plan for agriculture and agroforestry was determined by considering a) present agricultural land use and farming practices, b) slope gradient, c) demand of farmers, d) spacing of tree crops and marketing.
- (2) In consideration of the existing agroforestry system, AGF-I (Type I-2)/IM, AGF-I (Type

I-4)/IM, AGF-I (Type I-5)/IM, AGF-I (Type I-6)/IM, AGF-II (Type II-2)/IM, and AGF-III (Type III-2)/IM are employed in the Intensive Area. The key factors for improvement for each type of agroforestry are as follows: tree spacing and soil conservation for AGF-I/IM; tree arrangement, crop rotation of herbaceous crops and maintenance of soil fertility for AGF-II/IM; tree spacing, effective farming practices and soil conservation for AGF-III/IM and crop rotation, maintenance of soil fertility and supply of fuel wood for UF/IM.

- (3) The suitable type of agroforestry system for each zone is given in the following table.

Suitable Agroforestry System Type for Each Zone

Proposed Type	Area (ha)	Applied Zone
AGF-I (Type I-2)/IM	1,910	Bm1 and Bm2 Zones
AGF-I (Type I-4)/IM	860	Bm1 and Bw Zones
AGF-I (Type I-5)/IM	100	Bm1, Bm2 and Bm3 Zones
AGF-I (Type I-6)	10	Bm1, Bm2 Bm3 and Bw Zones
AGF-II (Type II-2)/IM	1,760	Bm2, Bm3 and F Zones
AGF-III (Type III-2)/IM	1,970	Bm2 and Bm3 Zones
UF/IM	1,760	Bm3 and F Zones
Total	8,370	

Note: Total area in this table excluded 640 ha of paddy

- (4) The anticipated crop production “with project” conditions are shown below.

Anticipated yield and production

Crop	Area (ha)		Yield (kg/ha)		Production (t)	
	without	with	without	with	without	with
Paddy	1,020	1,020	4,800	5040	4,900	5,140
Maize	5,343	4,955	2,900	3,050	15,500	15,110
Ground nut	320	600	1,080	1,130	350	680
Cowpea	130	360	900	950	120	340
Vegetables	340	485	7,000	7,350	2,390	3,570
Clove	1,470	2,570	200	215	295	550
Coffee	190	270	950	1,000	180	270
Coconut	190	80	1,200	1,250	240	100

Erosion Control Facilities Plan

- (1) The areas where soil loss is beyond the tolerable level require erosion control. Such lands are used mostly for agriculture and located on steep slopes. In such circumstances, simple and more productive vegetation measures should be applied in due consideration of the demands of the farmers. On the other hand, for the existing slope failures and torrent erosion, structures are the preferred corrective measures, but these could not be handled by local people, both financially and technically. Such structures shall be therefore constructed by the Project under the people’s participatory approach.
- (2) Implementing proposed measures of agroforestry with traditional terrace will reduce soil

loss. Soil loss after implementation is estimated 1.9 t/ha/year reduced from the present amount 19.0 t/ha/year.

51 P Zone

Forestry Management and Rehabilitation Plan

- (1) In this Zone, there are 6 protection forests, of which the total area is about 1,014 ha. Forestry conservation in P Zone consists of five plans, i.e. 1) boundary survey of protection forests, 2) community forestry, 3) reforestation, 4) forest patrol, and 5) research for non-wood forest products.
- (2) For the encroached area in the Soputan Protection Forest, it is recommended to apply community forestry considering recovery of forest function and also the livelihood of cultivators. The community forestry is to be established in an appropriate program including formulation of community, socio-economic approach, boundary survey, arrangement of lands, and planting and tending activities.

Agriculture and Agroforestry Improvement Plan

In this zone, agroforestry will be introduced to social forestry. Community forestry is divided into 3 parts, upper part, middle part and lower part, with respect to present land use. Forestry would be applied for the upper part, fruit tree dominant agroforestry system for the middle part and “tumpansary” system for the lower part.

Erosion Control Facilities Plan

A combination of gabion box slope protection works and bamboo terrace works is proposed for the rehabilitation of slope failure on the hillside at Mt.Maimberg.

52 Bm1 Zone

Forestry Management and Rehabilitation Plan

In this zone, timber tree planting will be carried out in accordance with agroforestry system. Construction of nursery and related extension services are essential. Nine nurseries and 30 extension workers are proposed in total. Fuel wood plantation is also proposed to cope with increasing demand. Thus, construction of delivery stations and dissemination of extension services are indispensable. One hundred and fifty hectares of fuel wood plantation is proposed, and 7 seedling delivery stations are needed in total. The requirements in this plan will be common for Bm2 and Bm3 Zones.

Agriculture and Agroforestry Improvement Plan

In this zone, AGF-I (Type I-2, Type I-4 Type I-5)/IM is proposed in this area from a viewpoint of soil conservation and production. It is also proposed to provide corrective measures such as terracing, contour ridge row cultivation, mulching, and non-tillage

cultivation.

Erosion Control Facilities Plan

Grading and sod facing works are proposed as protection works for the road at Eris-3 site. In addition, construction of 2 check dams (stone masonry and gravity type) are proposed at the Tandengan site and the Ranomerut site in the East Area.

53 Bm2 Zone

Forestry Management and Rehabilitation Plan

The same plan with Bm1 Zone is applied for this zone.

Agriculture and Agroforestry Improvement Plan

In this zone, AGF-III (Type III-2)/IM is basically proposed. AGF-I (Type I-2, I-4)/IM is proposed for relatively high soil erosion potential areas, and AGF-II (Type II-2)/IM for relatively low soil erosion potential areas.

Erosion Control Facilities Plan

In this zone, a gabion slope protection work with 3.0 m height is proposed for the Paleloan site in the East Area. It is also proposed to provide a wet masonry gravity check dam with 3 m height and 3 m thickness at Tataaran site in the West Area, to prevent disaster of debris flow. Furthermore, the existing check dam at the Leleko site in the West Area will be provided with rehabilitation works such as re-embankment and sod-facing works at the downstream slope of dam body.

54 Bm3 Zone

Forestry Management and Rehabilitation Plan

Fuel wood and timber trees will be procured through provision of agroforestry system.

Agriculture and Agroforestry Improvement Plan

In this zone, AGF-II (Type II-2)/IM and UF/IM are basically proposed. In the sloped area, AGF-III (Type III-2)/IM is proposed.

Erosion Control Facilities Plan

The existing check dam at the Kasuratan site in the West Area will require rehabilitation works such as riprap on the downstream part of the spillway to prevent further damage.

55 Bw Zone

Forestry Management and Rehabilitation Plan

Bw Zone will function as a buffer zone for the lake. Green belt is proposed for Bw Zone.

In order to keep the waterfront in good condition, Tree/Tree Crops Dominant agroforestry system is proposed. The proposed trees are fruits trees, trees and estate crops because 50 % of Bw Zone are occupied by dwelling area.

Agriculture and Agroforestry Improvement Plan

Bw Zone is small in area but its topography and land use is complicated. AGF-I (Type I-2)/IM is proposed for the steep sloped area along road. AGF-III (Type III-2)/IM is proposed for the moderate to gentle sloped area along road. Upland grass fallow is proposed to be changed into lowland field (flat and lower area), or into fruit dominant tree complex. In AGF-I (Type I-6)/IM (home garden), it is proposed to plant hedgerow trees to strengthen soil conservation activity.

Erosion Control Facilities Plan

No erosion control facilities are required for this zone.

56 F Zone

Forestry Management and Rehabilitation Plan

No special forestry activities are required for this zone.

Agriculture and Agroforestry Improvement Plan

In this zone, UF/IM and AGF-II (Type II-2)/IM are basically proposed. Since the plant density of trees is low under these farming categories, hedgerow cultivation is significant for organic carbon supply to soil, maintenance of soil fertility and supply of fuel wood.

Erosion Control Facilities Plan

In the Panasen river in this zone in the South Area, 6 river bed protection works and 900 m of river bank protection works are proposed to avoid further torrent erosion. The damaged existing check dam at Tountimomor site in the South Area will be rehabilitated with additional gabion works to strengthen its structural stability. In addition, a new stone masonry gravity type check dam will be constructed at the Tounipus site in the East Area for sand trap purpose.

57 Strengthening of Extension Services

- (1) At present, the Forestry Services Offices provide the insufficient extension services. It is therefore essential to strengthen the forest extension services. The proposed strengthening plan of extension services has two steps. Those are training for extension workers and that for farmers. One week training course for five years is recommended.
- (2) Agricultural extension service has a long history and the extension system has been completed. However, the activity of agricultural extension is poor due to a lack of transportation. To activate agricultural extension, the project will provide 30 motor

cycles and 60 bicycles.

- (3) At present, an extension service exists for agroforestry development under the District Forestry Service office, however, the organization for agroforestry extension is not distinct and the number of extension workers is so small that little progress is observed for agroforestry. It is required to establish an effective extension system for agroforestry development. For intensive extension of agroforestry, three agroforestry specialists and 60 extension workers would be required. The project would carry out intensive agroforestry extension programme for five years by employing the above mentioned staff and providing equipment.
- (4) Agroforestry training programme would be carried out progressively. Firstly, planners and specialists would be trained, and then these specialists and planners would train extension workers and key farmers. Key farmers who have been trained would train farmers in the field.

58 Institutional Development Plan

- (1) The institutional development involves a) Community institutional development , b) Technical institutional development program, c) Institutional development of forestry services, d) Accurate village boundary mapping, e) Institutional integration and strengthening of the legal and regulatory framework, f) Strengthening of the watershed management capacity at University of Manado, and g) Strengthen local NGOs. In addition to these 7 components, 6 villages will be selected as a pilot group in the first instance until the village proposal process is consolidated, after which, the consolidated framework will be implemented gradually in all participating villages.
- (2) The institutional development plan will take place, initially over a 5-year period. In the first year the preparations would be made to set the foundations for the remainder of the development period. All activities would be shared and integrated by cooperative arrangements including open sharing of data and resources. Ultimately all institutions will support each other for attainment of conservation objectives.
- (3) The people in the Tondano watershed have a low awareness of the need for its conservation. The relevant government agencies are currently conducting watershed management without proper coordination. In order to execute watershed conservation effectively, it is required to make adjustment among relevant government agencies and to have all watershed stakeholders participate in every stage of watershed conservation activities. The proposed manner for fulfilling these requirements is to organize a watershed conservation committee, and also to establish a watershed conservation board (*badan*) at the Provincial Forestry Services Office, to implement the recommendations of

the committee.

59 Community Empowerment Plan

- (1) To overcome the constraints faced by the community, communities need to be empowered, which requires external inputs and stimulus. The objective of the proposed community empowerment plan is to develop the capability of the community to improve its sustainable land use and community-based natural resource management. The proposed project targets 6 villages with approximately 9,000 people or 2,700 households. The duration of implementation would be 4 years with the estimated total cost of Rp. 9,751,841,000.
- (2) The plan consists of five components: 1) micro planning for sustainable land use, 2) awareness raising and environmental education, 3) organizing of local people and reorienting of officials, 4) strengthening of social safety net, and 5) gender and conservation. To implement these elements, government institutions, NGOs, academics, consultants and international supporters need to be mobilized.
- (3) As a scheme to implement the community empowerment plan, a pilot project was proposed. The proposed target beneficiaries are 6 villages, 9,000 people, 2,700 households. And proposed implementation period is 4 years. Based on the result of pilot project, district forest services officers to which technology was transferred will extend the activities to the other villages in the watershed.

60 Monitoring and Evaluation System Development Plan

- (1) Monitoring and evaluation are effective management method to understand the level of progress and constraints on a regular basis. The results of monitoring and evaluation will give useful information for improving operation and management of ongoing or future projects.
- (2) Monitoring for Engineering items is necessary for soil erosion, sedimentation, water quality, bottom materials, rainfall, lake inflow and outflow discharge, and lake water surface level. Duration for the monitoring is limited to 5 years for erosion and sedimentation, whilst other items need to be incorporated as regular operation activities.
- (3) A total watershed information system is proposed to collect and analyze the data on erosion and sediment, water quality and hydrology. In addition, slope failure, and landslide observation and river erosion shall be monitored by this system.
- (4) To develop socio-economic assessment system necessary for the comprehensive environmental monitoring and evaluation, monitoring and evaluation focusing on the socio-economic perspective should be included in the plan. Socio-economic monitoring

is important for the provision of relevant information and data to implementers and supporting agencies to be able to facilitate decision-making. Indicators to be monitored and evaluated should be identified in accordance with the objectives and expected outcomes of the implementation. The indicators must be objectively verifiable, and data and information for the verification must be retainable. The monitoring and evaluation process should be participatory using methods as Project Cycle Management (PCM), ZOPP, Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA) or logical framework. The results must be disclosed to the public for transparency.

III-3 Environment

61 Initial Environmental Examination

Initial Environmental Examination (IEE) was conducted to select the major issues in the EIA. The result of the IEE indicated that these were insufficient negative impacts.

62 Environmental Impact Assessment

- (1) Expected impacts are positive with respect to soil and land components and hydrology and water quality. For biotic aspects, negative impacts will be created if new species are introduced into the area by reforestation and green belt establishment and increased use of fertilizer through agroforestry extension. However positive impacts are more than negative side. For socio-cultural aspect, establishing community forest would reduce the income of farmers who are using the forest.
- (2) All the proposed activities will produce impacts but more on the positive side than the negative side, hence there is little need for mitigation measures to be considered. Species to be used in establishing the planned activities should be chosen from those existing in the area, since they are naturally adapted to the local ecosystem.
- (3) Alternative income source should be considered for the local people who experience negative impacts from the activities of establishing community forest. Involvement of the local community is important for establishing a plan to minimize negative impacts. Socialization of planned activities is required from the very early stage of the development process. Extension, training, and workshops should be carried out for farmers and local stakeholders in order to create positive perceptions and increase their capacity.
- (4) Measurement on erosion and sedimentation, water quality and water balance is required for proper management of the lake and its watershed. Diversity of fauna and flora in the forest areas needs monitoring. In the agricultural area, direct observation on production and plant pest and disease shall be made for perennial crops.

- (5) Monitoring activity on socio-economy and cultural components will be implemented for the issues on socialization of the project to the local people, people participation in each stage of the process, potential conflict within the local people, lost income, level and distribution income, and people is perception.

III-4 Project Implementation and Cost

63 Project Implementation

The Project will be implemented over 14 years as shown below:

Project Implementation Schedule

Component	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11	Year12	Year13	Year14
1 Physical Watershed Conservation Measures														
1.1 Forestry Management and Rehabilitation														
(1) Boundary survey for protection forests														
(2) Community forestry plan														
(3) Reforestation plan														
(4) Strengthening plan of forest patrol														
(5) Research plan for non-wood forest products														
(6) Fuel wood planting plan														
(7) Timber tree planting plan														
(8) Strengthening of extension services														
1.2 Agriculture and Agroforestry Improvement Plan														
(1) Agriculture														
(2) Agroforestry														
1.3 Erosion Control Facilities														
2 Institutional Development Plan														
(1) Community institutional development														
(2) Technical institutional development														
(3) Institutional development of forestry services														
(4) Accurate village boundary mapping														
(5) Institutional integration and strengthening of legal and regulatory framework														
(6) Strengthening of watershed conservation capacity at University of Manado														
(7) Strengthening of local NGO														
3 Community Empowerment Plan														
(1) Micro planning of sustainable land use														
(2) Awareness raising and environmental education														
(3) Organizing of local people and reorienting of officials														
(4) Strengthening of social safety network														
(5) Gender and conservation														
4 Monitoring and Evaluation System Development Plan														
(1) Engineering items														
(2) Socio-economic items														
5 Operation and Maintenance														

64 Executing Agency

The watershed conservation plan will be implemented by the District Forestry Services Office in cooperation with community under coordination of the Provincial Forestry Services Office. In order to implement the plan steadily, it is proposed to establish the executing group consisting of the District Forestry Services Office and community, and the operation group consisting of the Provincial Forestry Services Office, the Watershed Conservation Committee and the executing group. In addition, the Watershed Conservation Board will be established at the Provincial Forestry Services Office, to follow the decisions made by the Watershed Conservation Committee.

65 Project Cost

Total project cost was estimated at Rp.76,661 million as given below.

Summary of Project Cost

		Unit: Rp. Million		
	Component	F.C.	L.C.	Total
1	Physical Watershed Conservation Measures			
1.1	Forestry Management and Rehabilitation	425	9,284	9,710
1.2	Agriculture/Agroforestry Improvement	1,990	2,604	4,594
1.3	Erosion Control Facility Development	4,962	2,980	7,942
2	Institutional Development	9,762	2,101	11,863
3	Community Empowerment	8,503	1,248	9,752
4	Monitoring and Evaluation System Development			
4.1	Engineering Items	985	1,992	2,977
4.2	Socio-Economic Items	773	110	883
5	Administration of the Project	685	508	1,193
6	Physical Contingency*	383	213	597
7	Price Contingency	2,510	24,642	27,152
GRAND TOTAL		30,978	45,683	76,661

Note : * 10% of direct construction cost of 1.3

III-5 Project Evaluation

66 Scope of Project Evaluation

Technical evaluations of the proposed watershed conservation plan were carried out through formulating necessary actions and countermeasures, while an environmental evaluation on the watershed conservation plan was implemented by environmental impact assessment. Therefore, the watershed conservation plan is evaluated here only from economic, financial and institutional points of view.

67 Analytical Approaches and Methods

In accordance with the theoretical and measurement frameworks of environmental economics, values of the economic benefits from implementation of the watershed conservation plan were calculated in monetary terms. Applied evaluation methods and estimated value for each benefit are summarized in the next table.

Annual Economic Benefit of Plan Implementation			
Benefit Items	Evaluation Method	Benefit in 14th Year (Rp. million in 2000 price)	Ratio (%)
(1) Increased water resources	Replacement cost	1.0	0.0
(2) Conserved water quality	Preventive expenditure	negligible	---
(3) Strengthened erosion and flood control capacity	(a) Replacement cost	1.3	---
	(b) Change in productivity	1.9	---
	(c) Preventive expenditure	* 426.2	9.5
(4) Conserved air quality	Replacement cost	10.4	0.2
(5) Conserved aesthetic and recreational amenity	Contingent valuation, Travel cost, or Change in productivity	negligible	---
(6) Improved forestry resources	Change in productivity	23.5	0.5
(7) Improved fishery resources	Change in productivity	unmeasurable	---
(8) Improved agricultural resources	Change in productivity	4,025.2	89.7
Total		4,486.3	100

Note : * For Item (3), the benefit estimated with the Method C is only counted ignoring double counting with the Methods A and B.

68 Economic Evaluation

Comparing the estimated economic costs by measure with the above benefits, the economic internal rate of return (EIRR) was calculated as 4.5 %. Although this EIRR is not high, it can be said that the watershed conservation plan implementation is acceptable from the social viewpoint of the Study Area, considering that intangible benefits of the watershed conservation plan such as fishery, scientific, ecological and educational values as well as non-use value were not fully counted in the cost-benefit analysis.

69 Financial Plan and Evaluation

- (1) The financial internal rate of return (FIRR) was calculated as 5.4 %, simply comparing the incremental financial costs with potential revenues. This FIRR figure is much lower than the market interest rates in Indonesia. But the watershed conservation plan could be acceptable with FIRR of 5.8 % over 0 % FIRR, because most of the measures proposed under the watershed conservation plan are for watershed conservation and not for generating internal monetary profits.
- (2) The initial investment is to rely on the international donors' soft loan, while the O & M costs are covered by domestic financial programs and by charging to local farmers as users of natural resources in the Tondano watershed. Costs for the proposed institutional measures and software works, such as planning, surveys, training and equipment, are suited to local governmental budgets or grant assistance from possible donors. Comparing the cash outflows in the proposed financial plan and cost recovery schedules with the potential financial resources, the expected provincial budget for 60 years would be able to adequately cover the cash outflow as a whole. The proposed financial plan is thus appropriate to realize sound financial management for the watershed conservation plan.

70 Institutional Evaluation

The proposed institutional plan will narrow the scope of duties in the governmental offices concerned, and thereby boost efficiency while strengthening supporting organizations in watershed conservation. The resulting institutional development will increase inter-institutional coordination, promote community involvement in partnership with forestry offices, improve the quality and quantity of extension services, encourage development of the watershed management perspective, increase awareness, and decrease apathy in the community.

III-6 Conclusions and Recommendations**71 Conclusions**

The Project is proved to be feasible and viable judging from the technical, economic, financial and institutional points of view. The proposed physical erosion control facilities are simple and could be easily constructed using locally available materials at the district level. The EIRR of 4.5 % could be economically justified since it does not involve intangible benefits such as fishery, scientific, ecological and educational values as well as non-use values that were not fully counted in the cost-benefit analysis. The FIRR of 5.4 % also recognizes that the Project is financially acceptable from the viewpoint of the public implementing agencies because most of the measures proposed are for watershed conservation, not for generating internal monetary profits. Furthermore, it is proved from institutional viewpoint that the resulting institutional development will increase inter-institutional coordination, promote community involvement in partnership with forestry offices, improve the quality and quantity of extension services, encourage development of the watershed management perspective, increase awareness, and decrease apathy in the community.

72 Recommendations

Judging from the conclusions and watershed conservation demands obtained through the Master Plan Study and Feasibility Study, it is recommended that the Project be implemented as soon as possible. In particular, in order to realize the early implementation of the Project and to ensure the sustainability of the Project, special attention should be given to the following:

(1) Urgent Establishment of Watershed Conservation Committee

The watershed conservation of Tondano including Lake Tondano is related to the plural agencies. The proper watershed conservation will thus require multi-sectoral management. The responsibilities of extant PTPA and PPTPA related to the Tondano watershed, are restricted mainly to water quota allocations, disaster control measures (flooding) and reactionary management measures focusing only on short term economic benefits, and not real integrated “forward looking” management strategies formulated for watershed conservation. Judging from such present situations, it is proposed to organize a Tondano Watershed Conservation Committee as a sub-committee of PTPA and also to establish a Tondano Watershed Conservation Board for administrative support of the committee.

(2) Urgent Application of Community Forestry

At present, about 30 ha of Soputan Protection Forest is illegally used by the village

people for agricultural activity. It is necessary to introduce the community forestry for this encroached area, to avoid its further expansion and to recover the forest function. An informal meeting with the encroached farmers related that they basically accepted preliminary idea on community forestry. It is therefore recommended that the District Forestry Services Office should play a leading roll on establishment of community forestry urgently.

(3) Arrangement of Existing Data

For the Tondano watershed, many previous studies on engineering and socio-economy have been conducted by the different government agencies. However, these study results are kept by the respective agencies, and could not be effectively used. In connection with the establishment of a Tondano Watershed Conservation Committee as well as a Tondano Watershed Conservation Board, and monitoring and evaluation system, it is recommended that one copy of all such study results be kept by the Tondano Watershed Conservation Board.

(4) Urgent Settlement of Local Government under Decentralization Policy

Due to the decentralization policy, authority has been gradually transferred to the district level. However, the district office still uses previous regulations/decrees because the new ones have not yet been issued. Consequently, the activities presently taken do not meet the decentralization policy presently. It is thus recommended that new regulations/decrees be issued as soon as possible, to realize the proper watershed conservation condition.

(5) Urgent Execution of Community Empowerment

In order to maintain the sustainable watershed conservation, the community members as a driving force, are called for active participation in community-based natural resource management and problem solving. However, there are various constraints faced by the community to become a contributor and executor of watershed conservation. Therefore, it is recommended that community should be urgently empowered to overcome such constraints and to attain the sustainable watershed conservation.

(6) Urgent Establishment of Monitoring and Evaluation System for Engineering Items

At present, sufficient meteorological and hydrological data are not available for the catchment area centering Lake Tondano. Hence, it is difficult or rather impossible to clarify the accurate soil erosion loss, water balance condition and water quality of lake water for long term. It is therefore recommended that the monitoring and evaluation system for engineering items should be established urgently, to grasp the watershed condition accurately and on time.

(7) Urgent Socialization of Results of Zoning and Watershed Conservation Plan

The results of Zoning and the Watershed Conservation Plan proposed in the Report should be urgently socialized, to realize the sustainable land use and to prevent the severe soil erosion in the watershed.

- (8) Application of Proposed Watershed Conservation Plan to Lower Watershed of Tondano
- The Feasibility Study was conducted for the Intensive Area situated around Lake Tondano. From the results of the Study, many development/improvement components for the critical land/potential critical land and protection forest were recommended in the watershed conservation plan. In the lower watershed of Tondano, which is out of the Intensive Area, there occur similar problems in the critical land/potential critical land and protection forest. It is thus recommended that the proposed countermeasures in the Feasibility Study be applied for the lower watershed area of Tondano.