Appendix-E

LAND USE

THE STUDY
ON
CRITICAL LAND
AND
PROTECTION FOREST REHABILITATION
AT TONDANO WATERSHED
IN
THE REPUBLIC OF INDONESIA

Volume II

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LAND USE

CHAPTER 1 INTRODUCTION

In Appendix-E, analysis of present land use and zoning for both the master plan of the Study Area and the feasibility study of the Intensive Area are described.

In the master plan, present land use is analyzed on a basis of land use map in scale of 1 to 50,000 which was produced by the interpretation of air photographs taken in 2000. Legal land use classifications is also reviewed for selecting proper land use categories for the land use map. The history of land use development is summarized to assist the understanding of the present land use condition of the Study Area. In the zoning section, existing land use plans and zoning guidelines are reviewed for deciding reasonable zoning categories for the master plan. Then, zoning method and the result of zoning for the Study Area are mentioned.

In the feasibility study, present land use is precisely analyzed on a basis of detailed land use map in scale of 1 to 10,000 which was produced by the interpretation of air photographs taken in 2000. Land use categories for the map was further divided into 14 categories. In the zoning section, the result of zoning for the Intensive Area is mentioned. The same zoning method with the master plan is adapted for the zoning of the Intensive Area.

CHAPTER 2 MASTER PLAN STUDY FOR THE STUDY AREA

2.1 History of Land Use Development in the Study Area

Before the contact with Europeans in 16th centuries, it is assumed that the Study Area was mainly covered with tropical rainforest. Produce of cultivation in Minahasa was mainly concentrated to the different species of yam, banana and taro.

After Portuguese introduced maize in 1560, shifting cultivation occurred. From the 16th century onwards, maize, sweet potato and rice became increasingly important. In Minahasa, the annual food crops were grown in a system of shifting cultivation, which required the period of fallow for at least three years and even up to ten years. There were two general categories of land in the system. One is an area of a primary forest, which had never been cultivated; that is called *Tallun* (in terms of *Tombulu* language in Tomohon). The other is an area which had been cultivated at some time, that is called *u'uman*. *U'uman* was further divided into four categories. Those are *Uma* (lands which are actually in cultivation at the time), *rekat* (lands which have been left as a fallow for one or two years), *sawukow* (land which have been left for four or six years and were covered with young woods), and *kaka'in* (land which have been left for many years and was already cover with large trees).

During the 16th - 17th centuries the area was described as a pathless wilderness with small cultivation patches of rice and vegetables, or clumps of fruit. Until before the 19th century, the Tondano watershed was still covered with dense forests. Agriculture fields were limited to the areas surrounding the villages.

The colonial policy of the 19th century has changed traditional land use and land tenure system dramatically. At the beginning of the 19th century, forced cultivation of perennial crops became important. By that time rice production had diminished because the Dutch had discovered that coffee, an important produce in the world market, grew exceedingly well in the highlands of Minahasa. The government monopoly on coffee began in 1824. The production of coffee in Minahasa in 1822 was only 5,360 liter, whereas it up to 201,000 liters a year in the 1830's. And it reached up to the highest point of 1,809,000 liters in 1856. There is no information about the planted area in that time. But it was recorded that each cleaned coffee tree produced from ten to twenty pounds annually in Rurukan village on June 1859. In the late 1850's the farmers who had to work hard for slight returns protested with an attitude of non-cooperation (*merajuk*). They destroyed ripe coffee beans, which caused abrupt production decrease after the peak in 1856. Amount in 1862 reached only 508,128 liters.

On the other hand, coconut trees were extensively planted in the lowland of the areas and the cultivation became more important towards the end of the 19th century. Coconut cultivation with its low-energy technology was easily incorporated the traditional cultivation technology.

Cloves were introduced to the area by the Dutch in 1890, became an ornamental plant in 1920's. Since 1950's, it became a commercial crop and well distributed in the region. The total area of the clove plantation in the region was 5,538ha in 1962 and increased up to 35,804ha in 1991. Cloves were the most important cash tree crops in the period of 1973 - 1989 during which the price soared highly and became the main source of income for the farmers. Thus it contributed to the economic development of the area. During this period the expansion of the clove plantation with other food crops caused extensive deforestation in the area and thus soil erosion occurred. Since 1989 the clove price has fallen and many clove plantations were abandoned. (Some researcher said that 60% of the clove estates were abandoned.) Some were already converted to other crops such as vanilla, cacao, or inter-cropped with food crops and vegetables.

As described above, the Study Area has experienced its dramatic change of land use system since a contact with Europeans. Especially after 19th century the land is widely disturbed by intensive mono-cultural cropping system which is easily affected by world market and the situation is still continuing even now.

2.2 Existing Land Use Plans and Zoning Guidelines

2.2.1 Regional Spatial Plan (*Rencana Tana Ruang Wilayah, RTRW*)

A general overview of Spatial Plans on a national level, provincial level, and district level are shown in Table E.2.1. The mechanism of decentralization and autonomy of regional government is more emphasized in a national development program, and regional spatial plans are used as a guideline for development planning. The Spatial Plan is based primarily on the law N0.24/1995 concerning spatial plan/spatial arrangement. Zoning for spatial utilization of Tondano Watershed in RTRWs of North Sulawesi Province and Minahasa District prepared by BAPPEDA II is summarized in Table E.2.2.

In these spatial plans, objective areas are divided into protection zone and cultivation zone in principle. The protection zone has a main function for environmental protection. Main mountain areas, which are still covered with forest and assigned as protection forest, are nominated as the protection zone. According to *RTRW* of North Sulawesi Province, Mt. Klabat and Mt. Manimpoko (a part of Mt. Soputan) are

selected as forest zone for protecting their lower areas, then, Mt. Mahawu and Mt. Soputan are for sensitive natural disaster zone. Shores of Lake Tondano as well as riverbanks of the Tondano and Tikala rivers are also nominated as lakeshore protection zone and riverbank protection zone respectively. In *RTRW* of Minahasa District, some other places are selected for protection zone as they are shown in Table E.2.2.

On the other hand, cultivation zone has a function of agriculture and other utilization. *RTRW* of Minahasa District aims at the regional development, therefore industry zone, tourism zone, and mining zone are selected. Those are included within the cultivation zone.

The protection zone in the *RTRW* seems to be reasonably selected with equal consideration for mountain areas and waterfront areas, and present good example for zoning. On the other hand, the agriculture area should be further classified rather than one cultivation zone in accordance with land capability for soil erosion and hydrological cycle, if a watershed conservation plan for sustainable land use is planned. In addition, the master plan of JICA Study Team aims sustainable land use on the emphasis of forestry and agriculture, zoning for industrial development such as industrial or tourism zones is not suitable for the objectives.

2.2.2 Master Plan of Water Resources Management of Tondano Watershed by Irrigation Office of Public Works (*PU Pengairan*)

Zoning of Irrigation Office of Public Works (*PU Pengairan*) was also reviewed in Table E.2.2. The zoning criteria also follow the same law as the Spatial Plans. As the objective of the plan of Irrigation Office is water resources management, protection zone in and around water resources is designed in detail. Besides riverbanks and lakeshores, all water springs (in radius of 200 m) are nominated as the protection zone. Because of the objective of this plan mentioned above, classification of the zoning of inland areas has less considered comparing with waterfront areas.

2.2.3 Land Rehabilitation and Soil Conservation Plan of Tondano Watershed (*POLA RLKT-DAS TONDANO)* by *BRLKT*

Pola RLKT is a general long-term plan for land rehabilitation and soil conservation (25 years) of a watershed. This plan consists of (a) recommendation of land use zone, (b) recommendation of land rehabilitation and soil conservation, and (c) critical level order of sub-watershed/watershed.

Based on its function, the watershed is divided into three zones:

- Protection Zone
- Buffer Zone
- Cultivation Zone (for perennial crops, annual crops, and settlements)

Criteria which have been used for determining recommended land use are based on three factors. These are climate/rainfall, soil types, and slope. Each factor has been classified and has had a score (see Table E.2.3). These three factors have been overlaid and the scores have been summed up. Based on the scores, the area or zone has been determined as follows:

- Protection Zone: > 174
- Buffer Zone: 125 – 174
- Cultivation Zone: < 124

It should be confirmed to avoid confusion that buffer zone in this zoning does not literary mean a buffer area for protection zone but an area having an intermediate grade in its evaluation process.

Area of Land Use Zone in Tondano Watershed

No.	Function	Area	
		Ha	%
1	Protection Zone	9,295	21.25
2	Buffer Zone	14,965	34.20
3	Cultivation Zone	16,070	36.74
4	Lake	3,420	7.81
Total		43,750	100.00

Source: Pola RLKT DAS Tondano

As a result of the process, Tondano watershed has been classified into three recommended land use zones and the distribution was mapped on a scale of 1/100.000. The area of each zone is presented in the left table.

The method adapted in this zoning is simple and good for evaluating present natural condition from the viewpoint of soil conservation. Moreover, such a quantitative evaluation is easily understood by others. However, there have been found some problems in it. At first, this method heavily depends on only slope gradient considering the present condition of a few data accumulation on rainfall and more or less uniform distribution of soil in the Study Area. Secondly, present land use is not considered in this method. To actualize any conservation plan, present land use condition should be essential and the starting point of implementation.

2.2.4 New Forestry Law

The new forestry law specifies that no one is allowed to cut trees within a radius or

distance up to:

(a) 500m from the edge of a lake

(b) 200m from the edge of water resources and alongside rivers in a swamp area

(c) 100m from alongside of rivers

(d) 50m alongside of streams

(e) 2 times the depth of a ravine from the edge of a ravine

2.2.5 Concept of Action Plan of Tondano Watershed by *BAPPEDA I*

BAPPEDA I has compiled a concept of action plan for integrated management of Tondano watershed. The concept describes the planned activities that should be implemented in an integrated way. The proposed executing agencies are indicated. Details are shown in Table E.2.4.

2.3 Legal Land Use Classifications

There are several legal classifications of land use for different purposes that have been used in Indonesia. Among the various classifications, the following 7 classifications are common.

(1) Malingreau and Christiani (1982)

Malingreau firstly published the classification in 1977 in the titled "A Proposed Land Cover/Land Use Classification and Its Use with Remote Sensing Data in Indonesia " (The Indonesian Journal of Geography 7 (33): 5-27). After the first publication, Malingreau and Christiani revised and expanded the original work with a cooperation with their colleagues attempting to apply the classification.

This classification is composed of 6 layers as follows:

a) Land use/land cover ORDER ..... e.g. vegetated area
b) Land use/land cover SUB-ORDER ..... e.g. cultivated area
c) Land use/land cover FAMILY ..... e.g. permanently cultivated area
d) Land use/land cover CLASS ..... e.g. paddy field
e) Land use/land cover SUB-CLASS ..... e.g. irrigated paddy field
f) Land Utilization Type ..... e.g. continuos rice cultivation

The land use/land cover order consists of four categories. Those are water, vegetated area, non-vegetated/non-cultivated area, and settlement and build-up area. All the categories below the order and their arrangement in a hierarchical structure

are shown in Table E.2.5.

(2) Balsem and Buurman (1989)

This classification was prepared in Land Resources Evaluation and Planning Project (LREPP) conducted by Center for Soil Research. Because of its simplicity, Ministry of Forestry and Estate Crops adopts this classification in preparing land use information for field technical plan of soil conservation and land rehabilitation recommendation (Directorate General of Reforestation and Land Rehabilitation, Department of Forestry and Estate Crops, 1998).

In the classification, land use is classified into 12 categories as follows:

1) Arable upland (*Tegal*)
2) Paddy field (*Sawah*)
3) Shifting cultivation (*Perladangan berpindah*)
4) Grass land (*padang rumput*)
5) Estate (*perkebunan*)
6) Shrub land (*semak*)
7) Agroforestry (*wanatani*)
8) Reforestation area (*Reboisasi*)
9) Forest (*Hutan*)
10) Water body (*Air*)
11) Bare land (*Tandus*)
12) Settlement (*Pemukiman*)

Each category can be further divided into several sub-categories. The whole figure of the classification is shown in Table E.2.6.

(3) Regional Physical Planning Program for Transmigration (RePPProT, 1990)

The classification used in this program is more or less similar with Balsem & Buurman Classification.

(4) Center for Soil and Agroclimate Research (PUSLITTANAK- BOGOR, 1993)

This classification was prepared as a guideline for Semi-detailed Soil Survey of the Priority Areas in the Second Land Resource Evaluation and Planning Project (LREPP II). This classification aims to identify some aspects of vegetation / land use from 6 viewpoints as follows and the detail of the classification is shown in Table E.2.7.

a) Land Cover (climatic forest, other natural forest, open vegetation, grassland,

planted tree species, estate / industrial crops, food crops, fruits, and etc.)

b) Crop and Livestock Performance (poor, average, good, and etc.)
c) Cropping Pattern (mono, mixed)
d) Land Use Type (plantation forest, estate, grazing, and etc.)
e) Farm Stage (nursery, fallow, first crop rice, second year planting, and etc.)
f) Notable Farming Practices (fertilized, drained, etc.).

(5) Kucera (North Sulawesi Water Resources Agency - Public Works, 1993)

This classification is for integrated resource surveys of proposed irrigation area (pre-feasibility level) in North Sulawesi. It is based on the Malingreau and Christiani classification and modified on the emphasis of cultivated land. This system identifies type of crops, cropping pattern and amount of annual harvest. The classification system is given in Table E.2.8.

(6) National Land Agency (Badan Pertanahan National: BPN, 1997)

This classification was prepared for land use mapping in Indonesia conducted by National Land Agency (*Badan Pertanahan Nasional*; BPN). The method is based on the regulation of Ministry of Agriculture, the Head of National Land Agency No.1/1997.

Mapping area is divided into rural areas and urban ones. An interpretation of remote sensing data (aerial photographs and/or satellite imageries) and field survey are used for the mapping of rural area. The maps are produced in scale of 1:50,000 outside of Java and Bali, while those are in scale of 1:25,000 in Java and Bali.

According to the regulation, types of rural land use are divided into 12 categories as following.

1) Settlement (*Tanah Perkampungan*)
2) Industrial area (*Tanah Industri*)
3) Mining ground (*Tanah Pertambangan*)
4) Paddy field (*Tanah Persawahan*)
5) Arable upland for annual crops (*Pertanian Tanah Kering Semusim*)
6) Home garden (*Kebun*)
7) Estate (*Perkebunan*)
8) Pasture (*Padang*)
9) Forest (*Hutan*)
10) Fresh water (*Perairan Darat*)
11) Bare land (*Tanah terbuka*)
12) Other lands (*Lain-lain*)

The sub-category of rural land use is presented in Table E.2.9.

(7) Central Bureau of Statistics (*Biro Pusat Statistik: BPS*)

Land use is classified into two categories: Paddy field (*Sawah*) and Non- paddy field. Non- paddy field consists of the following categories (Source: Agriculture Statistics of North Sulawesi, 1996. Statistics Office of North Sulawesi).

1) Home garden
2) Arable upland
3) Pasture
4) Swamp
5) Brackish water fishpond
6) Fresh water fishpond
7) Fallow land
8) Tree crops land/ agroforestry land
9) Forest (state forest)
10) Plantation
11) Others: road, channel, bare land, etc.

In addition, Office for Land Rehabilitation and Soil Conservation (*BRLKT*) prepared the land use map for the Study Area in 1999. The legend of the map has 7 categories, i.e. forest, shrub, estate, arable upland, paddy field, sago palm, and settlement. The category seems to be fairly selected to adapt the present land use distribution of the area based on Balsem and Buurman classification.

2.4 Present Land Use

2.4.1 Selection of Land Use Category for the Study Area

The present land use map of this study is prepared that will be used to analyze present land use for a further watershed conservation plan. Considering the purpose of the study and the existing classifications mentioned above, it is considered that "Balsem and Buurman" and "National Land Agency" present a good standard for the land use categories of this study because of their well balanced categorization for forest vegetation and cultivated land. Then the categories for the present land use are selected based on "Balsem and Buurman" which is adopted by The Ministry of Forestry and Estate Crops, but not contradict to "National Land Agency". The selected categories are as follows:

1) Natural / semi-natural forest
2) Secondary forest

3) Planted forest
4) Estate
5) Mixture of estate and arable upland
6) Arable upland
7) Pasture
8) Paddy field
9) Swamp
10) Water body
11) Settlement and others

2.4.2 Distribution of Each Land Use Category

A present land use map has been produced in scale of 1:50,000 on the basis of an interpretation of air photographs taken in 1991 and 2000, topographic maps, and a field survey.

Areas of each land use category are shown in a table below which is measured on the digitized land use map. A reduced land use map is produced as shown in Figure E.2.1 and a distribution of each land use category is described.

Area of Each Land Use

No.	Legend	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

Natural/semi-natural forest occupies 6.8% of the Study Area. It is almost confined on top of mountains located on fringe of the Study Area. Larger ones are on Mt. Klabat in the northeast and on Mt. Soputan in the south.

Secondary forest is distributed around Natural/semi-natural forest or along rivers. It occupies 2.3% of the area. Planted forest is sporadic in small patches in the Study Area occupying 0.1%.

Estate covers 40.6% of the Study Area. It is continuously distributed in northern and eastern part of the area. Mixture of estate and arable upland is distributed in all over the area and occupies 14.7%. The large masses are located on western hills

and southern hills of the area. On the other hand, Arable upland is mainly distributed from west to south of the Study Area occupying 10.2%. Pasture is confined in western edge of the area below Mt. Tampusu and Mt. Kasuratan. It occupies only 0.2% of the area.

Paddy field occupies 10.9% of the area. It is mainly distributed in plains on the north and south shores of Lake Tondano. Comparatively small paddy fields are found in small valleys all over the area.

Swamp occupies only 0.5% of the area. Most of them are distributed along the shore of Lake Tondano.

Water body occupies 8.6% of the area. The biggest component is Lake Tondano.

Settlement and others occupies 5.1% of the area. The main settlements are Manado in the northern tip of the area, Tondano in the middle, and Langowan in the south. Small towns and villages are distributed all over the area especially in southern half of the area around Lake Tondano.

2.4.3 Characteristics of Each Land Use Category

(1) Natural/semi-natural forest

Natural/semi-natural forest is defined here as a tree stand of continuous canopy with comparatively large crown. Although it is named as “natural” forest, certain areas are already affected by selective cutting of valuable timber trees. This forest has multi-layers of vegetation and almost all ground surfaces are covered with plants. In spite of its distribution on comparatively steep slopes, it seems to be tolerant for soil erosion because of their dense plant coverage.

(2) Secondary forest

Secondary forest is classified from Natural/semi-natural forest by its open canopy or comparatively small crown. This area was supposed to be once intensely cut and then re-generated. Most of this forest has multi-layers of vegetation and almost all ground surfaces are covered with vegetation.

(3) Planted forest

Planted forest is distributed in small patches. Planted forest mainly consists of legume species such as kaliandra (*Caliandra calothyrsus*) and gamar (*Glyricidia sepium*). Those usually grow densely and cover ground surface well.

Although there are many planting activities and there exist many small scale planted

forests in the Study Area, those are very small in their area for describing as planted forest on the map. Moreover trees are very often planted as a single tree among cultivated lands and those planted area is included in following category such as Estate or Arable upland.

(4) Estate

Estate is classified here with density of tree coverage more than 75% from other dry cultivated land. The main tree species are coconuts in northern area and cloves in eastern area. Under the tree crops, many other crops are often cultivated but ground coverage seems to be fairly high through a year.

(5) Mixture of estate and arable upland

Mixture of estate and arable upland is defined as an area, which is used for dry cultivated land with the coverage of trees or tree crops canopies of between 25% and 75%. (More than that is classified as Estate and less than that is as Arable upland.)

Planted tree species are varied from estate crops such as cloves and coconuts to timber trees such as cempaka (*Elmerrillia spp.*). Fruits tree species are also often used. Ground surface coverage is lower than Estate.

(6) Arable upland

Arable upland is defined here as a dry cultivated land with tree coverage of less than 25%. The main crops are maize, many kinds of vegetables, groundnut. As a nature of Arable upland, ground coverage of vegetation is rather low. After plowing the ground surface, ground coverage of vegetation is minimized and the erosion potential becomes in maximum. In the field observation, such bare ground surface is soon recovered by growth of planted crops or weeds.

(7) Pasture

Although small pastures are found all over the area, those are included in Arable upland because the most of them are used as a pasture land in a system of cropping rotation. The coverage of the grass is varied but usually 60~70% by the field observation.

(8) Paddy field

Most of paddy fields are located in flat topographic feature around Lake Tondano. Some are distributed along valleys.

As a nature of paddy field, all of them are terraced and have few possibility of a source of soil erosion. On the contrary paddy fields located downstream of rivers can be a sink of soil particles.

(9) Swamp

Swamp consists of wet grass lands and some small sago palm forests. As same as paddy field, swamps have few possibility of a source of soil erosion in the Study Area because of its location and flat topographic feature.

(10) Water body

Water body consists of Lake Tondano and rivers flowing into and out from the lake. Water hyacinth (*Eichhornia crassipes*) is propagates in the lake. It is observed that clams of the aquatic plant drift toward the outlet of the lake.

Some ponds are sporadic among a paddy field in low plain. Besides them, there are many fishponds in the Study Area but because of their small scales, those are not identified on the map.

(11) Settlement and others

Settlement and others consists of lands with artificial groundcover such as houses, stadiums, and road. It includes home gardens behind of individual houses if there is a difficulty of separating the gardens as cultivated lands from the houses.

2.4.4 Slope Gradient and Land Use

A slope gradient map is shown in Figure E.2.2. The map was produced on the basis of the topographic map in scale of 1:50,000 and Terada method was adapted. In the method, square grids have been drawn on the base map and the number of the contour lines within an inscribed circle of the grid has been counted. Then calculation has been carried out following the expression shown below. 15 second of latitude and longitude which corresponds to about 463m around the Study Area is used as a grid unit.

$$Degree(\%) = N \times I \times 100 \,/\, D \times S$$

N : the number of the contours in a circle
I : interval of altitude between each contour line (25m)
D : diameter of a circle (9.26mm)
S : scale of the base map (50,000)

Steep slopes (more than 40.5% of slant) are distributed on Mt. Klabat in the north, on Mt. Soputan and Mt. Manimporok in the south, along the eastern edge of the Study Area, around Mt. Masarang and Mt. Tingtingon in the middle, and along the upper valley of Tondano River. On the other hand, flat areas (less than 8.1% of slant) are distributed in northern part of the area, the north shore of Lake Tondano, and southern part of the Study Area.

Comparing the land use map and the slope gradient map, relation between slope gradient and land use has been analyzed. Most of the steep slope areas seem to be covered with forests (Natural/semi-natural forest or Secondary forest).

2.5 Zoning of the Study Area

2.5.1 Zoning Guideline and Method

The purpose of this Master Plan is to achieve ***sustainable land use*** by preventing a creation of critical lands. Critical lands should be considered from the viewpoints of both a vegetation side and land productivity side (including water resources). It should also be considered, of course, that sustainable land use is for local residents in the Study Area. Zoning of the Study Area is thus done taking into account the purpose mentioned above. The flow of zoning process is shown in Figure E.2.3. Considering the land evaluating system adapted by *BRLKT*, simple scoring method has been employed for this zoning.

On the basis of the study of the present condition of the Study Area, it was considered that main elements, which support ***sustainable land use*** in the area, were these three as follows:

(a) Sound hydrological condition
(b) Sound ecosystem
(c) Productivity of soil

Therefore, the criteria of zoning have been selected as shown below. The method of *BRLKT* can evaluate potential critical land for soil degradation using 3 indicators i.e., rainfalls, slope gradient, and soil types. Two other criteria, sensitivity on hydrological cycle and fragileness of ecosystem, have been added to reflect these important factors to the Master Plan aiming at sustainable land use.

(a) Sensitivity on hydrological circulation
(b) Fragileness of ecosystem
(c) Potential for soil degradation

Then evaluation on each criterion has been carried out in the following process.

(a) Distribution of sensitive area on hydrological circulation

The identification of a hydrologically sensitive area such as headwater in steep slopes and river shore is selected. The distribution is shown in Appendix-H.

(b) Distribution of fragileness of ecosystem

A few studies have been carried out for clarifying the ecosystem and bio-diversity of the Study Area. Areas covered with natural vegetation are assumed to have a comparatively high bio-diversity and these areas are rather fragile and sensitive to human disturbance. Although most of the Study Area has been once affected by human activities, a less disturbed area is selected as an area with high bio-diversity on a basis of the land use map shown in Figure E.2.1. Those are Natural/semi-natural Forest, Secondary Forest, and Swamp.

(c) Distribution of potential critical area for soil degradation:

The identification of a potential critical area for soil degradation has been prepared on a basis of slope gradient, rainfall, soil type, and geological aspect. The result is shown in Appendix-H. Criteria which is used for determining recommended land use in *POLA RLKT* e.g. rainfall, slope gradient, and soil types, are included and reflected in this criteria.

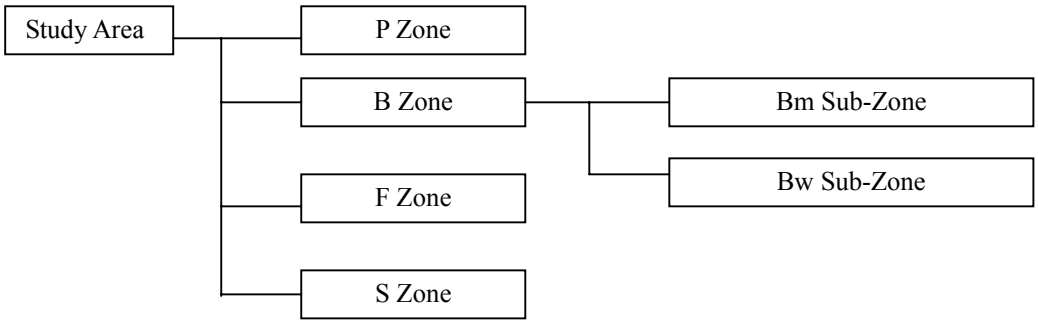
After producing the three maps mentioned above, those are overlaid and an evaluation map of the sensitivity area for sustainable land use is produced. In the map, overlaid areas of these criteria have been identified as highly sensitive areas.

Then zoning has been carried out on the basis of this evaluation map. Triple overlaid areas seem to have high priority to be protected in watershed management. Then double overlaid areas have second priority for conservation measures. At this time, not only a result of the evaluation map but also continuity of the area and present boundary of protection area should be considered for effectiveness of the Master Plan. It should be also reminded that areas alongside rivers are designated as protection areas from tree cutting by the new forestry law.

2.5.2 Zoning of the Study Area

Overlaying the three maps mentioned in the previous section is shown in Figure E.2.4. Sensitive areas for watershed conservation have been identified. Most of them are distributed along a fringe of the Study Area. Then a zoning map has been

prepared using the evaluation map, as shown in Figure E.2.5. The Study Area has been classified into four zones: P Zone, B Zone, F Zone, and S Zone. B Zone has been further divided into Bm Sub-Zone and Bw Sub-Zone. The evaluation of each zone is described in Sub-Section 2.5.3. P Zone and B Zone has been selected on the basis of the evaluation map and other factors mentioned in Sub-Section 2.5.1. On the other hand, the rest of the Study Area has been designated as F Zone and S Zone. Demarcation of F Zone and S Zone is on the basis of present land use.



2.5.3 Evaluation of Respective Zones

Evaluation of respective zones are as follows.

1) P Zone

All of the existing protection forest is included in this zone. The first priority of this zone is to protect forest stands. Enforcement of law, reforestation, and planting with people's participant such as Community Forest (*Hutan Kemasyarakatan*) are possible strategy.

2) Bm Sub-Zone

Bm Sub-Zone distributes below Protection zone and has a function of "buffer" for Protection zone. Bm Sub-Zone extends East and West sides of Lake Tondano and northern part of the Study Area. Some activities with slight disturbance of ground surface and vegetation are acceptable with care. Afroforestry, proper agricultural method, planting trees with people's participant such as People's Forest (*Hutan Rakyat*) are possible strategy.

3) Bw Sub-Zone

Bw Sub-Zone distributes along shore of Lake Tondano and alongside main rivers in the Study Area expected to function as a buffer for a fragile waterfront. Green belt, planting trees with people's participant such as People's Forest (*Hutan Rakyat*) are possible strategy.

4) F zone

It is distributed in intensive farming areas mainly on south and north shore of Lake Tondano and northern edge of the Study Area. Intensive farming is acceptable but propagating proper agricultural method such as contour farming is possible strategy. The agroforestry system is also applicable, but careful consideration shall be given to higher productivity.

5) S zone

S Zone is distributed in settlement areas of the Study Area. Maintain social condition such as sewage system in good level for preventing water resources.

CHAPTER 3 FEASIBILITY STUDY FOR THE INTENSIVE AREA

3.1 Present Land Use

3.1.1 Land Use Category for the Intensive Area

In the Master Plan Study, the "Balsem and Buurman classification" was used for selection of land use categories for the preparation of land use map, because of its well balanced categorization for forest vegetation and cultivated lands, and taking it into account that it is presently adopted by the Ministry of Forestry.

In the Feasibility Study, a detailed land use map for the Intensive Area has been prepared using a topographic map in a scale of 1/10,000. The category of this land use map has been decided on the basis of the former land use map in a scale of 1/50,000. In the following new category, "Planted forest" is further divided into "Planted forest (Timber)" and "Planted forest (Fuel wood)" by purpose of main usage. "Estate" is also divided into two categories on the basis of dominant tree crops. The category of "Bush" is newly established.

1) Natural / semi-natural forest,
2) Secondary forest,
3) Planted forest (Timber),
4) Planted Forest (Fuel wood),
5) Bush,
6) Estate (Clove),
7) Estate (Other tree crops, or mixture of various tree species),
8) Mixture of estate and arable upland,
9) Arable upland,
10) Pasture,
11) Paddy field,
12) Swamp,
13) Water body, and
14) Settlement and others

3.1.2 Distribution of Each Land Use Category

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

The land use map has been produced on a basis of an interpretation of aerial photograph taken in May 2000, topographic maps, and a field survey. Then the result has been digitized.

Areas of each land use category are shown in the right table which is measured on the digitized land use map. A reduced land use map is shown in Figure E.3.1, E.3.2, and E.3.3 and a distribution of each land use category is described.

"Natural/semi-natural forest" occupies 9.5% of the Intensive Area. It has been almost confined on the top of mountains located on fringe of the Intensive Area. The largest one is on Mt. Soputan in the South Area. "Secondary forest" is distributed around Natural/semi-natural forest or along rivers. A large extent is observed on northeastern slopes of Mt. Soputan. It occupies 5.0% of the area.

"Planted forest (Timber)" is distributed mainly in the southern part of the Intensive Area occupying 0.2%. "Planted forest (Fuel wood)" is also sporadic but can be found in all the Intensive Area. It occupies 3.8% of the area in total. It is especially concentrated in the West Area of the Intensive Area.

"Bush" is mainly distributed in small patches in the steep area of upper slopes, occupying 2.0%.

"Estate (Clove)" covers 8.0% of the Study Area. Large "Estate (Clove)" is found in the East Area. Contrarily, "Estate (Clove)" is distributed in rather small patches in the South and West Areas. "Estate (other tree crops, or mixture of various tree species)" is distributed all the Intensive Area covering 20.6%.

Mixture of estate and arable upland is distributed all over the area and occupies

15.3%. The large masses are located in the South Area. On the other hand, "Arable upland" is mainly distributed from the South Area to the West Area occupying 26.3%. "Pasture" is confined in western edge of the West Area below Mt. Lengkoan. It occupies only 0.3% of the area.

"Paddy field" occupies 5.4% of the area. It is mainly distributed in plains on the fringe of the Intensive Area. "Swamp" occupies only 0.2% of the area. Most of them are distributed along the shore of Lake Tondano.

"Water body" is only 6.0 ha because Lake Tondano, the biggest water body of Tondano Watershed, is not included in the Intensive Area. But the West Area and East Area adjoin the lake.

"Settlement and others" occupies only 3.4% of the area. As large settlements such as Tondano and Langowan are excluded from the Intensive Area, almost all the settlement areas in the Intensive Area are rather small. The main settlements are Tataaran and Kasuratan in the West Area, Tumaratau and Noongan in the South Area, and Touliang Oki and Tandegan in the East Area.

3.1.3 Distribution of Land Use in Three Areas

There are three areas in the Intensive Area and each area has the characteristic distribution of land use. Areas of each land use category by each area are shown in Table E.3.1.

(1) East Area

This area topographically consists of rather steep slopes and drainage density is high comparing with other two areas. Estate (Clove) (22.0%) and Estate (Other tree crops, or mixture of various tree species) (20.5%) are dominant land use. A large extent of Estate (Clove) is mainly distributed in the middle part of the area.

Though most of this area is developed for the estate and arable upland up to a dividing ridge, forest still remains in the upper slopes, for example on Mt. Kaluta (Lembean) in the northern part and Mt. Kaweng in the southern part. Natural/semi natural forest and Secondary forest occupy 11.9% of the East Area. Planted forest (Timber) is also found on hills north to Mt. Kaweng.

Arable upland is sporadic among the estates occupying 11.0% of the area. Settlement and Paddy field are located in the eastern fringe along Lake Tondano.

(2) South Area

This area mainly extends on the eastern slopes of Mt. Soputan and Mt. Manimporok.

The part with the highest elevation is mainly covered with Natural/semi-natural forest (21.6%), and Secondary forest is distributed just below the Natural/semi-natural forest covering 14.1% of the area. Cultivated areas such as Arable upland are sporadically distributed among Secondary forest. Planted forest (Timber) is also distributed among the upper part of Secondary forest.

Lower area is mainly covered with Mixture of estate and arable upland and Arable upland in mosaic. The former occupies 21.7% and the latter covers 25.2% of the South Area respectively. Settlements are distributed in a line along the lower fringe of the South Area. Paddy field is also distributed in lower plain sporadically.

Two types of estates occupy only 8.5% of the area in total.

(3) West Area

This area topographically consists of a complex of gentle plateaus and surrounding steep slopes in principle. The gentle slopes tend to be occupied by Arable upland, and surrounding slopes are mainly covered by Estate (Others). The northern part of the area where drainage density is rather high is also covered with Estate (Others). Arable upland covers 36.8% of the area, and Estate (Others) covers 29.0%. Estate (Clove) is found but only in a few locations with small patches (3.9%).

Natural / semi-natural forest is confined on upper slopes of Mt. Tampusu, Mt. Kasuratan, and Mt. Lengkoan. It occupies 1.3% of the area. Planted forest (Fuel wood) is distributed in many places occupying 7.0% of the area. There distribute large ones on the northeastern slopes of Mt. Tampusu and on Pinasuan hills.

3.1.4 Characteristics of Each Land Use Category

(1) Natural/semi-natural forest

"Natural/semi-natural forest" is defined here as a tree stand of continuous canopy with comparatively large crown. Although it is named as "natural" forest, some areas are already affected by selective cutting of big and valuable timber trees. This forest has multi-layers of vegetation and almost all ground surfaces are covered with plants. In spite of its distribution on comparatively steep slopes, it seems to be tolerant for soil erosion because of their dense plant coverage. Most of "Natural/semi-natural forest" is confined within Protection Forest areas.

(2) Secondary forest

"Secondary forest" is mainly classified from "Natural/semi-natural forest" by its comparatively small crown. This forest is supposed to have been strongly affected

by human activities such as intensive logging or fuel wood collecting. Most of this forest still has multi-layers of vegetation and almost all ground surfaces are covered with vegetation.

(3) Planted forest (Timber)

"Planted forest (Timber)" here mainly consists of pine (*Pinus merukusii*) plantations. Most of the pine forests defined here are mature with more or less 20 m in height with a closed canopy.

cempaka (*Elmerrillia sp.*) and mahogany (*Swientenia sp.*) are also main timber species, but most of them are very often planted as a single tree or on the line among cultivated lands in low density. Therefore, those planted areas are included in the following categories such as "Estate" and "Arable upland".

(4) Planted forest (Fuel wood)

"Planted forest (Fuel wood)" mainly consists of legume species such as kaliandra (*Caliandra calothyrsus*) and gamar (*Gliricidia sepium*). Those are usually planted densely (per/m^2 in the most case) and cover ground surface well. These trees are periodically cut (supposed to be 2 or 3 years in interval), and the average height of the trees is not more than 7 m.

Some of gamar (*Gliricidia sepium*) forests are supposed to grow from stays of vanilla after vanilla estates were abandoned.

(5) Bush

"Bush" mainly consists of a mixture of some shrub species and tall grass species. It is assumed that these bushes are established on areas which were once tried to be used for cultivation and later abandoned for more than 5 to 10 years because of its low productivity. Alang-alang (*Imperata cylindrica*) grassland is also included into this category.

(6) Estate (Clove)

"Estates (Clove)" are classified here with density of tree coverage more than 75% from other dry cultivated land. Among the estates, Estate (clove) is distinguished from other estate by the existence of dominant clove trees in an upper layer. Cloves are normally planted at 6 m in interval.

Under the cloves, some annual crops such as maize are sometimes cultivated with plowing. If there is no annual crops, the ground surface is covered with grasses.

(7) Estate (Other tree crops, or mixture of various tree species)

Estates except clove-dominant one are classified into this category. There is a few estates consisting of other single tree crop such as coconut in the Intensive Area, but most of them consist of a mixture of various tree species. Sugar palm (*Arenga pinnata*), bamboo (*Bambusa sp.*), *kemeri* (*Aleurites moluccana*), and other useful species compose forest-like structure with other naturally growing species. Because of its forest-like structure, it is often difficult to distinguish it from "Secondary forest". But the existence of some tree species mentioned above are used for the indicator of this category. Timber species such as cempaka (*Elmerrillia sp.*) and mahogany (*Swientenia sp.*) are also found in this tree complex. Ground coverage seems to be fairly high through a year.

(8) Mixture of estate and arable upland

"Mixture of estate and arable upland" is defined as an area, which is used for dry cultivated land with the coverage of trees or tree crops canopies of 25~75%. (More than that is classified as Estates and less than that is as Arable upland.)

Planted tree species varies from estate crops such as cloves and coconuts to timber tree such as cempaka (*Elmerrillia spp.*). Fruit trees such as banana and coconut are also often used. Kanonan (*Cordia blancoi*), main usage of which is as fuel wood, is often grown in the South Area.

In the South Area, planted tree species tend to consist of timber and fuel wood trees, which seem to be located randomly in a field. On the other hand, it is often observed that estate crops and fruit trees are planted in a line along ridges neatly in the West Area.

(9) Arable upland

"Arable upland" is defined here as a dry cultivated land with tree coverage of less than 25%. The main crops are maize, many kinds of vegetables, and beans. As a nature of "Arable upland", ground coverage of vegetation is rather low. After plowing the ground surface, ground coverage of vegetation is minimized and the erosion potential becomes in maximum. In the field observation, such bare ground surface is soon recovered by growth of planted crops or weeds. Except some intensive farming areas, a few trees planted or left is usually observed among the areas (less than 25% of ground coverage as mentioned above).

(10) Pasture

Although small pastures are found all over the area, those are included in "Arable upland" because most of them are temporarily used as pasture lands in a system of cropping rotation. Only one extensive pasture is identified and its coverage of the grass is estimated between 60~70% by the field observation.

(11) Paddy field

Most of paddy fields are located in flat topographic feature in low elevation of the Intensive Area. As a nature of paddy field, all of them are terraced and have few possibility of a source of soil erosion. On the contrary, paddy fields located downstream of rivers function as a settling basin of the eroded soil.

(12) Swamp

Swamp consists of muddy plain with some grass species such as sedges. Sometimes sago palm trees are found. Most of the swamp is distributed along the shore of Lake Tondano and its extent is affected by water level of the lake.

(13)Water body

"Water body" in the Intensive Area defined on the map is only a small pond in the West Area. Small rivers are distributed all the Intensive Area, but their width is less than a few meters. The biggest river in the area is the Saluwangko River originated from Mt. Manimporok, but the water is normally dried up in its most part because of the high capability of water absorption of the soil.

(14) Settlement and others

"Settlement and others" consists of lands with artificial groundcover such as houses, stadiums, and road. It includes some home gardens of individual houses if there is a difficulty in separating the gardens as cultivated lands from the houses because of their mosaic distribution.

3.2 Zoning of the Intensive Area

3.2.1 Zoning Guideline and Method

In the Master Plan Study, zoning of the Study Area was carried out along a flow shown in Figure E.2.3. Detailed data of slope gradient, rainfall, soil and geology, and present land cover have been utilized as indicators of each criterion for the zoning of the Intensive Area. After the selection of sensitive area for sustainable

land use, present boundary of protection forest and distance from the lakeshore have been considered to draw the boundary of each zone for effectiveness of the plan. Continuity and extent (about 10 to 15ha in one patch) has been also considered to avoid complicated zoning distribution for further implementation program.

Government regulation for protected area (riverbanks) has been also taken into account, but it has been concluded that special zone is not necessary for riverbanks in the Intensive Area because all the rivers in the area are so small and countermeasure should be united with that of mountain slope areas.

On the other hand, in the feasibility study of the Intensive Area, areas for second priority for conservation measure are further divided into three zones (Bm1, Bm2, and Bm3) mainly based on slope gradient which is the most important factor for soil conservation when land conservation measure is planned.

3.2.2 Zoning of the Intensive Area

As a result of the works mentioned above, zoning map of the Intensive Area has been produced as shown in Figure E.3.4. 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 map and other factors mentioned above. On the other hand, rest of the Intensive Area has been designated for F Zone and S Zone. Demarcation of F Zone and S Zone has been on the basis of present land use.

Area of Each Zone

Zone	Area (ha)	Ratio (%)	Zoning in Master Plan Study
P Zone	1,460	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	

The area of each zone is shown in the right table. P Zone occupies 1,464ha (12.3%) of the Intensive Area. It is mainly distributed on the highest parts on fringe of the Intensive area. The biggest P Zone is located in southern part below Mt. Soputan and Mt. Manimporok. Bm1 Zone occupies 1,993ha (16.7%). It is mainly located in middle slopes of the East Area. 4,306ha (36.1%), the largest area is shared for Bm2 Zone. The main location is the West Area, middle slopes of the South Area, and lower slopes of the East Area. Bm3 Zone occupies 1,696ha (14.3%) and mainly located on gentle plateaus of the West Area and middle slopes of the South Area.

Bw Zone has only 94ha (0.8%) of the Intensive Area. It is located along the shore areas of Lake Tondano in the East and West Areas. Areas between shorelines and main road along the lake are dedicated for the zone. F Zone and S Zone are located in lower and flat parts occupying 2,075ha (17.5%) and 270ha (2.3%) respectively.

Characteristics of zoning for each area are summarized as follows.

1) East Area

Bm1 Zone is widely arranged in the East Area mainly because of its steep topographic feature. P Zone is located on top of mountains sporadically. Masses of Bm2 Zone occupy lower slopes. Bw Zone is arranged along the shore areas of Lake Tondano.

2) South Area

The belts of the zones are formed in the South Area. Western part (the highest part) is occupied by P Zone and eastern part is occupied by F Zone. Bm2 Zone and Bm3 Zone are arranged between them. Bm1 Zone is located in 2 parts below P Zone.

3) West Area

In the West Area, Bm2 Zone is arranged widely and Bm3 Zone is sporadic among Bm2 Zone. Three small patches of P Zone are located on top of mountains. Bm1 Zone is arranged in northern part of this area where slope gradient is rather steep and density of valley is comparatively high. Bw Zone is arranged along the shore areas of Lake Tondano.

3.2.3 Evaluation of Respective Zones

Evaluation of respective zones are as follows.

(1) P Zone

Most of this zone is on steep slopes (more than 40%). All the existing protection forests are included in this zone. The first priority of this zone is to maintain well-stocked forest stand. Enforcement of law, reforestation, and planting with people's participant such as Community Forestry (*Hutan Kemasyarakatan*) are possible strategy.

(2) Bm1 Zone

Bm1 Zone mainly distributes on rather steep slopes and most of the area is covered

with non-forest vegetation at present. Areas with slope gradient over 40% is often included. Tree dominant agroforestry, reforestation, and planting with people's participant such as Private Forest (*Hutan Rakyat*) are possible strategy.

(3) Bm2 Zone

Bm2 Zone is mainly located on slightly steep slopes (between 15 and 40% in principle). Agroforestry, proper farming practice, planting with people's participant such as Private Forest (*Hutan Rakyat*) are possible strategy.

(4) Bm3 Zone

Bm3 Zone is mainly on rather gentle slopes (less than 15%). Sometimes include areas of slope gradient more than 15% with non-rugged topographic features. Most of this area is used as dry upland. Intensive farming with care such as contour farming and planting trees in hedge is acceptable.

(5) Bw Zone

Bw Zone is distributed along shore of Lake Tondano. Most of the area is on rather steep slopes. Green belt, planting with people's participant such as Private Forest (*Hutan Rakyat*) are possible strategy.

(6) F Zone

Intensive farming is acceptable, which introducing tree species in the area is recommendable measure for supply of fuel woods.

(7) S Zone

Maintenance of social condition such as sewage system in good level should be done for preserving water resources.

Tables

Table E.2.1 General Overview of Spatial Plan (*Rencana Tata Ruang Wilayah, RTRW*)

No.	S P A T I A L P L A N (*RENCANA TATA RUANG WILAYAH, RTRW*)		
	NATIONAL LEVEL	**PROVINCIAL LEVEL**	**DISTRICT LEVEL**
COVERAGE	Strategic and recommended policy of the national spatial utilization that consist of: a. national objectives of spatial utilization for improving community welfare and security defense. b. Structure and pattern of national spatial utilization c. Criteria and pattern of the management of protected zone, cultivation zone and specific zone.	Spelling out of the strategic and recommended policy of the national spatial utilization into structure and strategy of provincial spatial utilization that consist of: a. Provincial objectives of spatial utilization for improving community welfare and security defense. b. Structure and pattern of provincial spatial utilization c. Guidance for provincial spatial utilization control	Spelling out of the provincial spatial utilization into the implementation strategy of provincial spatial utilization that consist of: a. District objectives of spatial utilization for improving community welfare and security defense. b. Structure and pattern of district spatial utilization plan c. General plan and spatial plan of district d. Guidance for controlling district spatial utilization
CONTENT	a. National protection zone, cultivation zone, and specific zone b. Condition and criteria of spatial utilization c. Guidance for spatial utilization control	a. Recommendation of the management of protection and cultivation zone, b. Recommendation of the management of rural zone, urban zone, and specific zone. e. Recommendation of zone development for settlements, forestry, agriculture, mining, industry, tourism and others. f. Recommendation of central system development for rural and urban settlements g. Recommendation of regional infrastructure systems: transportation, telecommunication, energy water resources, and environment management, h. Recommendation of the priority zone, i. Recommendation policies of land use plan, water use plan, space use plan, other natural resources use plan, and pay attention for the integrity of human and artificial resources.	a. The management of protection zone and cultivation zone b. The management of rural zone, urban zone, and specific zone, c. Systems of development activities and rural and urban settlements d. Infrastructure systems of transportation, telecommunication, energy, water resources, and environment management e. Land use plan, water use plan, space use plan, other natural resources use plan, and pay attention for the integrity of human and artificial resources.
GUIDELINES FOR	a. Formulation of integrity, interrelatedness, and balance of inter-region development and inter-sector harmony b. Creating integrity, interrelatedness, and balance of inter-region development and inter-sector harmony c. Recommendation of investment place d. Provincial and district planning	a. formulation of main provincial spatial plan policies b. Creating integrity, interrelatedness, and balance of inter-provincial development and inter-sector harmony c. Recommendation of investment place d. District spatial planning which is a basis for controlling the permission of development location	a. formulation of main district spatial plan policies b. Creating integrity, interrelatedness, and balance of inter-district development and inter-sector harmony c. Determining location of investment d. Formulating detailed district spatial plan e. Using land/space for development activities
PERIOD	25 years	15 years	10 years
REGULATION	Government regulation (*peraturan pemerintah*)	Regional regulation (*peraturan daerah*)	Regional regulation (*peraturan daerah*)
SCALE/INTENSITY	Minimum 1 : 1.000.000	Minimum 1 : 250.000	Minimum 1 : 100.000

Table E.2.2 Zoning of Spatial Utilization in Tondano Watershed (1/2)

No	ZONES	Location according to		
		Provincial Spatial Plan (*RTRW Propinsi*) by *BAPPEDA PROPINSI*	District Spatial Plan (*RTRW Kabupaten*) by *BAPPEDA Minahasa*	Zonation of TWS by *PU Pengairan*
A	**RECOMMENDATION OF STABILIZING PROTECTED ZONE**			
A.1	ZONE FOR PROTECTING ITS LOWER AREA 1. PROTECTED FOREST ZONE 2. WATER ABSORPTION ZONE	Mt.Klabat, Mt.Manimporok Protected forest and Tondano watershed	Mt. Klabat, Mt. Lembean, Mt. Mahawu, Mt. Masarang, Mt. Tampusu, Mt. Lengkoan, Mt. Kawatak, Mt. Soputan Protected forest and Mt. Manimporok	Districts of Tompaso, Langowan, Kakas, Remboken, Eris, Tondano, Tomohon, Pineleng, Kauditan, Airmadidi ----------same as above----------
A.2	IN-SITU PROTECTION ZONE 1. RIVER BANK ZONE 2. SURROUNDING LAKE ZONE 3. SURROUNDING WATER SPRING ZONE	 River Tondano Lake Tondano Not yet indicated	 River Tondano (100 m of left-right side), River Tikala (50m of left-right side) Lake Tondano (50 – 100 m surrounding lake), Lake Sendow (50 m surrounding lake) Not yet indicated	 River Tondano and River Tikala Lake Tondano All water spring in the catchment (in radius of 200 m)
A.3.	NATURAL AND CULTURAL RESERVE ZONE 1. NATURAL RESERVE ZONE 2. CULTURE RESERVE ZONE	Not indicated Not indicated	Not indicated Ancient Tomb in Sawangan-Airmadidi	Tomohon and around the lake (ecotourism park) Not indicated
A.4.	SENSITIVE NATURAL DISASTER ZONE 1. VOLCANOES ERUPTION 2. MASS MOVEMENT/LANDSLIDE 3. FLOODING	Mt.Mahawu, Mt.Soputan Not indicated Not indicated	Mt. Mahawu, Mt.Soputan Telap – Tasuka Not indicated	Not indicated Not indicated Cities of Manado and Tondano
B	**RECOMMENDATION OF DEVELOPMENT OF CULTIVATION ZONE**			
B.1	PRODUCTION FOREST ZONE	-	-	
B.2	AGRICULTURE ZONE 1. WETLAND CEREAL CROPS ZONE 2. ESTATE AND CEREAL DRYLAND FARMING ZONE 3. ANIMAL HUSBANDRY ZONE 4. FISHERY ZONE		 Tondano, Kakas, Remboken, Langowan Clove cultivation: Kombi, Eris, Kakas, Tomohon, Tondano, Pineleng; Coconut cultivation: Airmadidi, Pineleng, Dimembe; Coffee cultivation: Tomohon, Langowan, Tompaso, Kakas, Kawangkoan; Nutmeg cultivation: Kauditan, Airmadidi; Cinnamon cultivation: Langowan Fruit trees: Dimembe (*Nephelium, Durian*); Vegetables: Tomohon, Remboken, Kawangkoan; Floriculture: Remboken Poultry commodity (Ducks): Remboken, Kakas, Tondano Livestock: Langowan (Goat) Animal Husbandry: Langowan, Tomp[aso, Tondano (Sapi, Kuda) Freshwater fish: Kakas, Eris, Tondano (around lake Tondano)	 Tompaso, Kakas, Tondano, Eris, Airmadidi, Langowan <u>Cereal dryland farming:</u> Tompaso, Langowan, Eris, Remboken, Tondano, Airmadidi <u>Estates Crops:</u> Langowan, Eris, Remboken, Tondano, Airmadidi, Mapanget, Kauditan, Tomohon, Pineleng <u>Animal Husbandary</u>: Tondano, Langowan, Remboken, and Tomohon Lake Tondano, Airmadidi, River Tondano
B.3	ZONE OF MINING	Not indicated	Digging (*Galian C)*: Maumbi, Noongan, Districts of Langowan, Dimembe (Klabat) have to be monitored periodically	-

Table E.2.2 Zoning of Spatial Utilization in Tondano Watershed (2/2)

No	ZONES	Location according to		
		Provincial Spatial Plan (*RTRW Propinsi*) by *BAPPEDA PROPINSI*	**District Spatial Plan (*RTRW Kabupaten*) by *BAPPEDA Minahasa***	**Zonation of TWS by *PU Pengairan***
B.4.	ZONE OF INDUSTRY	Not indicated	Tourism industry (mountain, lake tourism) and agroindustry: Districts of Tomohon, Langowan, Kakas, Eris, Tondano, and Remboken	
B.5.	ZONE OF TOURISM		Main tourism zone of Tomohon – Tondano and its surrounding: Water tourism, ecotourism (agrictourism)	Langowan, Tompaso, Remboken, Tondano, Tomohon, Airmadidi, Manado
B.6.	ZONE OF SETTLEMENTS		Development of planned housing: Airmadidi, Pineleng, Tondano, Kauditan, Remboken, Langowan, Kawangkoan; Resting places: Tondano, Remboken, Kakas; Labor housing: Kauditan, Airmadidi	All kecamatans
C.	**RECOMMENDATION OF DEVELOPING RURAL ZONE**			
D.	**RECOMMENDATION OF DEVELOPING URBAN ZONE**			
E.	**RECOMMENDATION OF SPECIFIC ZONE**			
E.1.	INTEGRATED ECONOMIC DEVELOPMENT ZONE (***KAPET***) MANADO - BITUNG		Manado – Bitung corridorr (core zone of *KAPET* industry	
F.	**RECOMMENDATION OF DEVELOPING AND MANAGING PRIORITY ZONE**			
F.I.	DEVELOPING STRATEGIC ZONE 1. WATER TOURISM: LAKE TONDANOT		Integrated with other tourism activities as like *FESBUDATON* (in Paleloan village), Pottery handycraft industry (Pulutan village)	
F.2.	DEVELOPING GROWTH REGIONAL TRIGGER ZONE		-	
F.3.	DEVELOPING FAST GROWTH AREA 1. CORRIDOR OF MANADO – BITUNG 2. CORRIDOR OF MANADO – TOMOHON		Along corridor Manado – Bitung Along corridor Manado – Tomohon	
G.	**DEVELOPING SPECIAL ZONE** 1. MANADO – BITUNG HIGHWAY 2. TONDANO RIVER DAM		Along the planned higway Not yet indicated	

Sources :

1. *Review of Spatial/Land Use Plan of North Sulawesi (Review **Rencana Tata Ruang Wilayah PropinsiSulawesi Utara**). 2000. Regional Government of Province of North Sulawesi. Manado.*
2. *Review of Spatial/Land Use Plan of District of Minahasa (Review **Rencana Tata Ruang Wilayah Kabupaten Minahasa**). 1997. Regional Government of District of Minahasa. Tondano*
3. *Zonation of Tondano Watershed (**Pekerjaan Penataan Kawasan DAS Tondano**). 1997. Dinas Pekerjaan Umum Propinsi Sulawesi Utara. Manado.*

Table E.2.3 Scores for Determining Recommended Land Use

1. Classification of Intensity of Daily Rainfall and its Score

No	Intensity of daily rainfall (mm/day)	Class	Score
1.	< 13.60	very low	10
2.	13.6 – 20.7	low	20
3.	20.7 – 27.7	moderate	30
4.	27.7 – 34.8	high	40
5.	> 34.8	very high	50

2. Classification Soil Type and its Score

No	Soil Type (Center for Soil Research, Bogor)	Classification	Score
1.	Aluvial, Gley Planosol, Hidromorf Kelabu, Laterik Air	Not sensitive	15
2.	Tanah	Low sensitive	30
3.	Latosol	Moderately sensitive	45
4.	Brown Forest Soil, Non Calcic Brown, Mediteran		60
5.	Andosol, Laterit, Grumusol, Podsol, Podsolik Regosol, Litosol, Organosol, Renzina	Sensitive Very sensitive	75

3. Classification of Slope and its Score

No	Slope gradient (%)	Classification	Score
1.	00 - 08	Flat	20
2.	08 – 15	Gentle	40
3.	15 – 25	Moderate	60
4.	25 – 40	Steep	80
5.	> 40	very steep	100

Table E.2.4 Concept of Action Plan of Tondano Watershed Conservation

No.	Main activities	Description	Executing agency
1.	Protecting sedimentation	Reforestation/Planting: 1. Nursery/sedling: a. Reforestation b. Planting 2. Rearing 3. Construction of check dam 4. Maintaining of the dam	Kanwil Forestry & Estates Crops Dinas Kehutanan Propinsi Dinas Kehutanan Kabupaten Dinas PU (Pengairan)
2.	Water Use	Water use retribution	Reg. Govn. Propinsi & Kabupaten, Dipenda, DPRD
3.	Water lake polution	1. Garbage management and weeds control 2. Hadycraft industry (Eceng gondok) 3. Controlling of Liquid garbage, fertilizer, pesticide, detergent, etc (extension service for floating net fishery)	Dinas PU (pengairan) Kanwil industry and commerce BAPEDALDA Dinas Perikanan Propinsi
4.	Sempadan Danau dan sungai (surrounding lake and river bank zone)	1. delimiting boundary of zone 2. Extension and sosialization	BAPPEDA Minahasa BAPPEDA Minahasa
5.	Spatial Plan of the Watershed	1. Detailed spatial plan Second year: legalization and sosialization 2. Definiting forest boundary	UNSRAT, BAPPEDA, PU (cipta karya) Dinas Kehutanan Propinsi
6.	Demography/ pressure on the watershed	1. Resettlement 2. application of appropriate technology for conserving land (training) 3. Diversification and supplement livelihood (seeds assistance) 4. Research in demography and ecosystem. The activities: 1st year : preliminary study on community perception 2nd year experimental study (pilot project) 3rd – 4th year : implementation 5. improving community awareness and attitude changing 1st year: extension/training 2nd year:developing environmental human resources 3rd year: improving capability and participation of NGOs 4th year: giving appreciation 5th year: evaluation 6. Training on environmental aspects 7. Funds assistance for farmers	Regional government (Prop. & Kab.) Politeknik, Kanwil Pertanian Kanwil industry & commerce UNSRAT BAPEDALDA BAPEDALDA BAPEDALDA
7.	Watershed Management Institution	1. Formulating the Management Board 2. Formulating and revising the regulation 3. Extension services for stakeholders 4. Formulating integrated watershed management 5. Obtaining environmental geology data/ information 6. Supervising/ law enforcement 7. Evaluation	BAPPEDA, LAW BUREAU OF REGIONAL GOVNT. NGOs Related agency Kanwil Pertambangan (mining office) Police Department BAPPEDA

Table E.2.5 Land Use Classfication of Malingreau & Christiani (1/2)

Order	Sub-Order	Family	Class	Sub-Class
Water	Water Bodies	Sea	Open sea (laut terbuka)	
			Water inlet (muara)	
			Estuary (corong)	
			Bay (teluk)	
			Atoll (atol)	
			Staright (selat)	
		Lakes	Volcanic lake(danau volkanik)	Crater lake (danau kawah)
				Caldera lake (danau kaldera)
			Tectonic lake (danau tektonik)	
			Volc./Tectonic lake Closed	
			coral atoll Oxbow lake	
			(danau tapal kuda)	
			Lagoon (laguna)	
		Ponds	Fishponds (kolam ikan)	
			Coastal fish pond (tambak)	
			Salt pond (tambak garam)	
			Single purposeMulti purpose	
		Reservoir	Single purpose	
			Multi purpose	
		Inudated Areas (daerah banjir)		
		Marsh,Swamp (rawa)	Stream, river, rivulet	
		Water Courses	Irrigation canal	
			Drainage canal	
			Irrigation and drainage	
Vegetated Area	Cultivated Area	Permanently cultivated	Paddy field(sawah)	Irrigated paddy field (sawah beririgasi)
				Rainfed paddy (sawah tadah hujan)
				Flood fed paddy (sawah pasang surut)
				Deep water rice (lebak)
				Rice + intercropping (sawah surjan)
				Rice + fish rearing (mina padi)
			Upland Crops – dry fields	Open field crops (tegalan)
				Horticultural crops (kebun sayur)
		Agroforestry System	Intercropping 0f upland crops	Rows
			(tegalan)	Fences
			Mixed garden (kebun camp.)	Open mixed garden
				Dense mixed garden
			Homestead garden(pekarangan)	
			Orchard (kebun)	
			Forest garden (talun)	
		Estates (perkebunan)	Commercial estates(perusahan)	Bush / tree crops (tan.keras)
				Other crops
			Small holdings (perkebunan rakyat)(.same as above)	

Table E.2.5 Land Use Classfication of Malingreau & Christiani (2/2)

Order	Sub-Order	Family	Class	Sub-Class
		Non-permanently cultivated	Shifting cultivation (ladang)	In forest cover
				In grass cover
			Agroforestry systems	In production forest (tumpang sari)
				In swamp forest
			Grazing areas	
	Non-cultivated Area	Primary Forest	Climatic forest	High altitude rain forest
				Low altitude rain forest
				Dry deciduous forest (hutan musim
			Edaphic forest	Bamboo forest (hutan bambu)
				Tidal forest (hutan payau
				Coastal forest (hutan pantai)
				Swamp forest (hutan rawa)
				Peat swamp forest (hutan gambut)
				Riparian forest (tergenang air sungai)
		Secondary Forest	Climatic formation	Heath forest (hutan kerangas
			Edaphic formation	
		Bush and Shrub	Dry sites	
				Cont. thicket (belukar)
			Wet sites	Scattered shrubs (semak)
		Grass land	Dry conditions	Alang-alang
				Savanah
			Wet conditions (rumput rawa)	Coastal marshes
				Inland/upland marshes
				Reservoirs+hydrophytic vegetation
		Forest Plantations	Production Forest	Teak (jati)
				Mahogany (mahony)
				Pine
				Others
			Reforestation (Reboisasi)	
Non-Vegetated & Cultivated Area		Critical lands		
		Coastal sand	Beaches (pantai)	
			Dunes (bukit pasir)	
			Ridges (igir)	
		Rock outcrop		
		Lava and Lahars		
		Sandbars in river		
		Open pits		
Settlement/ Built-Up Areas	Town (kota)			
	Kampong (kampung)			
	Industrial Complex			
	Communication network			
	Recreation area			
	Airport			

Table E.2.6 Land Use Classification of Balsem and Buurman (1/2)

U = Arable upland (*tegalan)*
- Uc = mixed garden *(kebun campuran)*
- Us = vegetables, horticulture crops (*sayur-sayuran dan tanaman hortikultura)*
- Ut = upland crops (*tanaman tegalan*)

S = Paddy field (*Sawah)*
- Ss = Paddy field (*Sawah*)
- Si = Irrigated paddy field (*Sawah irigasi*)
- Sr = Rain fed paddy field (*sawah tadah hujan*)
- Sp = Flooded paddy field (*sawah pasang surut*)

L = Shifting cultivation (*perladangan berpindah*)
- L1 = Shifting cultivation (*ladang berpindah*)

R = Grass land (*padang rumput*)
- Ra = *Imperata* grass land (*alang-alang*)
- Rr = Wet grass land (include sedges, pandunus) (*rawa*)
- Rs = Savanna
- Rt = Range land (*padang penggembalaan*)

P = Estate (*Perkebunan*)
- Pa = Pineapple (*nenas*)
- Pb = Tobacco (*tembakau*)
- Pc = Coconut (*Kelapa*)
- Pg = Clove (*cengkih*)
- Pi = Coffee (*kopi*)
- Pk = Rubber (*karet*)
- Pl = others (*lain-lain*)
- Pm = Banana (*pisang*)
- Po = Cacao (coklat)
- Pp = Oil palm (*kelapa sawit*)
- Ps = Vanilla (*panili*)
- Pt = Tea (*teh*)
- Pu = Sugarcane (*tebu*)
- Pv = Cassava (*singkong*)

B = Shrub land (*Semak*)
- Bl = Mountainous shrub (*semak/rumput pegunungan*)
- Bu = Lower altitude shrub (*semak, belukar dataran rendah*)

A = Agroforestry (*wanatani*)
- Aa = Agro-silvicultural system (*wanatani pola kayu/tanaman semusim*)
- Ab = Silvo-pasture (*wanatani pola kayu / rumput*)

F = Reforestation area (*Reboisasi*)
- Fp = Regreening (*penghijauan*)
- Fr = Reforestation (*reboisasi*)
- Fm = Rejuvenation (*peremajaan*)

Table E.2.6 Land Use Classification of Balsem and Buurman (2/2)

H = Forest (*Hutan*)

Ha = Palm forest (*Hutan palem*)
Hb = Bamboo forest (*Hutan bambu*)
Hc = Coastal forest (*Hutan pantai berpasir*)
Hd = Seasonal deciduous forest (*Hutan rontok di musim kering*)
He = Mixed savanna forest (*Hutan savana campuran*)
Hf = Primary sub-montane forest, alt 1000 – 2000 m (*Hutan submontane primer, biasanya pada ketinggian 1000 – 2000 m dpl*)
Hg = Peat swamp forest (*hutan gambut*)
Hh = Low altitude primary forest, wet condition (*Hutan dataran rendah primer basah, biasanya pada ketinggian 1000 mdpl*)
Hi = Limestone forest (*Hutan kapur*)
Hj = Teak forest (*hutan jati*)
Hk = Heath forest (*hutan kerangas*)
Hl = Mahogany forest (*hutan mahoni*)
Hm = Primary montane forest, altitude > 2,000 m (*hutan montane primer basah, biasanya pada ketinggian > 2000 m dpl*)
Hn = Nipa forest (*hutan nipah*)
Ho = Brackish forest (*hutan gelam*)
Hp = Pine forest
Hq = Other forest, kebun karet yang terbengkalai,dll
Hr = Swamp forest (*hutan rawa*)
Hs = Riparian forest of meander belt
Ht = Tidal forest include mangrove, nipa, and palm (*hutan pasang surut (payau), terasuk mangrove, nipah, dan palem (nibong)*)
Hu = Hilly ultrabasic forest (*hutan pada bukit-bukit ultrabasik*)
Hv = Mangrove forest (*hutan bakau*)
Hw = Low altitude forest, wetland (*Hutan becek dataran rendah*)
Hx = Log forest (*hutan log*)
Hz = Secondary forest (*hutan sekunder*)

W = Water body (*Air*)

Wd = Lake (*danau*)
Wg = Salt pond (*tambak garam*)
Wt = Fish pond (*tambak ikan*)
Wu = Reservoir (*waduk*)

T = Bare land (*Tandus*)

Tb = Beach (*pantai*)
Td = Sand dune (*bukit pasir*)
Tf = Alluvial Fan (*kipas aluvial*), River bed (*dasar sungai*)
Tv = Lava flow (*aliran lava dan lahar*)
Tr = Rock outcrop (*batu singkapan*)
Ts = Rock fall (*runtuhan batu lepas*)

K = Settlements (*Pemukiman*)

Kk = Town (*Kota*), Village (*desa*), Industrial area (*kawasan industri*), Airport (*bandar udara*), Recreation areas (*daerah rekreasi*), Other settlement (*tempat pemukiman lainnya*)
Ks = tempat penimbunan sampah
Kt = Mining (*tambang*)

Table E.2.7 Classification of Center for Soil and Agroclimate Research (1/4)

a) Land Cover

HI = CLIMATIC FOREST
- hm = moist primary mountain forest
- hf = moist primary sub-mountain forest
- hh = moist primary lowland forest
- hd = dry deciduous forest
- hk = heath forest
- he = mixed savanna forest (*melaleuca* dominant)

HP = TIDAL FOREST
- hv = mangrove forest
- ha = palm forest (e.g. sago)
- hn = nipa forest
- ho = *gelam* forest
- ht = *nibung* forest
- hl = undifferentiated tidal forest

HQ = OTHER EDAPHIC FOREST
- hc = coastal forest on beach and dune
- hs = riparian forest of meander belt
- hr = swamp forest
- hg = peat swamp forest

H = OTHER NATURAL FOREST
- hb = bamboo forest
- hy = logged (extracted primary forest)
- hz = secondary forest
- hx = other forest, grove, abandoned rubber forest

OV = OPEN VEGETATION
- ol = high mountain grass/ bush on peat
- os = shrub land
- ou = woodland (thicket)

O = OTHER VEGETATION
- oh = hydrophytic vegetation

R = GRASSLAND
- ra = alang-alang
- rr = marsh
- rt = pasture, grazing land
- rs = savanna
- n = non-vegetated

T = PLANTED TREE SPECIES
- teu = eucalyptus
- tma = mahogany
- tpn = pine
- tte = teak
- too = other plantation forest
- tfr = reforestation of forestry area
- ttm = rejuvenation
- ttp = replanting forest

E = ESTATE/INDUSTRIAL CROPS
- ece = clove
- eck = cocoa
- eke = coconut
- eko = coffee
- eop = oil palm
- epd = pine, resin collection
- eka = rubber

Table E.2.7 Classification of Center for Soil and Agroclimate Research (2/4)

etb = sugar cane
eth = tea
eto = tobacco
epa = vanilla
exx = other unspecified estates
SR = FOOD CROPS RICE
srl = deepwater rice
sri = irrigated wetland rice
srr = rain fed rice
srp = tidal rice
srd = upland rice
PA = FOOD CROPS NOT RICE
pco = cabbage
puk = cassava
pca = chili
pbp = garlic
pkp = green bean
pja = maize
pkh = mung bean
pbm = onion
psp = other vegetables, home gardens
pkt = peanut
ppo = potato
pso = sorghum
pkk = soybean
puj = sweet potato
pxx = undifferentiated food crops
BB = FRUIT
bpi = banana
bjb = grapefruit
bje = lemon
bma = mango
bpa = papaya
bna = pineapple
bxx = other fruit trees
bc = mixed gardens of fruit trees

b) Crop and Livestock Performance

m = poor
t = average
b = good
s = diseases, pests
l = drought stress
h = nutrient deficiency
r = toxicity symptoms

c) Cropping Pattern

mr = mono at random
ml = mono in line
xr = mixed at random
xl = mixed in separate lines
xw = mixed within the lines
mp = mixed in small patches

Table E.2.7 Classification of Center for Soil and Agroclimate Research (3/4)

d) Land Use Type

f = plantation forest
fm = rejuvenation of single or restricted
fr = reforestation of rested areas
ft = production forest
fu = unspecified protection forest
p = estate
pc = commercial estate
pn = nucleus estate
ps = small holder plot
l = shifting and semi-permanent cultivation
lh = shifting cultivation
lp = semi-permanent cultivation
u = upland permanent cultivation
us = horticultural crops, vegetables, home garden
uc = mixed garden of fruit trees
ut = undifferentiated upland crop
s = wetland permanent cultivation
sl = deepwater
sr = rain fed
sp = tidal water supply
sb = water supply by diversion
so = water supply by pump
sw = water supply by reservoir
g = grazing
gd = dairy farm
ge = extensive grazing
gr = ranch
x = mixed system
xf = agroforestry
xp = agro-pastralizm
xw = agro-pisciculture
xs = agro-silvi-pastralizm
k = non-agricultural use
kt = mining area and mine tailing
kk = town, village, industrial area, recreation area
kw = water body
ks = waste dump

Table E.2.7 Classification of Center for Soil and Agroclimate Research (4/4)

e) Farm Stage

nu = nursery
fa = fallow
p1 = first crop rice
p2 = second crop rice
p3 = third crop rice
pp = dry season crop
cl = cleared (recently)
cb = cleared and burnt
y1 = first year planting
y2 = second year planting
ys = planting after several years cultivation
bl = bush fallow (low)
bm = bush fallow (medium)
bh = bush fallow (high)
bv = bush fallow (very high)
ss = seedling stage
is = immature stage
ms = mature stage
se = senile stage
as = abandoned stage

f) Notable Farming Practice

nf = not fertilized
f = fertilized
om = organic manure
h = with use of herbicides
p = with use of pesticides
dr = drained
dw = drained with groundwater control
si = sprinkler irrigation
ls = lightly shaded
hs = heavily shaded
at = animal traction
pt = power tiller
fm = fully mechanized
mr = mulched with crop residue
me = mulched from external sources
if = improved fallow
ip = improved pasture
og = overgrazing
cg = controlled grazing

Table E.2.8 Land Use Classification of Kucera

System	Sub-system	Mapping symbol	Present Land Use Type of Crops	Description of cropping pattern, vegetation type or land utilization
CULTIVATED FIELD CROPS	PADDY	S2 P1	2 Paddy rice + upland crop	Two crops of rice followed by one crop of upland crop a year
		S3	Paddy rice x 3	Tree crops of rice a year
		S10P1	Paddy rice (possible crop loss) + Upland crop	Usually local rice variety resistant of flood, frequent crop loss due to flooding
		P2	Paddy but usually with only upland crop	Bounded and leveled but usually with two upland crops a year, due to shortage of water
	PADDY +FISH	S2I1	Paddy rice x2 + fish	Two harvests of rice followed by one harvest of fish a year
		S1I2	Paddy rice + fish x2	One harvest of rice followed by two harvests of fish a year
		I2/I3	Fish x 2 or 3	Fish, two or three harvests a year or fish pond
	UPLAND CROPS	To	Upland crops Non terraced	Cassava, paddy gogo, maize, soybean, cow pea or other root or fiber crops planted in open fields. May include some *alang-alang* grass land
		T	Upland crops 50 % terraced	Cassava, paddy gogo, corn, soybean, cow pea or other root or fiber crops planted in open fields. Often inter cropped
		T1	Upland crops 85 % terraced	Cassava, paddy gogo, corn, soybean, cow pea or other root or fiber crops planted in open fields. Often inter cropped
CULTIVATED TREE CROPS	SMALLHOLDER UPLAND AND ORCHARD CROPS	Kc	Mixed orchard	Predominant tree crops and agroforestry including coconut, banana, cloves, mango, coffee or other fruit trees. Often some perennial crops included
		Kk	Coconut orchard	Predominant coconut trees. Usually simple terraces constructed
		Kn	Clove orchard	Predominant cloves. Usually simple terraces constructed
		Kr	Rubber orchard	Predominant rubber. Usually simple terraces constructed
		Kb	Bamboo	Predominant small holders bamboo
CULT'D ESTATE CROPS	SMALL-HOLDER CASHCROP	O	Tobacco	Tobacco grown as a upland crop after rice
		U	Sugarcane	Sugarcane grown by individual farmers
CUL-TIVATED FOREST	PRODUCT-ION FOREST	Hn	Mahogany forest	Managed production mahogany forest
		Hj	Teak forest	Managed production teak forest
		Hp	Pine forest	Managed production pine forest
NON CULTIVATED LAND	PROTECT-ION FOREST	Hn	Protection forest	Managed protection forest
		Fm	Mangrove forest	Coastal mangrove forest, some shrimp, fish or charcoal production
		Hi	Primary forest	Natural primary forest
		Hs	Secondary forest	Natural secondary forest, partially logged
	GRASS-LAND AND WATER	G	Grassland	Grass land usually *alang-alang*
		B	Shrub land	Shrub or thicket formation
		R	Swamp	Low lying areas inundated or with water table at or near the surface for most of the year. Grassland or aquatic vegetation is common. May be bounded with some local variety rice grown in the dry season in places
QUALIFYING SYMBOLS		A	Salt evaporation ponds	Salt production
		J	Maize	Maize grown on paddy or upland
		K	Soybean	Soybean on paddy or upland
		S	Cassava	Cassava on upland
		j-k	Inter cropping cultivation	Maize and soybean inter cropped
		M	Rice with fish	Rice with fish in paddy field

TableE.2.9 Land Use Classification (Rural Areas) of National Land Agency (1/3)

Scale 1 : 50.000	Scale 1 : 25.000
1. SETTLEMENT	**1. SETTLEMENT**
1.1. Village (*Kampong*)	1.1. Village (*Kampong*) * Sparse * Dense
1.2. Housing (*Perumahan*)	1.2. Housing (*Perumahan*) * *Perumahan jarang* * *Perumahan padat*
1.3. Emplacement (*Emplasemen*)	1.3. Emplacement (*Emplasemen*) * *Emplasemen sementara* * *Emplasemen tetap*
1.4. Stadium/park (*Lapangan Olahraga/Taman*)	1.4. Stadium / Park *(Lapangan Olahraga/Taman)* * *Komplek Olahraga* * *Lapangan golf* * *Taman*
1.5. Grave/tomb (*Kuburan/Pemakaman*)	1.5. Grave/tomb (*Kuburan/Pemakaman*) * *Kuburan/Pemakaman umum* * *Makam pahlawan* * *Makam khusus*
2. INDUSTRIAL AREA	**2. INDUSTRIAL AREA**
2.1. Agriculture (*Pertanian*)	2.1. Agriculture (*Pertanian)* * *aneka pangan* * *aneka sandang*
2.2.. Non-agriculture (*Non Pertanian*)	2.2. Non-agriculture *Non pertanian* * *aneka kimia dan serat* * *aneka bahan bangunan* * *industri logam* * *industri kimia* * *industri kecil*
3. **MINING GROUND (***PERTAMBANGAN***)**	**3. MINING GROUND (***PERTAMBANGAN***)**
	3.1. Open mining (*pertambangan terbuka*) 3.2. Closed mining (*pertambangan tertutup*)
4. **PADDY FIELDS (*PERSAWAHAN*)**	***4.*** **PADDY FIELDS (*PERSAWAHAN*)**
4.1. Irrigation (*Irigasi*) *Two rice a year or more *(2 x padi/tahun atau lebih*) *One rice a year *(1 x padi / tahun)* 4.2. Rain fed (*Tadah Hujan*) 4.3. Flood fed (*Pasang Surut*) *two rice a year or more (*2 x padi/tahun atau lebih*) *one rice a year (*1 x padi/tahun*)	4.1. Irrigation (*Irigasi*) * Two rice a year or more (*2 x padi/tahun atau lebih)* * *2 x padi + palawija/tahun* * *2 x padi /tahun* * One rice a year (*1 x padi/tahun*) * *1 x padi + palawija/tahun* * *1 x padi/tahun* 4.2.Rain fed (*Tadah Hujan*) 4.3. Flood fed (*Pasang Surut*) * two rice + one upland crop a year (*2 x padi+palawija/tahun*) * *2 x padi+palawija/tahun* * *2 x padi/tahun* * one rice a year (*1 x padi/tahun*) * *1 x padi+palawija/tahun* * *1 x padi/tahun*
5.ARABLE UPLAND FOR ANNUAL CROPS (*PERTANIAN TANAH KERING SEMUSIM*)	**5.ARABLE UPLAND FOR ANNUAL CROPS (*PERTANIAN TANAH KERING SEMUSIM*)**
5.1. Upland crops(*Tegalan/Ladang*) 5.2. Vegetables (*Sayuran*) 5.3. Flowers (*Bunga*)	5.1. Upland crops (*Tegalan/Ladang*) * divided by grown species (*menurut jenisnya*) *5.2.* Vegetables (*Sayuran*) * divided by grown species (*menurut jenisnya*) *5.3.* Flowers (*Bunga*) * divided by grown species (*menurut jenisnya*)

TableE.2.9 Land Use Classification (Rural Areas) of National Land Agency (2/3)

6. HOME GARDEN (*KEBUN*)	**6. HOME GARDEN (*KEBUN*)**
6.1. Mixed garden (*Campuran*)	6.1. Mixed garden (*Campuran*) * divided by dominant species (*jenis tanaman dominan*)
6.2. Mono cultural type (*Sejenis*)	6.2. Mono cultural type (*Sejenis*) * divided by grown species (*jenis tanaman yang dihasilkan*)
7. ESTATE (*PERKEBUNAN*)	**7. ESTATE (*PERKEBUNAN*)**
7.1. Commercial estates (*Perkebunan Besar*)	7.1.Commercial estates (*Perkebunan Besar*) * divided by grown species (*menurut jenisnya*) * *sudah menghasilkan* * *belum menghasilkan* * *tidak lagi menghasilkan*
7.2.. Small-holder plantation (*Perkebunan Rakyat*)	7.2.Small-holder plantation (*Perkebunan Rakyat*) * divided by grown species (*menurut jenisnya*) * *sudah menghasilkan* * *belum menghasilkan* * *tidak lagi menghasilkan*
8. PASTURE (*PADANG*)	**8. PASTURE (*PADANG*)**
8.1. Savannah (*Padang Rumput / Sabana*)	8.1. Savannah (*Padang rumput/ Sabana*) * *padang rumput* * *sabana*
8.2. *Alang-alang* grass land	8.2. *Alang-alang* grass land
8.3. Shrub (*Semak*)	8.3. Shrub (*Semak*)
9. FOREST (*HUTAN*)	**9. FOREST (*HUTAN*)**
9.1. Primary Forest (*Hutan Lebat*)	9.1. Primary Forest (*Hutan Lebat*) * divided by types (*menurut jenisnya*)
9.2. Secondary Forest (*Hutan Belukar*)	9.2. Secondary Forest (*Hutan Belukar*) * divided by types (*menurut jenisnya*)
9.3. Single species Forest (*Hutan Sejenis*)	9.3. Single species Forest (*Hutan Sejenis*) * natural (*alami*) * *menurut jenisnya* * artificial (*buatan*) * *menurut jenisnya*
FRESH WATER (*PERAIRAN DARAT*)	**10. FRESH WATER (*PERAIRAN DARAT*)**
10.1. Fresh water ponds (*Kolam Air Tawar*)	10.1. Fresh water ponds (*Kolam Air Tawar*)
10.2. Fishponds (*Tambak*)	10.2. Fishponds (*Tambak*) * divided by fish species (*menurut jenisnya*)
10.3. Salt pond (*Penggaraman*)	10.3. Salt pond (*Penggaraman*)
10.4. Reservoir (*Waduk*)	10.4. Reservoir (*Waduk*)
10.5. Lakes (*Danau/Situ/Telaga*)	10.5. Lakes (*Danau/Situ/Telaga*)
10.6. Swamp (*Rawa*)	10.6. Swamp (*Rawa*)
11. **BARE LAND (*TANAH TERBUKA*)**	**11. BARE LAND (*TANAH TERBUKA*)**
11.1. Non-arable land (*Tanah Tandus*)	11.1.Non-arable land (*Tanah Tandus*)
11.2. Badland (*Tanah Rusak*)	11.2.Badland (*Tanah Rusak*)
11.3. Temporarily open land (*Tanah terbuka Sementara*)	11.3. Temporarily open land (*Tanah terbuka sementara*)

TableE.2.9 Land Use Classification (Rural Areas) of National Land Agency (3/3)

12. **OTHERS (*LAIN-LAIN*)**	**12. OTHERS (*LAIN-LAIN*)**
12.1.Roads (*Jalan*)	12.1. Roads (*Jalan*)
* *jalan aspal*	* *jalan aspal*
* *jalan batu*	* *jalan batu*
* *jalan tanah*	* *jalan tanah*
* *jalan setapak*	* *jalan setapak*
* *jalan kereta api*	* *jalan kereta api*
* *jalan lori*	* *jalan lori*
12.2.Channels (*Saluran*)	12.2.Channels (*Saluran*)
* River (*sungai*)	* River (*sungai*)
* Irrigation canal (i*rigasi*)	* Irrigation canal (i*rigasi*)
	* *irigasi induk*
	* *irigasi sekunder*
	* *irigasi tersier*
12.3.Reservoirs (*Bendungan*)	12.3.Reservoirs (*Bendungan*)
* *bendungan teknis*	* *bendungan teknis*
* *bendungan semi teknis*	* *bendungan semi teknis*
* *bendungan non teknis*	* *bendungan non teknis*
12.4.Altitudes (*Ketinggian*)	12.4.Altitudes (*Ketinggian*)
* *gunung*	* *gunung*
* *titik ketinggian*	* *titik ketinggian*
12.5.Administrative Boundary (*Batas admnistrasi*)	12.5.Administrative Boundary (*Batas admnistrasi*)
* *batas negara*	* *batas negara*
* *batas propinsi*	* *batas propinsi*
* *batas kabupaten*	* *batas kabupaten*
* *batas kecamatan*	* *batas kecamatan*
* *batas desa*	* *batas desa*
* *batas pemukiman*	* *batas pemukiman*

Source : The regulation of Ministry of Agrarian Affairs/Head of National Land Mapping No.1/1997 concerning Rural Land Use Mapping, Urban Land Use Mapping, Land Capability and the Use of Symbol/Color for Map Design.

Table E.3.1 Area of Each Land Use by Three Areas

Upper: Area (ha)
Lower: Ratio (%)

No.	Legend	East Area	South Area	West Area	Intensive Area
1	Natural/Semi/natural forest	327	735	66	1,128
		9.8	21.6	1.3	9.5
2	Secondary forest	70	478	52	600
		2.1	14.1	1.0	5.0
3	Planted forest (Timber)	11	12	1	24
		0.3	0.4	0.0	0.2
4	Planted forest (Firewood)	83	6	359	448
		2.5	0.2	7.0	3.8
5	Bush	120	48	74	242
		3.6	1.4	1.4	2.0
6	Estate (Clove)	731	19	200	950
		22.0	0.6	3.9	8.0
7	Estate (Others)	684	269	1,491	2,444
		20.5	7.9	29.0	20.6
8	Mixture of estate and arable upland	461	742	618	1,821
		13.8	21.7	12.0	15.3
9	Arable upland	368	859	1,895	3,122
		11.0	25.2	36.8	26.3
10	Pasture	0	0	36	36
		0.0	0.0	0.7	0.3
11	Paddy field	388	125	125	638
		11.6	3.7	2.4	5.4
12	Swamp	10	2	8	20
		0.3	0.1	0.2	0.2
13	Water body	1	0	5	6
		0	0	0.1	0.0
14	Settlement and others	85	105	216	406
		2.5	3.1	4.2	3.4
	Total (ha)	3,339	3,400	5,146	1,185
	Total (%)	100.0	100.0	100.0	100.0