



## **Chapter I Basic study of the watersheds of Mantasoa and Tsiazompaniry**

### **1 Natural environment**

#### **1-1 Location**

The Republic of Madagascar is an island in the southern hemisphere, located in the western Indian Ocean, separated from the African Continent by the Mozambique Channel, around 400 km wide. The Tropic of Capricorn ( $23^{\circ}30''$  of the southern latitude) crosses south of the country. The country, with a total surface of  $587,041 \text{ km}^2$ , or 1.6 times Japan, extends between the  $11^{\circ}57''$  and  $25^{\circ}35''$  of the southern latitude and  $43^{\circ}14''$  and  $50^{\circ}27''$  of the eastern longitude. The length from north to south is 1570 km and the maximum width from east to west is 580 km. This makes the country the 4th largest island in the world (after Greenland, New Guinea and Borneo).

The Mantasoa and Tsiazompaniry lakes, located in the study area, are in the eastern part of the central plateaus, respectively at around 60 km east and 80 km southeast of Antananarivo, the capital. The Mantasoa and Tsiazompaniry lakes are artificial lakes created by the construction of dams in 1936 and 1955 respectively. Administratively, the Mantasoa zone belongs to the Manjakandoriana department. The Tsiazompaniry zone belongs to the Andramasina department. Rivers flow from these two converging downstream lakes to form the Ikopa river which goes towards the north after crossing the Antananarivo (capital) alluvial plane, and drops into the Mozambique Channel (Figure I-1). These two lakes are essential sources of water for the metropolitan area. Their watersheds are used for agricultural activities and provide water for daily needs. They are also an important hydroelectrical source. Since the Lake Mantasoa is easily accessible from the metropolitan area, it is also the site for weekend outings and open-air activities for primary schools.

#### **1-2 Topography, geological features and type of soil**

##### **1-2-1 Topographical and geological features**

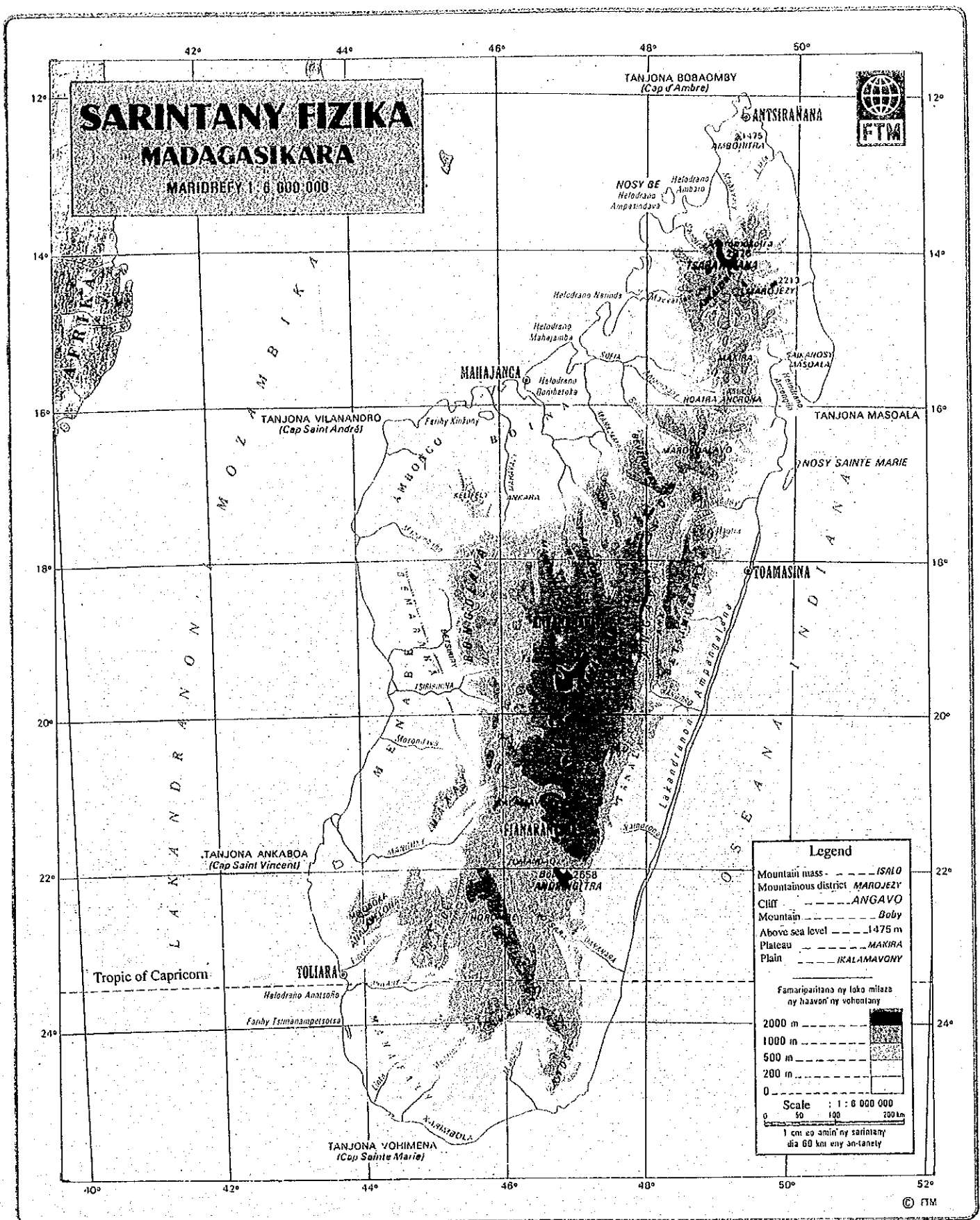
Madagascar island is a shield composed of an old platform which includes rocks formed during the pre-Cambrian period. They formed diversified topography due to the effect of erosion, volcanic activity, and fault formation movements. As per topography, Madagascar island is subdivided into 3 zones: 1) Central plateaus, 2) Eastern coastal zone and 3) Western coastal zone.

As mentioned above, the two areas of Mantasoa and Tsiazompaniry covered by this study, are located in the eastern part of the central plateaus. This zone abounds with mild undulations at an altitude of 1350 to 1700 m. The lines of the principal peaks are roughly in the north-south

direction, with the valley plains practically parallel to them. As shown in the geological map (Figure 1-2), the platform of this region is formed with granite, with outcrops at various areas forming peaks. Outcropping granite rocks of all sizes are also visible in the plains. In some regions, these rocks have become objects of worship. The surface of the plains is limited in size, with mild slopes of the hills used as agricultural land. Since the peaks are finely subdivided, the banks of the artificial lakes of Mantasoa and Tsiazompaniry are also cut in a complex way. The altitude of the Lake Mantasoa surface is around 1400 m, while that of the Lake Tsiazompaniry is 1450 m. The altitude of the platform plateau increases as it moves towards the south. The difference in altitude between the surface of these lakes and the hill summits surrounding them is around 200-300 m. Valleys reaching the lakes are also generally short. The capture zone for each small watershed is also small.

The study area generally has a very slight undulating relief. Even if there are vast spaces of grassy hills and no bare area with an eroded surface layer, there is practically no area with soil destruction problems. This problem was never raised in any of the villages where interviews were conducted. However, the old destroyed relieves due to faults are visible in the hill areas in the southwestern part of lake Tsiazompaniry. Aerial photos also revealed that around 1.5 km west of Analamihoatra, there is a continuous cut of around 5 km in the north-south direction. The destroyed surface layer is also covered by vegetation in certain areas. It has been confirmed that this relief is presently stabilized.

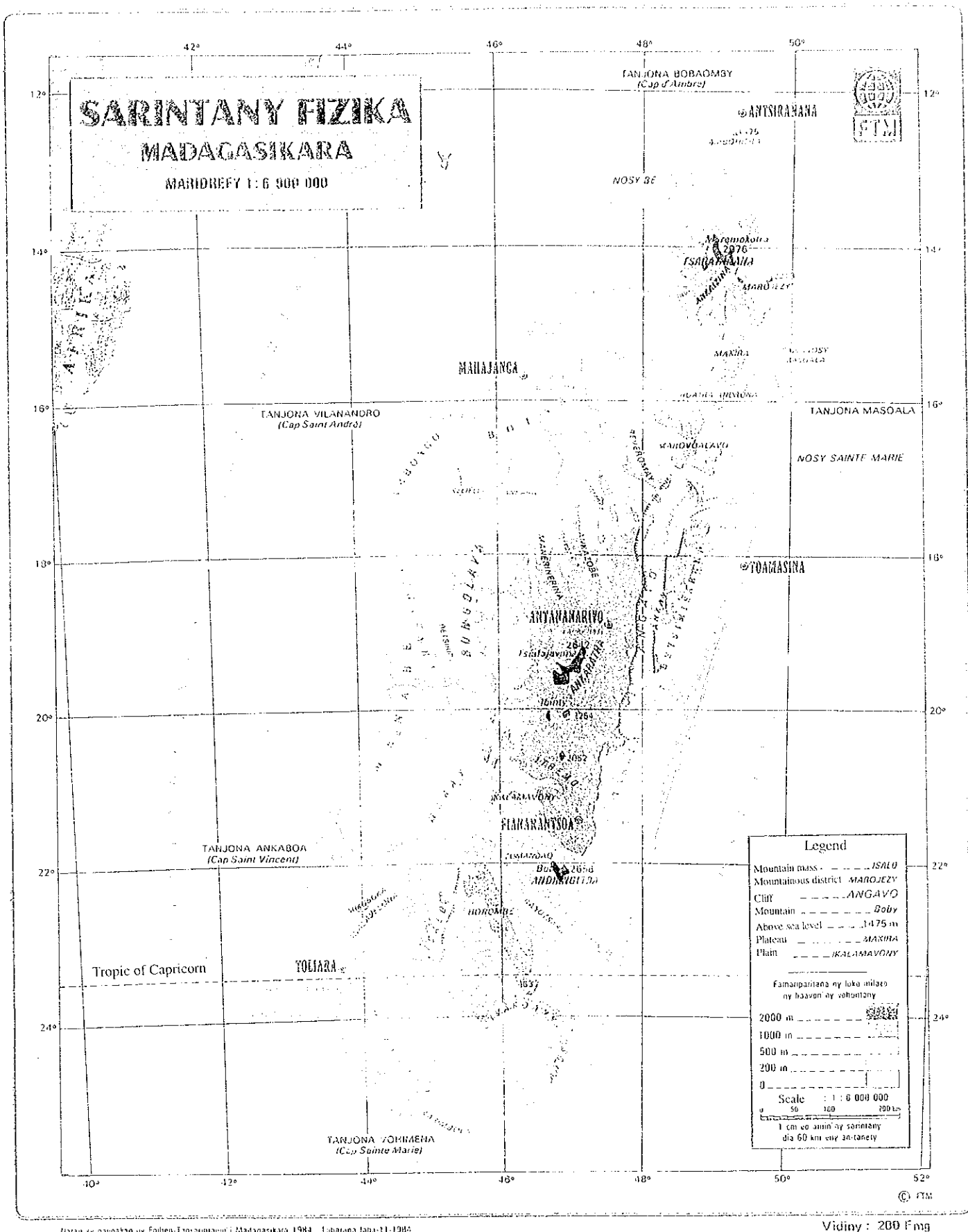
The zone outside the eastern limit of the study area consists of mountainous regions (Angavo Mountain). Its undulating relief is in contrast with the western part beyond the limit. A huge continuous rocky block is found in the south-north direction, whose altitude gradually diminishes towards the east and is transformed into a plain towards the Indian Ocean in the East.



Itaon sy navoakan' ny Folben-Taosorimanin'i Madagasikara 1984. Laharana faha-11-1984

Vidiny : 200 Fmg

Figure I-1 Map of Madagascar  
Source: FTM (National Mapping Institute) in 1984



Nizana ny navoakan'ny Folben-Tsositrimaizy i Madagasikara 1984. Loharana faha-11-1984

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Figure I-1 Map of Madagascar  
Source: FTM (National Mapping Institute) in 1984

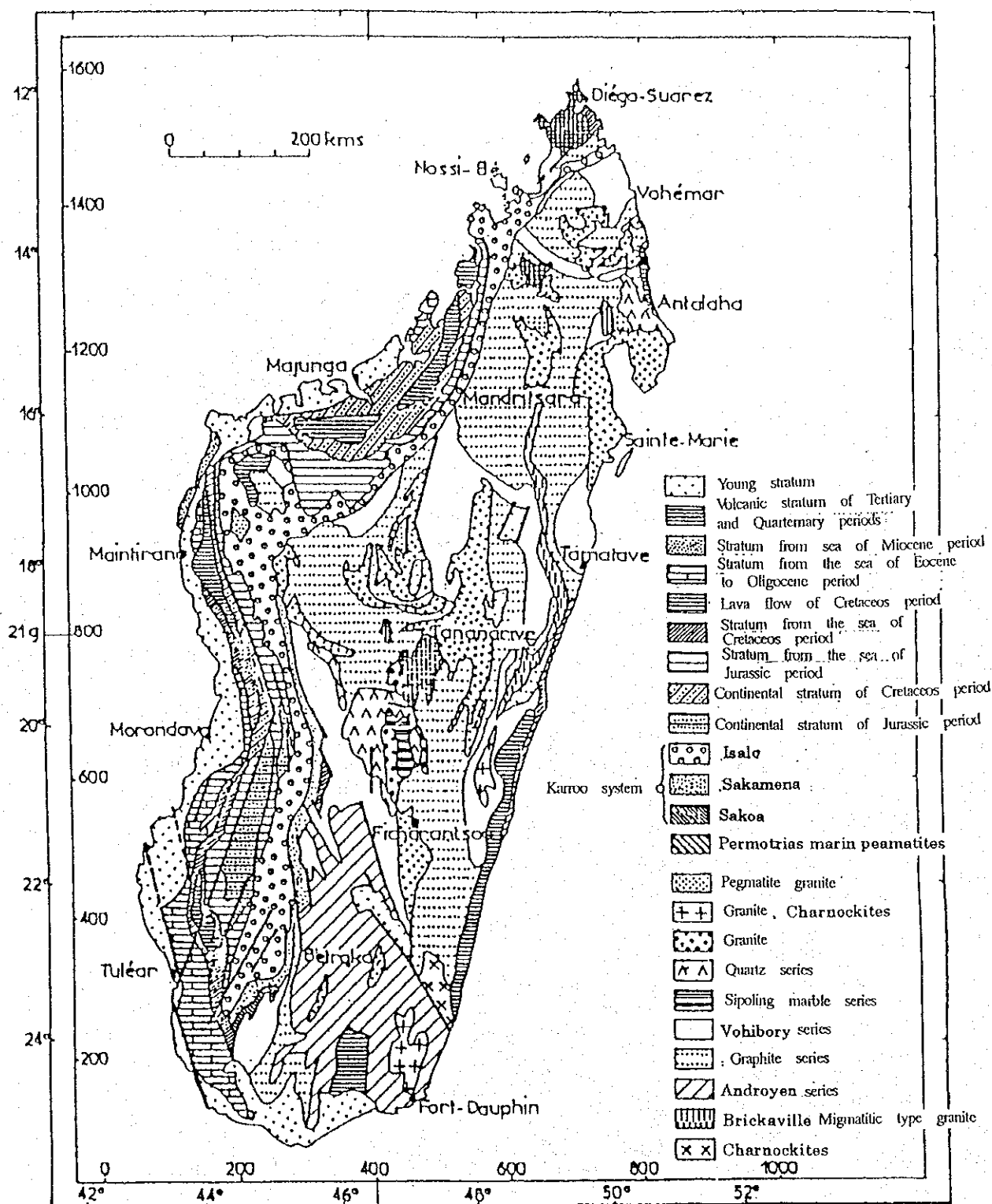


Figure I-2 Geological Map

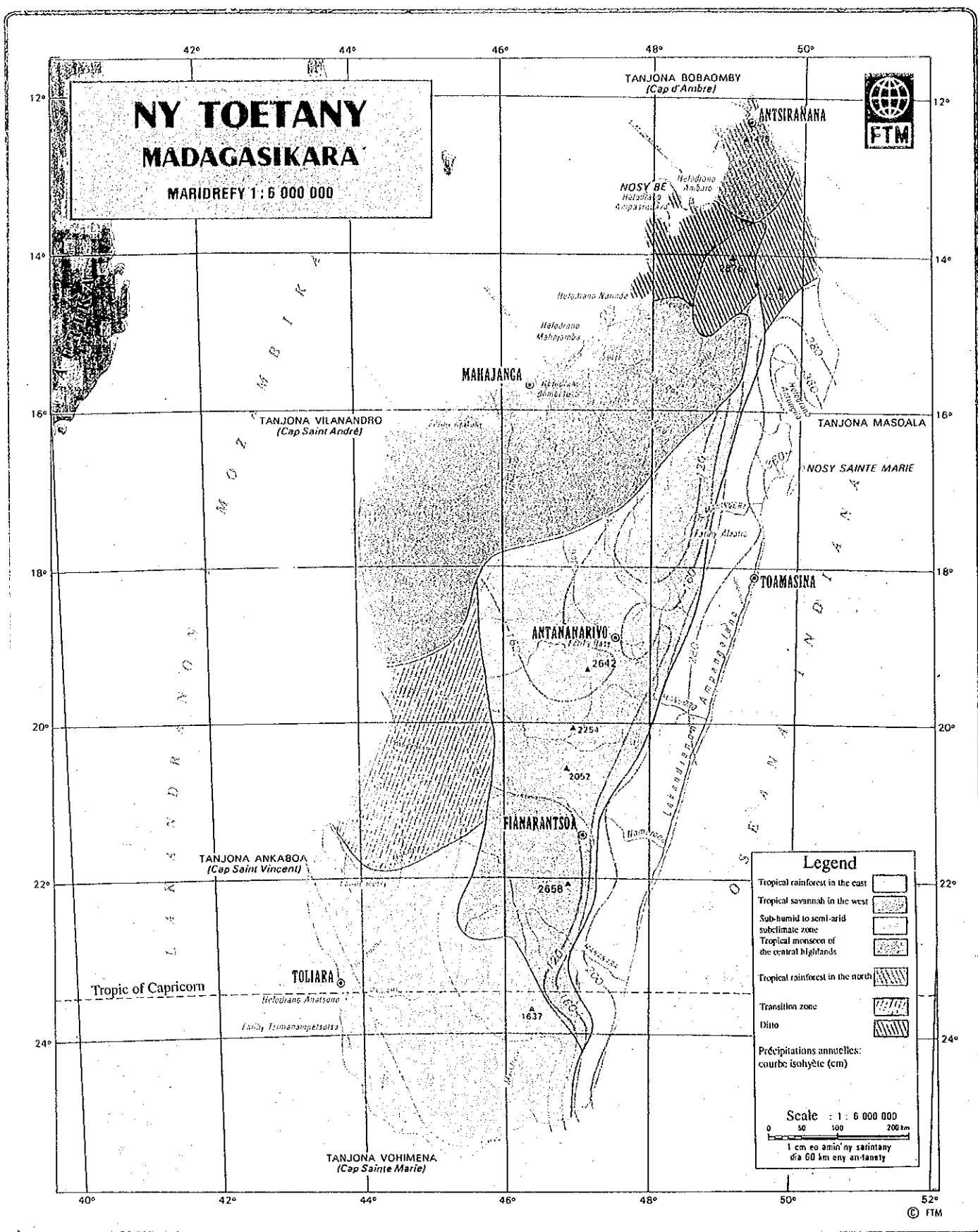
Source: FAO, FO: SF/MAG8, Rapport technique 7, 1970

### **1-2-2 Type of soil**

Laterite is a characteristic of the Madagascar soil often found throughout the island. Madagascar is often called the "red island" due to its typical red color. The major part of the island is north of the Tropic of Capricorn. The alternation between a very rainy season and a severely hot dry season which destabilizes the organic components of the surface layer, forms a clayey laterite soil with a huge accumulation of iron and aluminum particles due to the alteration and decomposition of the platform rocks. Its color varies from light pink to orange red and dark brown according to the oxidized iron content and the type of parent rock. This laterite layer is widely found in the study area. A detailed study of the type of soil will be conducted during the Third study of the site.

### **1-3 Climatic zone**

The Tropic of Capricorn crosses Madagascar island, thus placing the entire country in the Tropical zone. However, the southeast trade winds which blow from the Indian Ocean largely affect the climate of the island. The island may be divided into 5 climatic zones (tropical forest in the east and north, tropical savannah, subtropical semi-arid zone, tropical monsoon of the highlands) and transition zone (Figure I-3). Since the study area is located in the eastern part of the central plateaus, its climate is classified into a tropical monsoon of the highlands. The trade winds from the Indian Ocean blow through the Angavo mountains, which are aligned in the north-south direction in the eastern part of the study area and receive significant rainfall. The eastern hill area has the tropical rain forest climate. Furthermore, the study area with a highland tropical monsoon climate may be divided into the rainy season and the dry season during the year. The rainy season lasts for 4 months, from November to February. This is followed by a transition period of 1 to 2 months, then the dry season for around 5 months, from May to September. Based on the climatic division of Thornwaite, this area has a sub-humid to semi-arid subclimate. In other words, the wet season constitutes a period marked by lack of water in the soil for 2 to 6 months, with an annual precipitation of 600-1500 mm, potential evapotranspiration of 1200-1500 mm (2000 mm on the highlands), humidity of 20-100%. The dry season is clear but with some drizzle (precipitation above 15 mm during the dry season). The study area has a longer rainy season and more fog and drizzle than in the Antananarivo zone.



Natao sy navoakan'ny foiben-Taosaintanin'i Madagasikara 1984. Laharana laha-12-1984

Vidiny : 200 Fmg

Figure I-3 Climatic division  
Source: FTM (National Mapping Institute) in 1984



### 1-3-1 Rainfall

Rainfall and climatic data concerning the Mantasoa and Tsiazompaniry zones are as follows.

Table I-1 Rainfall and temperature of the Mantasoa and Tsiazompaniry zones

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Mantasoa													
Temperature (°C)	19.5	19.6	19.1	17.6	15.3	13.4	12.3	13.0	14.5	16.5	18.9	19.3	16.6
Rainfall (mm)	299.7	263.6	237.6	57.9	31.4	33.2	37.0	38.1	24.4	49.5	145.5	309.5	1527.4
Tsiazompaniry													
Temperature (°C)	18.1	20.3	19.3	17.1	14.3	12.6	12.7	12.9	15.0	18.0	19.6	19.8	16.6
Rainfall (mm)	253.1	165.2	326.2	40.4	10.6	16.2	11.5	5.0	9.4	17.2	199.5	295.6	1349.9

Source: Report of the Sector A study for the Ikopa watershed management plan in the Antananarivo plain, Hydrology, December 1994.

As shown in the table, similar changes are found in the patterns of both annual precipitation. Months with precipitation of 100 mm or more are November to March, 4 months in total. This period is a season of cyclones which sometimes land in Madagascar Island and do a great deal of damage in various places. The large amount of rainfall brought by cyclones also results in a rise in the water level of the Mantasoa and Tsiazompaniry lakes, but also contributes to securing water sources in the dry season. Table I-1 shows that precipitation in the Tsiazompaniry area in the dry season is slightly more severe than that in the Mantasoa zone. There is a period of rainfall around June and July, which does not appear remarkably in this table. Called the small rain season in this district, people seem to prepare for farming work. In any case, management of water sources in the dry season is very important to stabilize agricultural production. Precipitation generally tends to decrease toward west and toward south in the target area.

### 1-3-2 Temperature

Since the climate is classified into highland tropical monsoon, as opposed to average and high altitude zones, the difference in temperatures is low and the climate is pleasant throughout the year. As shown in Table I-1, the average temperature in the Mantasoa zone during the coldest period is 12.3°C in July. The temperature during the hottest period is 19.6°C in February. In the Tsiazompaniry zone, the average temperature during the coldest period is 12.6°C in June, and during the hottest period, is 20.3°C in February. Therefore, the annual temperature difference is 7-8°C, which is very low with respect to the temperate zone monsoon (annual difference in Tokyo: 21.9°C).

### 1-3-3 Natural disaster, etc.

Torrential rains during the rainy season and cyclones cause significant damages every year. Bridges carried away and flooded roads considerably cut the road network of the region. Furthermore, control of the volume of water from irrigation piping networks has become

impossible due to the breakage of embankments for water storage tanks. Side ditches that individual farmers cut for block allotment of Tanety are further scooped as a result of these heavy rains. Drift sand expands gradually and develops to extensive gully erosion. As terraced farming is not generally employed on the slopes, the outflow of surface soil due to rainwater is remarkable. As the latest example of damage by cyclones, a cyclone (Eline) that hit in late February 2000 can be taken. This study area was under its influence. There was a village in which someone had drowned, and the area suffered damage such that some farmers' fruit trees and old afforested trees were blown down by strong winds. Fortunately, however, the cyclone did not bring about large flood damage in the lower watershed. As a reason for this, the flood control function of dams cannot be overlooked.

On the other hand, during the dry season, this region has also suffered damages due to the El Niño drought in 1982-1983. However, thanks to the monsoon climate rains, the frequency of droughts is generally low. Fires are the most important problem during the dry season. These are caused by various reasons but generally by human activities such as slash and burn farming, controlled burn for pastures, etc., which are traditional practices. Based on the report on bush fires (1998), 97% of the two cases found during the last 6 years took place in Tanety\* (see Table I-2).

Table I-2 Location of brush fires during the last 6 years (87-90, 92-93)

Location	Number	%
Tanety	4,547,096	97.3
Natural forest	31,868	0.7
Tree planting	94,564	2.0

Source: Study of Brush fires in three Firaisampokontany of Antananarivo  
Atsimondrano covered by village reforestation, 1998

## 1-4 Forest vegetation

### 1-4-1 General condition of forest vegetation

An in-situ study and a study viewed from a helicopter were conducted to evaluate the present state of vegetation in the study area. The present state of the vegetation in the entire study area was established from aerial photos. Chapter 7 on the study of the land use and vegetation provides details.

The eastern hill area of the Angavo mountainous zone extends in the north-south direction. The eastern part of the study area is a tropical rain forest and an important zone rich in flora and a precious habitat for wild animals. Over the Angavo mountains grow many plant species such as Tambourissa, Weinmannia, Symphonia, Dombeya, Dilobeia, Dalbergia, Canarium, Diospyros, Eugenia, and Protobus. Mares, prevail in the undergrowth with many herbaceous plants such as shrubs and ferns. The forest vegetation in the nearby study area has almost the same composition as the tropical evergreen broad-leaved forest in the Angavo mountains.

However, the original vegetation has been considerably destroyed by human activities. Very few natural forests which remain at present are almost all secondary forests. These natural forests are also localized in valleys and on small surfaces on slopes.

As for tree planting, Eucalyptus tree planting (*Eucalyptus robusta*) is spread widely, particularly in the hill area near the hamlets. The western part of the Mantasoa area is mainly covered by Eucalyptus trees. Pine tree planting (principally *Pinus patula*) is found partly. The present state of the vegetation is very different in the east and west of the Mantasoa and Tsiazompaniry lakes. There is practically no natural forest in the western part of the two lakes where most of the hamlets are located. In the eastern part where the population is scattered, such forests remain only in specific areas.

The classification of local conditions for forest vegetation has provided the following division.

#### North-east part of the Mantasoa zone

Natural forests are found at the edge of the valley on the eastern slope of the hilly zone, east of the Lake Mantasoa, and on mild slopes. At present, these areas are also subject to illegal cutting. Many of the trees have suffered damages provoked by flying sparks from brush fires made by scattered new farmers for clearing by controlled burn. The repeated propagation of fires has transformed the region into shrubbery (principally *Philippia spp.*, *Helichrysum spp.*) or grassland. However, tree planting of *Eucalyptus robusta* (abbreviated below as eucalyptus) is in progress.

#### North-west part of the Lake Mantasoa

The entire area bordering the lake in the northwest part of the Lake Mantasoa is a housing site with secondary residences and hotels thanks to easy access from Antananarivo. It has many scenic forests, principally pine, creating an artificial landscape. Among the afforested pines, some trees are more than 40 years old. The eucalyptus tree planting to produce firewood largely extends to the hilly zone near the local hamlets where there are no natural forests.

#### Western part of the Lake Mantasoa

This zone is close to the metropolitan area and is a supplier of firewood from its wide tree planting of eucalyptus trees. It has many agricultural areas such as rice fields and Tanety, and land use is intensive. Consequently, natural forests are very found only in limited areas (mountain summits) and they are in fact degraded secondary forests.

#### Southern part of the Lake Mantasoa

There are a few natural forests at the valley border. Shrubbery and grassland extend from the central to eastern parts. The planting of eucalyptus is progressing around scattered hamlets.

#### Eastern part of the Lake Mantasoa

This entire area is placed under the supervision of the Ministry of Water and Forests, but illegal clearing and cutting by immigrants are increasing. This area is almost entirely covered by shrubs and grassland but eucalyptus is being planted at the bank of the lake. Hamlets are scarce, leaving a relatively large natural forest at the eastern end. Since there are no roads in the Angavo mountains outside the limit of the study area, primeval forests still remain.

#### Northern part of Lake Tsiazompaniry

Grasslands extend over the areas around the bank and there is no natural forest. However, eucalyptus has been planted around the scattered hamlets in the northern part.

#### Western part of Lake Tsiazompaniry

Areas surrounding the bank are under the supervision of the Ministry of Water and Forests. In the past, the area had pine and eucalyptus trees planted by the Ministry of Water and Forests. However, patrol surveillance has not been sufficient and illegal cutting was carried out everywhere. Pasture areas are found even within the forest. Eucalyptus trees were planted in the western part where the hamlets are located, but forested areas decrease towards the south where the large part is grassland. There are a few natural forests in this area.

#### Southern part of Lake Tsiazompaniry

Large natural forests remain in the southeastern part. Grassland extends over the rest of this area, which is a deserted hilly zone. Eucalyptus trees are planted for firewood to be used in homes in several scattered hamlets.

#### Eastern part of Lake Tsiazompaniry

Grassland extends over the north. However, some natural forests remain on the eastern slopes and part of the western slopes further south. Most of these natural forests have suffered damages due to fire propagation and have become secondary forests. In the central part of the bank, formerly under the responsibility of the Ministry of Water and Forests, there are pine trees which have become open forests after damages suffered from illegal cutting and burning of the land surface by fires lighted to create pasture lands. Grassland occupies the rest of this part. Natural forests remain in the south, up to the bank, with a natural forest keeping the aspects of primeval forest on the eastern side of the mountain ridge.

Concluding the above, the vegetation of the study area can be classified into the following 5 levels:

Table I-3 Classification of vegetation

Class	Type of vegetation
I	Closed forest
II	Devastated forest
III	Shrubs/grasslands
IV	Tree planting
V	Others

#### (I) Closed forest

The closed forest includes the same diversified arborescent plant found in the tropical evergreen leafy area in the Angavo mountains. This is an original forest with a combination of high and low trees. The low plants are rich and dense. Consequently, this forest which holds a wide diversity of species, is humid and constitutes the original vegetation of the Madagascar forests. This type of forest is localized along the length of the eastern border of the study area. One part even extends to the study area but presently, it only remains along the length of several valleys and some steep slopes.

The southeast area of Lake Tsiazompaniry does not have a road network. Access from the exterior is difficult and settlement has not progressed. The in-situ study and the study by helicopter revealed the existence of a relatively large closed forest in this zone. Groups of trees within the closed forest have suffered damages due to the extended propagation of incendiary fires or the fire set to create pasturelands. This shows that settlement has progressed and agricultural activities are developing. In this study area, there is one remaining large natural forest. Results of the study of this closed forest are given in paragraph 2-4-2.

#### (II) Devastated forest

A devastated forest signifies a formerly closed primeval forest that has lost taller trees after excessive forest exploitation or the illegal cutting and collection of firewood, etc, that has become a secondary forest after devastation by bush fires, etc. Composition of species and the original vegetation have not been preserved. Many of these devastated forests extend over the east of the Lake Mantasoa, near the above-mentioned closed forest and particularly along the length of the valleys and part of the slopes. The privatization of land and settlement are limited in this zone placed under the supervision of the Ministry of Water and Forests. There has been no large-scale clearing of the land. These are forests remaining around tree cutting areas to provide agricultural land for particular immigrants or for families. Since their number will still increase in the future, these devastated forests will soon be the targets of new agricultural land extensions. These forests will still diminish or even disappear due to new and expected bush fires.

In the study area, we noted the presence of a large number of young eucalyptus trees and stumps in the forests. New farmlands cleared by immigrants were noted at the border of these trees. If controlled burn for land cultivation continue, the soils will deteriorate further, with

the rapid multiplication of shrubs such as *Philippia spp.* which will grow and replace the existing vegetation. Consequently, it will be very difficult to bring back the forest to its original vegetation.

### (III) Shrubs/grasslands

This type of vegetation covers a huge portion of the study area. Aside from afforested areas, this type of vegetation occupies the largest surface. In particular, aerial photos show that grasslands represent more than half of the vegetation in the south of the Tsiazompaniry area. There are two types of small shrub vegetation: areas consisting of shrubs of various species, and relatively simple vegetation composed of *Philippia spp.* and *Helichrysum spp.* The former is frequently found on land cleared then abandoned by the villagers, on soil around agricultural land, and in the valleys. It includes many pioneer species such as *Acacia dealbata*, *Tsidia altissima*, *Vernonia spp.*, etc. The *Acacia dealbata* is a tree of medium height which may reach more than 15 m, and grows relatively densely. Other shrubs are less than 5-6 m high. The latter is frequently found around devastated forests. Higher shrubs may reach up to 4 m. The *Philippia spp.* multiplies rapidly and covers the entire surface with a dense, high and uniform cover species. This type of undergrowth maintains humidity relatively well. This type of vegetation may be found in areas with repeated controlled burns or fires to create pasture land.

Most of the grassland is visible on the south-west of the two lakes, in the zone between the two lakes and in the eastern part. The land was certainly burned to improve the growth of young grass to be used as fodder for grazing, which has destroyed all the original vegetation to create grasslands. Some grasslands have low shrubs, but in general, there is only grass. With repeated burning, the roots of herbaceous plants have been appeared on the surface at a height of 10 cm. This indicates that the surface layer has almost completely eroded. Surface erosion due to rains has revealed the laterite clayey soil and the hardened surface has lost its infiltration capacity. This type of soil erosion in grasslands is a big problem from the viewpoint of safeguarding of soils, and must be resolved in one way or another for the watershed management.

The principal herbaceous plants in grasslands are Horompotsy, Horona, Tsivongo, Buzaka (or Bozaka = plant of legume family: *Cyperus spp.*) etc. Tsivongo is used for cattle fodder. Buzaka is used for roofs and to cover furnaces for the production of charcoal.

### (IV) Tree planting

The tree planting zones in the study area only consist of pines and eucalyptus trees. Since the study area is at an altitude of 1350-1700 m, pines are principally of the *P. patula*, *P. kesiya* species. Tree planting with pine is carried out under the supervision of the Ministry of Water and Forests, in order to protect the soils at the banks of the two dams and to prevent soil

erosion. However, this tree planting project has been suspended since 1973 due to lack of funds. Tree planting was therefore interrupted at the halfway of the project. The growth of pines is slower than that eucalyptus and does not ensure cash revenue in the short term. As such, it has no interest for farmers.

Tree planting with eucalyptus principally includes the *E. robusta* species. The Mantasoa zone supplies firewood for Antananarivo, the capital. Aside from their agricultural activities, the farmers wishing to have cash revenue, planted many eucalyptus trees (*E. robusta*) with rapid growth, a short rotation period, and high regeneration, such as firewood. Part of the forest trees is maintained up to a tall height for the production of construction wood. In the western part of the 2 lakes, the principal roads and the road network connecting the hamlets have been developed and used to transport wood. This has led to a wide-scale planting of eucalyptus trees. In the past, when Madagascar was still a French colony, eucalyptus was produced to serve as fuel for trains, thus showing that eucalyptus planting has a long history.

In the hilly area east of the Lake Mantasoa under the supervision of the Ministry of Water and Forests, eucalyptus has been planted for a long time on small plots by a small number of farmers. The eastern part of the Lake Tsiazompaniry is also placed under the supervision of the Ministry of Water and Forests. There, the farmers hardly practice tree planting activities since the area is far from the market, the access roads have not been developed, and the transport of firewood is not profitable. As such, the planting of eucalyptus is concentrated in the western part of the 2 lakes. The rotation period for these eucalyptus trees being short, cutting and regeneration have been repeated. Some trunks are as thick as 1 m.

#### (V) Others

Vegetation classified outside tree planting consists of agricultural products and fruits. Rice paddies occupy the flat part of the valleys and the surrounding slope areas. Fruit trees are planted around many farms.

### 1-4-2 Results of the forest survey

A study per lot was conducted on the spot to get details on the actual condition of forests in the study area. The analysis of data obtained will serve as the basis for the watershed management plan. In addition, the interpretation of surface area data will reinforce precision during the establishment of the vegetation map based on the interpretation of aerial photos. The study per lot covered natural forests and pine and eucalyptus tree planting areas.

#### Study of natural forests

The study of natural forests covered forests localized in the hilly area east of the Lake Mantasoa with relatively easy access. The study was conducted as follows.

The lot for the study covered 20 m x 50 m (0.1 ha) for the study of trees in the upper layer, 10

m x 10 m for trees in the middle layer, and 2 m x 2 m for trees in the lower layer. The study covered the type of planting, the vegetation, the identification of species, the composition of species and the existence or non-existence of succeeding trees under medium layer trees, as well as the type of soil in the upper layer. In forest areas where a study per lot was difficult, a study was conducted to identify the tree species in the upper layer, using binoculars. Individual identification was made for trees in the upper layer with a diameter of more than 10 cm high at the height of the chest (1.20 m above the ground), those in the middle layer with 4-9 cm, and trees in the lower layer with height of more than 1 m. A local botanist familiar with local species helped us to identify the different special species in Madagascar. Table I-4 indicates the results of this study.

As shown in the Table I-4, there are many successor trees of species forming the upper layer of trees for the planting of the middle layer. The same applies for the planting of the lower layer. With adequate forest management, it is quite possible to re-establish the original vegetation including high trees and suggests the possibility of durable exploitation of the forest. At present however, forest management is not strict enough and illegal cutting is carried out by immigrants and urban companies, etc. In the lot covered by the forest study (0.1 ha), we confirmed 12 trees pulled out by the roots, which shows the risk for precious natural resources.

Although the study to identify the herbaceous plant species for the planting of the lower layer was not carried out, it was confirmed that the density produced by humidity and the colloidal layer (layer A0) was as thick. In the entire forest, there is a huge diversity of species due to the humidity. However, it is clear that human activities such as the cutting of trees and controlled burns destroy the forest ecosystem, lead to soil erosion of the forest floor and rapid degradation.

The study of shrubs was conducted in the north-east part of the Lake Mantasoa. This was formerly a virgin forest but the repeated cutting of useful trees has led to the disappearance of taller species. At present, no trees have reached the size suitable for construction wood. Almost all the existing trees have only reached 4-5 m in height. The undergrowth is very humid and contains much ferns and moss. Table I-5 indicates the relatively high number subsisting trees and their use.



Table I-4 Species of trees in natural forests

## (1) Name of trees and their number of appearance

	Upper layer	Middle layer	Lower layer	Study using binoculars
Scope of the lot (m)	(20x50)	(10x10)	(2x2)	
Scientific name	No. of appearance (time)			
<i>Agauria spp.</i>	3			
<i>Ampalis spp.</i>		1		
<i>Anthocleista madagascariensis</i>	8	1		Numerous
<i>Apodocephala spp.</i>			3	
<i>Aphloia theaeformis</i>	3	3		Scarce
<i>Brachylaena rmiflora</i>	4	3		Numerous
<i>Canthium spp.</i>	13	3		Scarce
<i>Croton spp.</i>			1	Scarce
<i>Deuteromalotus spp.</i>	1			
<i>Dichaeatanthera spp.</i>				Numerous
<i>Dilobeia thouarsii</i>				Scarce
<i>Dombeya spp.</i>			1	Numerous
<i>Elaeocarpus spp.</i>		3		
<i>Enterospermum spp.</i>				Scarce
<i>Eugenia emirnensis</i>		2		Scarce
<i>Garcinia spp.</i>	2			Scarce
<i>Grewia spp.</i>				Scarce
<i>Harungana madagascariensis</i>				Scarce
<i>Homalium spp.</i>	1			Scarce
<i>Ilex mitis</i>	2	1		Scarce
<i>Macaranga spp.</i>			2	
<i>Malleastrum spp.</i>	1			
<i>Memecylon spp.</i>		1		
<i>Ochrocarpus spp.</i>	1			
<i>Ocotea spp.</i>	2			Scarce
<i>Polyscias spp.</i>	6			Numerous
<i>Ravenea robustior</i>				Scarce
<i>Ravensara spp.</i>	1	2		Numerous
<i>Rhotmannia talagnania</i>				Scarce
<i>Schefflera vantsilana</i>	7			Numerous
<i>Sloanea rhodantha</i>	2			Numerous
<i>Symphonia spp.</i>				Scarce
<i>Tambourissa spp.</i>	8	7	2	Scarce
<i>Tina chapelieriana</i>	6			
<i>Trema orientalis</i>				Scarce
<i>Vitex coursii</i>	1			
<i>Weinmannia srutenbergii</i>	10	2		Numerous
<i>Wlaedcarpus alnifolius</i>				Scarce
<i>Xylopiia spp.</i>	1			
<i>Zanthoxylum madagascariensis</i>				Scarce
Number found	84	29	9	

## (2) Number of trees per ha

Classification	Number
Upper layer	840
Middle layer	2,900
Lower layer	22,500
Total	26,240

Table I-5 Principal tree species in a destroyed forest and their particular characteristics

Scientific name	Family	Characteristics of the species	
		Height	Use/Characteristics
<i>Acacia dealbata</i>	Leguminosae	~18m	Fuel/adapted to fertile soil, forms groups in the cutting areas, lower layer vegetation in tree planting zones
<i>Anthocleista madagascariensis</i>	Loganiaceae	~15m	Belongs to the Loganiaceae family, Hypophylla, with big leaves, visible in the valleys
<i>Brachylaena ramiflora</i>	Asteraceae	~20m	Wood for construction, medicine (backaches, fortifying)
<i>Crotalaria spp.</i>	Fabaceae	~2m	Yellow flowers of the aconite type, grains of the legume type, likes fertile soil
<i>Dilobeia thouarsii</i>	Proteaceae	~30m	Framework material, oil (leaves)/white bark
<i>Harungana madagascariensis</i>	Hypericaceae	~20m	Medicine (stomachache), tint/yellow bark
<i>Helichrysum spp.</i>	Asteraceae	~4m	Firewood/mixed with <i>Philippia</i> in heather form, appears when the ground is fertile
<i>Homalium nudiflorum</i>	Flacourtiaceae	~25m	Material for framework, beams, furniture/rose color, mixed with <i>Philippia</i>
<i>Ilex mitis</i>	Aquifoliaceae	~30m	Material for musical instruments/similar to tea leaves, groups in valleys, small grains
<i>Lantana camara</i>	Verbeaceae	~3m	Medicine for wounds (leaf sap)/thorn
<i>Philippia spp.</i>	Ericaceae	~4m	Firewood, materials for perfumes (leaves)/heather form, principal type of shrub
<i>Polyscias ornifolia</i>	Araliaceae	~7m	Light and soft, used for washing dishes/straight stem
<i>Ravensara crassifolia</i>	Lauraceae	~20m	Material for structures, furniture/white bark
<i>Solanum aurantium</i>	Solanaceae		Solanaceae family
<i>Tina chapelieriana</i>	Sapindaceae	~25m	Construction wood/flowers at the edge of branches
<i>Tsiadia Altissima</i>		~3m	Medicine against headache/mixed with <i>Philippia</i>
<i>Vaccinium spp.</i>	Ericaceae	~12m	<i>Vaccinium</i> <i>Vitis-Idaea</i> , small leaves, numerous in south of Madagascar
<i>Vernonia spp.</i>	Asteraceae	~3m	The leaf resembles <i>Elaeagnaceae</i> , in scroll form, bunch of flowers at the end of the leaves, mixed with <i>Philippia</i>
<i>Weinmannia rutenbergii</i>	Canoniaceae	~20m	Firewood, for furniture/resembles <i>Enkyanthe</i> , mixed with <i>Philippia</i>

As shown in Table I-5, there are still many trees which can grow to more than 15 m in height and it is possible to replant the forest with high trees as in the past, through correct management of the forest.

The Angavo mountains lying in the north-south direction, east of the study area, are continuously hit by trade winds from the Indian Ocean. This allows all forests in the study area to conserve their high humidity. Furthermore, the evapotranspiration of the Mantasoa and Tsiacompaniry lakes maintain high humidity throughout the year. This is why vegetation in the forest, including shrubs, is dense in the lower layer. There are also many lichens, moss and epiphyte plants covering the trunks. There are many herbaceous type plants used daily by the villagers for medicinal purposes. A development study on this subject may allow the establishment of a market for use of these medicinal plants. Some villagers practice apiculture, but only for family consumption. Very few farms practice it on a commercial basis. In the future, the development of various special forest products may create new sources of revenue. The protection of this natural forest with various species and its durable use will provide benefits to the villagers. The participation of the villagers is indispensable for the protection and renewal of the degraded natural forest. The villagers must be aware of the importance of preserving the natural forest as a resource. For this purpose, it will be necessary to increase the number of forest rangers on the spot in order to reinforce the management of the forest, and simultaneously to educate the villagers to ensure a durable and global forest management.

#### Artificial forest study

##### Eucalyptus

The artificial forest study was conducted in 3 areas (4 lots) in the eucalyptus tree planting area. The studied species is *E. robusta*, frequent in this region. The villagers do not buy seeds to cultivate plants. Often, their planting method uses the plants gathered in the forest. Planting is carried out at a leisurely rate during the resting season from agricultural activities. The artificial planting of forest is of 2 types. First, firewood is produced to be used as fuel. Trees are planted for a short rotation period (4-6 years) before cutting. Plants with small diameter obtained through the regeneration of shoots are used as new plants. For trees to be used as construction wood, the rotation period is long (more than 20 years). They are grown to obtain a wide diameter.

These tree planting studies to be conducted for information on the growth of eucalyptus, were centered on planting for construction wood without cutting. A study per position and per purpose is also necessary, but various limitations on the spot have required us to restrict the study areas. These artificial forest studies gave the results in Table I-6. Annex 13 gives details of these results.

Table I-6 Volume of wood per lot and annual growth

Lot no.	Age of trees (after the last harvest)	Number/ha	Average height (m)	Volume of standing trees (m <sup>3</sup> /ha)	Annual average growth (m <sup>3</sup> /ha/year)
1	15	1,275	8.59	40.58	2.71
2	8	1,700	8.19	9.60	1.20
3	50	1,090	17.77	275.86	5.52
4(Note)	1,5	1,690	7.26	15.98	10.65

Note: Lot 4 is a forested area undergoing a regeneration of shoots.

Based on the division proposition of Mr. Randriannjafy, explained in the paragraph on "Tree planting activities", aside from lot 4, and other tree planting activities are part of the lowest level VI. The average annual growth is slow and less than the rate of tree planting for eucalyptus, studied by Mr. Randriannjafy in the Manjakandriana zone. This time, number of samples is insufficient to allow a general evaluation. Nevertheless, selected tree planting activities for the studies do not occupy the worst positions in the area. Consequently, these tree planting activities must be studied in more detail in order to allow an evaluation for classification, position, etc., in the study area.

Farmers owning the land do not have sufficient specialized knowledge regarding the growth of trees and tree species. Growth conditions also differ individually. There are cases where tree planting is carried out on soil considered unproductive for tree planting because the surface soil is poor.

At present, the need for eucalyptus is well established in the Mantasoa and Tsiazompaniry zones, and must still be developed due to the strong demand for charcoal. Eucalyptus also represents a sure source of revenue. It is adapted to the local climate, and its growth and regeneration through shoots is simple. The planting of eucalyptus trees places an important role for the environment as a water reserve and for soil protection. Tree planting activities conducted by the villagers must be encouraged and actively supported by the local organizations concerned, including the Ministry of Water and Forests. They are considered important for the development of the region.

#### Pine trees

The study of Pine tree tree planting was conducted in the secondary residential area at the shore of the Lake Mantasoa. The lot studied was 20 m x 50 m. There were 3 species of trees: *P. kesiya*, *P. patula* and *P. chinensis*, interplanted in 1952 (46 years ago). The planting interval is around 3 m x 2 m. The soil is not fertile but ordinary without deterioration. The trunks are relatively straight. In the undergrowth, many shoots have regenerated naturally. Successive trees reaching 2 m also exist. There are practically no other herbaceous plants. The colloidal layer reaches 10 cm and the surface soil layer maintains relative humidity. No development activity was conducted after the planting of these trees. The number of trees per species and their average diameters at the chest height (1.2 m above the ground) are as follows:

Table I-7 Average diameter at the chest height per species

Species	Number of trees	Average diameter at the chest height (cm)
<i>P. kesiya</i>	84	18.0
<i>P. patula</i>	22	15.2
<i>P. chinensis</i>	5	32.4

The *P. chinensis* species were few but have shown a reasonable growth. This species is not often planted in other tree planting areas. Aside from the enumeration study, sampling was carried out to calculate the average height of the trees with respect to their diameter. Figure I-4 below gives the average height curve.

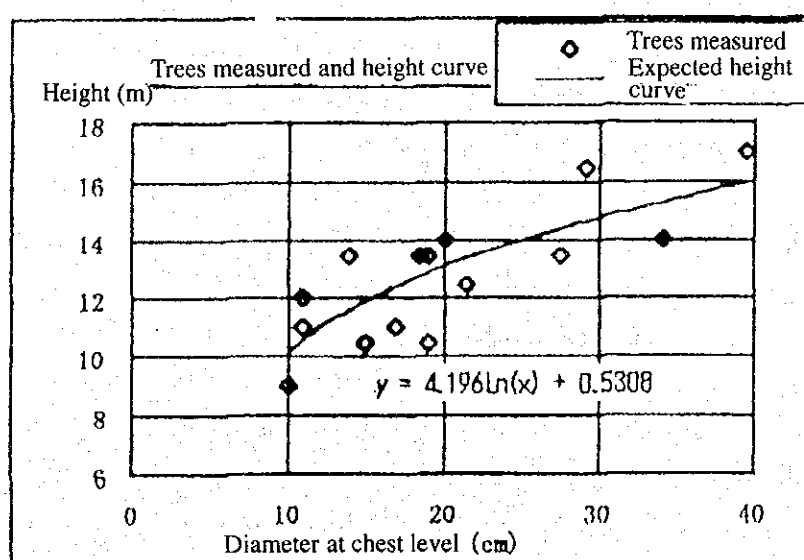


Figure I-4 Height curve of *P. kesiya*

### 1-5 Tree plantation activities

The species for tree planting were introduced to Madagascar at the end of the XIXth century. Until the present, more than 40 species of pine and more than 100 species of eucalyptus have been introduced. Adaptation and growth, etc., tests have been conducted. Consequently, Madagascar has advanced know-how on tree planting activities. In 1986, a grain center (SNGF: National Silo for Forestry Grains of Madagascar) was created in Antananarivo with the assistance of Switzerland, and technical cooperation was carried out in 3 phases up to December 1998. A system allowing the production and sale of tree seeds adapted to Madagascar has been established. Seed germination tests were conducted according to the ISTA (International Seed Testing Association) standards. A well-managed system will ensure nursery tests for reproduction and storage. Two storage facilities which may provide grains of stable quality are in operation. The SNGF, under the supervision of the Ministry of Water and Forests until the present, has become an independent organization which manages the sale of

seeds and actively produces manuals giving instructions on tree planting techniques.

Pine and eucalyptus are the two main species widely afforested in Madagascar and in the study area. We will now discuss the planting of pine and eucalyptus trees in the study area.

#### Pine tree planting

Pine tree planting carried out by the Ministry of Water and Forests is visible at the shore of the Lake Tsiazompaniry and around the housing site of the northwest shore of Lake Mantasoa. These are few in other parts of the study area. Pine tree planting was carried out several decades ago. *P. patula*, a species better adapted to this zone with relatively high altitude and a humid climate, was selected. The *P. kesiya*, adapted to drier zones and to a lower altitude, is planted in wide areas of the Moramanga zone, although outside the study area.

This tree planting zone is located in the watershed of the Mangoro river, around 70 km east of Antananarivo. This consists of industrial tree planting for the production of pulp chips, carried out since 1969 by FANALAMANGA (Forest Development Office). The planted area is around 80,000 ha, the biggest pine tree planting area in Madagascar. Every year, the planted surface covers 4,000-8,000 ha. Under a feasibility study conducted in 1981/82 by the World Bank, the hired Canadian consultant reported an internal profit rate of 2%. Since this tree planting has not attained the profitability level, the orientation of the tree planting plan was considerably modified. The annual tree planting surface was reduced to 200 ha since 1986 and remains as such up to the present. Pine trees planted are ready for cutting and forestry companies have installed themselves near the tree planting area to cut and transform the trees. At present, the Company with French capital which owns the highest production capacity principally produces pallets at 100% for export towards Europe and south-east Asia.

In the study area, there is another tree planting site on bare land, carried out by the Ministry of Water and Forests for the protection of soils around the Lake Tsiazompaniry. This tree planting suspended in 1957 but was suspended since 1973 due to financial difficulties. As such, only the northern half of the shore of the Lake Tsiazompaniry is afforested.

The *P. patula* is the principal species planted in this high altitude zone. A magnificent pine forest can now be found on the slopes of the north-west shore. However, since patrol surveillance is insufficient, evidence of illegal cutting is visible everywhere. The villagers also graze their livestock in the forest. Trees damaged by fire set to create pasture areas are visible here and there.

Pine tree planting has also been carried out in the housing site north-west of the Lake Mantasoa, but trees are planted mainly for ornamental purposes in this area with secondary residences and hotels. Contrary to the governmental tree planting around the Lake Tsiazompaniry, this Pine tree tplanting is within private property. Even in the absence of the owner, caretakers ensure the management of the trees, with procedures totally different from the preceding tree planting area.

Aside from these 2 tree planting activities, Pine tree planting is carried out by the villagers themselves, with very limited dimensions. This is because, compared to eucalyptus, the growth period for pine is relatively long, the period between planting and harvesting is too long, regeneration of the shoots is impossible for pine trees, the price of pine charcoal is less than the price for eucalyptus charcoal, etc. No new pine tree planting was observed during the in-situ study, even if the demand for pine as construction wood is significant. This is evident from the illegal cutting carried out in the governmental tree planting areas.

#### *Eucalyptus robusta* tree planting

Eucalyptus has been planted on wide areas by governmental organizations since the French colonial period, and was used as fuel for trains. At present, eucalyptus is widely used as fuel for heating, cooking and as construction wood. It constitutes the most important forest resource in Madagascar. *Eucalyptus robusta* tree planting is carried out on a small scale everywhere for use as firewood since its wood is dense and has a high calorific value. Among the different species, *E. robusta* is best adapted to the natural environment of the central plateaus and has been planted there for more than 150 years. As mentioned above, the study area near the metropolitan zone is a major firewood supplier. The area at the west of the two lakes are largely populated and the road network necessary for the transport of firewood is well developed, eucalyptus is planted in abundance. These tree plantings are carried out on large surfaces, mainly in the Mantasoa zone. The percentage of land use for *Eucalyptus robusta* tree planting in this area is high (see Annex 48).

Pine tree planting with private financing started in the Manjakandoriana region. Today, the region is largely covered with eucalyptus trees. The planting of eucalyptus gradually extended to the neighboring areas with the growing awareness of its commercial possibilities based on the needs in the region. Today, the villagers themselves are undertaking eucalyptus tree planting on a grand scale. This major development is due to the initiative of the villagers and not under governmental direction, thus representing a rare event even in neighboring countries. As such, tree planting in the Manjakandoriana region will certainly have a significant impact on the nearby villagers.

In Mantasoa village, Manjakandoriana prefecture, eucalyptus nursery producers sell the plants at 75-100 FMG per unit. However, lack of knowledge concerning the production of plants and tree planting techniques lead the villagers to often conduct tree planting with the plants taken from the tree. The regeneration of eucalyptus shoots is simple and possible to repeat. With their rapid growth, the villagers have actively practiced tree planting. Tree-planting where firewood is produced through the repeated regeneration of the shoots has been practiced for more than 50 years. For eucalyptus tree planting carried out to produce construction wood. Its rotation period is more than 20 years, while it is generally less than 10 years for firewood. For eucalyptus tree planting to produce fuel, the cultivation period must be 10 to 20 years after

planting to allow the trunk shoots to grow in sufficient size. Since branches with 2 to 3 cm in diameter can be used as firewood, all shoots are left without applying cultivation work after planting and the trees are left to grow naturally. Studies concerning the number of shoots to be cultivated and the number of years required for the rotation period, must be established to obtain the maximum firewood production. This includes techniques for the exploitation of eucalyptus trees including work volumes required.

Based on the report of Mr. Randrianjafy (see note) concerning the development of eucalyptus tree plantings in the Manjakandoriana prefecture, a 10-year growth is ideal for eucalyptus shoots. The most efficient exploitation consists of cutting before 10 years since growth will slow down after this. In reality, around 70% of the eucalyptus trees are cut before 8 years. Since the supply is unable to satisfy the demand, some farmers cut the trees earlier to rapidly ensure cash revenue. In particular, in the zone near the route National 2 directly connected to Antananarivo, close to 70% of the farmers have adopted a short rotation period of 2 to 5 years. Results of the eucalyptus tree planting study in the Antananarivo area, conducted by Mr. Ramamonjisoa (1993) indicate the percentages in Table I-8, showing the rotation period for the production of firewood.

Note: Production and management of short rotation eucalyptus copse: Honore Randrianjafy, 1993.

Table I-8 Percentage of rotation periods for eucalyptus tree planting

Rotation period	Percentage (%)	Total
2 years	26	26
2-3 years	23	49
4-5 years	17	66
6-7 years	6	72
8-9 years	12	84
10-11 years	10	94
12-20 years	6	100
Total	100	

Source: The city with a thousand charcoal burners, Bruno S. Ramamonjisoa, 1993

It appears that the reason why the villagers have chosen a shorter period than the rotation period adapted for eucalyptus is based on a calculation of the difference in revenue generated by extending or shortening the rotation period by one year. This choice is due to the fact that the farmers prefer to obtain cash revenue through a short rotation period even if the revenue is somewhat lower.

Mr. Randrianjafy divided the eucalyptus tree plantings in the Manjakandoriana prefecture into 6 classes, with a forecast of growth and harvest per position. The lower part of the slopes is classified as I (position index 1.3), II (1.1), hillside III (1.0), IV (0.9) and the fault line V (0.8) and VI (0.7). The 3 groups below are defined based on the productivity of these positions.



Group with high productivity      Positions I and II  
 Group with average productivity      Positions III and IV  
 Group with low productivity      Positions V and VI

Table I-9 indicates the average height of trees per position, age and upper height of the trees. The upper height of the trees is the average height for 1,000 trees by converting the study area to 1 ha.

Table I-9 Average height of trees per position, age and upper height of the trees

	Position											
	I		II		III		IV		V		VI	
	Position index											
	1.3		1.1		1.0		0.9		0.8		0.7	
	Height (m)											
Age	Average	Superior	Average	Superior	Average	Superior	Average	Superior	Average	Superior	Average	Superior
1	2.87	3.43	2.47	2.93	2.24	2.64	2.04	2.38	1.87	2.17	1.70	1.95
1.5	4.12	5.04	3.54	4.30	3.21	3.87	2.91	3.49	2.66	3.18	2.42	2.87
2	5.32	6.57	4.57	5.61	4.13	5.05	3.74	4.55	3.42	4.14	3.10	3.74
2.5	6.47	8.03	5.55	6.85	5.02	6.17	4.53	5.56	4.14	5.06	3.76	4.57
3	7.56	9.42	6.48	8.05	5.86	7.25	5.29	6.52	4.83	5.94	4.38	5.36
4	9.61	12.03	8.23	10.27	7.43	9.25	6.71	8.33	6.12	7.59	5.54	6.85
5	11.47	14.41	9.82	12.30	8.87	11.08	8.00	9.97	7.30	9.09	6.61	8.20
6	13.18	16.57	11.28	14.15	10.17	12.75	9.17	11.47	8.37	10.45	7.57	9.43
7	14.73	18.55	12.60	15.84	11.37	14.27	10.25	12.84	9.35	11.70	8.46	10.56
8	16.14	20.36	13.81	17.38	12.46	15.66	11.23	14.09	10.25	12.84	9.26	11.59
10	18.61	23.50	16.92	20.07	14.36	18.08	12.94	16.27	11.80	14.82	10.67	13.38
12	20.67	26.12	17.67	22.30	15.94	20.09	14.36	18.08	13.10	16.48	11.84	14.87
16	23.80	30.11	20.35	25.71	18.35	23.16	16.53	20.85	15.08	18.99	13.62	17.14

If we consider trees with superior height in the 10-year tree planting areas, the annual average growth is 24.5 to 25.6 m<sup>3</sup>/ha/year in high fertile zones (positions I, II), and 23.1 to 23.8 m<sup>3</sup>/ha/year in medium fertile areas (positions III, IV), and 21.9 to 22.5 m<sup>3</sup>/ha/year in low fertile zones (positions V, VI).

Table I-10 Height of eucalyptus trees per position and average annual growth

	Degree of fertility	Fertility index	Height (m)	Average annual growth (m <sup>3</sup> /ha/year)
Very fertile	I	1.3	23.5	25.6
	II	1.1	20.1	24.5
Ordinary	III	1.0	18.1	23.8
	IV	0.9	16.3	23.1
Low fertility	V	0.8	14.8	22.5
	VI	0.7	13.4	21.9

Source: Production and management of eucalyptus copse with short rotation, Honore Randrianjafy, 1993

## 1-6 Land use and vegetation

Photo diagnosis was carried out with 290 air photos (scale: 1:20,000) taken under this investigation project from May to August 1998. In addition, conformity of the diagnosis was confirmed on the site. Land use, classification of vegetation and each area of (1) the study area and (2) the target area, which were obtained from these works, are as shown in Table I-11.

Table I-11 Surface with land use and type of vegetation

### (1) Study area

Land use and type of vegetation			Surface (ha)	Proportion of composition	
Forest	Natural forest		Approximate density above 50%	18,993	21
			Approximate density less than 50%	710	1
	Tree planting	Pines	Approximate density above 40%	3,557	4
			Approximate density less than 40%	1,581	2
		Eucalyptus		8,806	10
		Land being prepared for tree planting		32	-
	Others		90	-	
	Shrubs		8,132	9	
	Sub-total		41,901	47	
Grassland			29,624	33	
Damp plain (flooded plain)			2,420	3	
Rice field			4,743	5	
Fields			6,481	7	
Exposed rocks			79	-	
Housing areas (houses, etc.)			344	-	
Cemetery			17	-	
Water surface			4,991	5	
Total			90,600	100	

### (2) Target area

(2) Target area

Land use and type of vegetation			Surface (ha)	Proportion of composition	
Forest	Natural forest		Approximate density above 50%	3,819	8
			Approximate density less than 50%	142	-
	Tree planting	Pines	Approximate density above 40%	2,744	6
			Approximate density less than 40%	1,239	3
		Eucalyptus		4,407	9
			Land being prepared for tree planting	16	-
	Others		31	-	
	Shrubs		3,173	6	
	Sub-total		15,571	32	
Grassland		21,164	43		
Damp plain (flooded plain)		1,380	3		
Rice field		2,319	5		
Fields		3,617	7		
Exposed rocks		62	-		
Housing areas (houses, etc.)		184	-		
Cemetery		0	0		
Water surface		4,904	10		
Total		49,201	100		

Regarding land use in the target area, villages are concentrated on the whole west side of the Mantasoa and Tsiazompaniry lakes. In particular, as population density on the west side of the Lake Mantasoa is high, land use there is intensive. As the characteristic form of land use seen in these areas, paddy field farming with irrigation discharge is widely carried out. Since the villagers' principal food is rice, the lowland parts along rivers are used as rice fields. Many farmers plant potatoes as a secondary crop. The surrounding terraced heights are used for plowed fields of vegetables such as taros and maize. Higher inclining land is used to cultivate cassava and leguminous plants. In hill areas on the upper slope, there is overspreading land afforested with eucalyptuses, mainly for the purpose of production of fuel materials. Intensive land use exist from the lowland to the upper slope. Tree planting with eucalyptuses is actively carried out in the Mantasoa zone; such forests become gradually sparser toward south. Considering the present situation of land uses, characterization can be made as follows.

#### North-east part of Mantasoa

Land exploitation for agriculture is flourishing around the hamlets, but there is unused land covered with shrubs and meadows in hill areas far from the hamlets.

#### North-west part of Mantasoa

This housing site has secondary residences and hotels with artificial pine forests for ornamental purposes and gardens.

#### Western part of Mantasoa

As indicated above, there is intensive land use in this area. Low and flat lands are all used as rice fields. Sweet potatoes are planted on terraces, while corn, cassava, and leguminous plants are planted on the slopes. Eucalyptus trees occupy the upper hill and the meadows are used for grazing. Unused or fallow lands are rare.

#### Southern part of Mantasoa

The hamlets are scattered and land use is extensive. Lands around the hamlets are principally used for agriculture. Eucalyptus trees are found in particular areas on the hillsides. The meadows take up a large proportion of this area.

#### Eastern part of Mantasoa

This property belongs to the State under the responsibility of the Ministry of Water and Forests. However, immigrants from the west have cut trees in the natural forest and have established farms in some areas by planting on burned land. The natural forest near the hamlets has become a secondary forest due to the propagation of flames for planting on burned land. However, some tall trees remain in the valleys.

#### Northern part of Tsiazompaniry

Land use is extensive, with areas around the hamlets principally used for agriculture. Tree planting exists in certain areas.

#### Western part of Tsiazompaniry

Land use is similar to Mantasoa, but towards the south, the hamlets become fewer and land use is extensive. There are many grazing areas.

#### Southern part of Tsiazompaniry

Aside from the south-west, the major part is used extensively, including pastureland. There are a few agricultural areas only near the hamlets.

#### Eastern part of Tsiazompaniry

As for the eastern part of Mantasoa, the slash and burn method is practiced by immigrants who have created new farms. Wide spaces are extensively used as pastureland.

As indicated above, specific characteristics are evident in the land use according to zones. They not only reflect the natural conditions in this region, but also must be viewed based on the socioeconomic conditions of the different hamlets in this area. This essential point must be considered for the establishment of a participatory watershed management plan for the entire region.

## **2 Socioeconomic environment**

### **2-1 Socioeconomic situation**

#### **2-1-1 Administrative divisions in the study area**

The Mantasoa zone is located in the Manjakandriana prefecture, in the state of Antananarivo, and is subdivided into 4 rural communes: Ambatolaona, Mantasoa, Miadanandriana and Merikanjaka. The study area in the Mantasoa zone has a total of 17 fokontanys. The Tsiazompaniry zone is located in the Andromasina prefecture, in the state of Antananarivo, and is subdivided into 4 rural communes: Anosibe Trimoloharano, Ambohimiadana, Tankafatora and Fitsiniovana Bakaro. The study area in the Tsiazompaniry zone has a total of 18 fokontanys.

### 2-1-2 Population

The 1997 census indicated a total population of 159,406 villagers for the Manjakandriana prefecture and 109,444 villagers for the Andromasina prefecture. The population in the study area is 16,619 villagers (10% of the total prefecture population) for the Manjakandriana prefecture and 17,571 villagers (16% of the total prefecture population) for Andromasina. Table I-12 indicates the distribution of the population of each fokontany belonging to the study area.

### 2-1-3 Living conditions

#### (1) Condition of infrastructures

The interview conducted with rural commune authorities indicated the following conditions of the infrastructures within the study area.

Rural commune office:

Located in the central village of the rural commune.

Schools: There are public schools and catholic schools. Each rural commune in the study area has more than eight primary schools. The rural communes of Mantasoa, Miadanandriana, Merikanjaka and Ambohimiadana have secondary schools. While primary schools are fully improved in many rural communes, it cannot be said that junior high schools are so. As to the percentage of school attendance, that of attendance at primary schools is high but those of attendance at junior high schools and schools of the higher level are low. Particularly, the percentage of women's attendance at junior high schools and schools of the higher level are low.

Hospitals: The rural communes of Mantasoa and Merikanjaka have hospitals or doctors providing care. In the 6 other rural communes, there are health clinics without doctors, called the CSB. Each of the 4 rural communes in the Mantasoa zone also has a maternity clinic. As is evident from the description written above, there are neither hospitals nor maternities in Tsiazompaniry zone, and the infrastructure for health and sanitation has not been developed.

Churches: There are several churches in each rural commune and a big church in each county town of the rural commune.

Post office: There are post offices in the 5 rural communes other than Miadanandriana, Tankafatora and Fitsinjavana Bakaro.

Public telephone: 1 in the Mantasoa rural commune.

Electricity: Electricity is provided in the 4 rural communes of Mantasoa and in Ambohimiadana.

Water supply: In one place in the Merikanjaka rural commune county town.

Public market: Aside from the Anosibe Trimoloharano rural commune county town, there is a public market in each country town on one fixed market day during the week. Fresh food products such as vegetables, meat, etc., and clothes, products for daily use, are available.

Public transport: Aside from the rural communes of Anosibe Trimoloharano and Tankafatora, 6 rural communes have a bus service connecting Antananarivo, the capital, and the county town.

Table I-12 Population per fokontany in the study area

Prefecture	Rural commune	Fokontany	Population
Manjakandoriana	Ambatolaona	Ambatolaona	2,512
		Mahitsitady	789
	Mantaso	Andrefanivorona	308
		Anjozoro Est	2,005
		Mantaso	2,020
		Masombahiny	1,170
		Miahamanjaka	556
	Miadanandriana	Ambohimanjaka	662
		Ambohipeno	972
	Merikanjaka	Merikanjaka	1,161
		Ambahinia	674
		Ambohidraisolo	476
		Falefika	960
		Ambohidraondriana	392
		Ambohijafy Est	830
		Tsiazompaniry-Kely	879
		Miarinarivo	253
		Sub-total	16,619
Andramasina	Anosibe Trimoloharano	Andriantsiajo	415
		Angodongodona	1,963
	Ambohimiadana	Iharamalaza	2,627
		Manandriana	699
	Tankafatora	Analandambo	576
		Ampangabe I	441
		Andaranofankatia	382
		Ampangabe II	334
		Morarano Saofiraisana	954
		Anosivola	675
		Andohariana	482
		Analamihotra	702
		Ankazotelo	702
		Anovondriana	477
		Kelilalina	516
	Fitsiniovana Bakaro	Ambohijanaka	3,887
		Kelimañana	1,489
		Ambatamitsangana	250
		Sub-total	17,571
		Total	34,190

Source: Interviews conducted in each county town of the prefecture.

## (2) Tasks according to gender

Specific tasks linked to gender in the Mantasoa and Tsiazompaniry areas are as follows, with respect to agricultural activities.

Work requiring force such as work on rice fields and slopes, are carried out by the men. For example, plowing on rice fields is generally carried out by a group of 2 or 3 men. The same applies for work using oxen. Soil puddling work is also carried out by men. Planting on slopes, from cutting grass to plowing is also carried out by men. Agricultural work carried out by women consists of transporting the compost to rice paddies and fields, followed by the planting of rice. On slopes, women plant cassava.

Men and women work together for harvesting potatoes, etc.

Work requiring strength is also leaving to men, but the plowing of rice fields is occasionally carried out by men and women in a team.

As for household activities, the preparation of meals, water collection, washing, etc., are assigned to the women. Household work for women begin at around 5:00 in the morning and end at 7:00 in evening after dinner. When the men return from the fields, they collect firewood and take care of the children. Use of cash revenue is generally discussed between the spouses.

Agricultural and household tasks are shared between men and women and they collaborate as necessary. This type of cooperation is common in the Tana plain, but the situation appears to be different in the western coast.

It was mainly men who spoke out and actively participated in the meetings to explain the study to the villagers or in the PRA organized by the NGOs. Particularly, this tendency was strong in the initial stage of execution of the PRA. Men had leadership in a larger group, and women rarely led the group by speaking actively.

### 2-1-4 Traffic

The principal means of transport for the villagers in the study area are medium size buses, carts drawn by oxen, bicycles, and walking. As mentioned above, the medium size bus is well managed as the common means of transport. The principal lines and the number of buses are indicated in Table I-13.

Table I-13 Principal bus lines and number of services

Principal bus lines	Number in circulation
Antananarivo ⇄ Mantasoa rural commune county town	1 / day
Antananarivo ⇄ Miadanandriana rural commune county town	3 / day
Antananarivo ⇄ Merikanjaka rural commune county town	Data not available
Antananarivo ⇄ Andramasina ⇄ Ambohimadana	1 / day
Antananarivo ⇄ Fitsinjovana Bakaro	3 to 4 per week

The medium size buses run on specific roads and are only used by the villagers to go to

Antananarivo, the capital. They usually travel on foot. Some villagers even go to Antananarivo by bicycle or on foot. Carts drawn by 2 oxen are largely used for the transport of agricultural products, charcoal, fertilizers, etc.

In the study area, most of the road sections are unpaved, lack repair, and in poor condition. Even during good weather, a 4-wheel drive vehicle would require much travel time due to uneven roads and slopes. During or after the rain, the roads become muddy and slippery, with risks of getting stuck in the mud.

In the study area, the bridges are made of reinforced concrete, iron or wood. Wooden bridges often use log and squared wood. These wooden bridges were built by the village villagers. All operations from transformation to the mounting of wooden materials were carried out by the village organization. As such, for villages with financial difficulties for purchasing wood and those who do not have a solid organization for shared work, the repair or replacement work for damaged bridges is left undone. Since the passage of vehicles on the bridge is impossible, villagers have to go to the villages on foot, and sometimes even this is impossible.

#### **2-1-5 Industries in the area**

The principal industries in the study area are agriculture, the manufacture of charcoal, fishing in continental waters, apiculture and handicraft industries such as manufacture of baskets. A detailed analysis of the specific conditions in villages covered by questionnaires, cover these principal activities with a summary given below. The rural communes of Ambatolaona and part of Mantasoa facing the lake in the Mantasoa zone are housing areas, with hotels operating in the Mantasoa fokontany. In these housing areas, carpentry work to repair houses and maintenance work for gardens, etc., are the sources of cash revenue.

As Mantasoa zone is located in the suburbs of the capital, Antananarivo, it is relatively near the wage labor markets in the capital, Manjakandoriana, etc. and, therefore, people are blessed with opportunities for wage labor.

On the other hand, as Tsiacompaniry zone is located in a remote area from the urban part which has the wage labor market, so that people are not blessed with opportunities for wage labor and depend on the sale of farm products, such as potatoes, as the sources of cash income in the present situation.

##### **(1) Agriculture**

Agriculture is the most important activity in the study area as a source of cash revenue and for food production for family consumption. The principal and particular forms of agricultural production are a combination of rice and potatoes on flat land and fields (planting of cassava, cereals, etc.), orchards, stockbreeding in meadows, etc., on slopes.

For the alternative cultivation of rice and potatoes on flat land, most of the rice produced is used for family consumption, while potatoes are commercial products. General planting



periods are from March to June and July to September (2 harvests) for potatoes and October to February for rice. Potatoes are therefore planted for 7 months and rice for 5, which makes rice a catch crop.

Planting fields on slopes are generally called Tanety in Madagascar. The principal crops planted are cassava, sweet potato, corn, taro, legumes such as green beans, and pineapple. Cassava planting is the most important in quantity.

Fruit trees are generally planted around the farms. The principal fruits are persimmon, loquats, peaches, pears, grapefruits, bananas, plums, etc.. Fruits trees are planted for family consumption and are also sold for cash revenue.

Principal livestock breeding includes cows, pigs, rabbits, chickens, ducks, geese, turkeys, sheep, etc. Cattle are raised to draw carts, for field work, as well as to provide meat and milk. Poultry, such as chickens, and pigs are raised in the garden and on flat agricultural land. Rabbits are raised in the farmhouse. Sheep are fewer than other animals and there are very few goats and horses.

## (2) Charcoal-making industry

Charcoal making using eucalyptuses from tree planting flourishes in the study area. More than half of firewood and charcoal consumed in the Antananarivo Metropolitan area is produced in Manjakandoriana Prefecture. Particularly in the Mantasoa zone, because it is near the Metropolitan area, the charcoal-making industry flourishes. Many farming families engage in charcoal making as a side job or a special occupation.

Charcoal is produced by the traditional method, the so-called "lying." A kiln is generally 3 m in width, 3 - 4 m in length and 50 cm - 1 m in depth. Capacity is about 18 - 24 m<sup>3</sup>. The time spent for charcoal making is usually 5 - 7 days. There are the following three forms of charcoal-making operations:

- ① Independent charcoal making in which a manager himself/herself burns eucalyptuses from an artificial forest owned by him/her as a side job,
- ② Independent charcoal making in which a manager burns eucalyptuses from a purchased artificial forest as a special occupation, and
- ③ Employed charcoal making in which an employee makes charcoal as a laborer.

The first sales price of charcoal ranges from 7,500 FMG to 9,000 FMG per 20 kg sack, although this changes according to the season. The sales price tends to become higher in the rainy season. Charcoal sold to brokers and others is an important source of farmers' cash income.

## (3) Fishing in continental waters

Two types of fishing are practiced in the study area. One is fishing of tilapia and black bass from the two lakes as the principal or secondary occupation. For this type of fishing, there are

4 fishing cooperatives in the Mantasoa zone and at least one in Tsiazompaniry. One of the fishing cooperatives in the Mantasoa counts 800 villagers as members. Fishing is carried out from small boats with nets spread out in the lakes.

The other type of fishing is in the rice fields after the harvest and in small waterways. In this case, the women and children install simple traps. The small fish caught are dried in the sun then sold, or consumed as a source of protein by the families. Some of the villagers also catch crawfish in waterways then sold to obtain cash revenue.

#### (4) Apiculture

Apiculture is a secondary activity of the farmers in the study area. The modern method applied consists of installing beehives near the house or in an artificial eucalyptus forest. Honey is consumed as a nutritive element by the families or sold to obtain cash revenue. Apiculture is widely practiced in one hamlet in the Tankafatora rural commune in the Tsiazompaniry zone, with the installation of beehives throughout a slope.

#### (5) Handicraft industry, manufacture of baskets, etc.

The handicraft industry for the manufacture of baskets, hats, etc., using the leaves of a plant called "Boaherana" in Malagasy, is a secondary activity of the farmers and women. The "Boaherana" which grows at the bank of small waterways is cut and dried under the sun to produce the material. The baskets, hats, etc. produced are sold in department stores, etc. and constitute a source of cash revenue for the villagers, especially women.

#### (6) Deforesting industry

Much of the building raw material distributed in the Metropolitan area is taken from natural forests, and some farmers are engaged in such timber-felling operations as laborers and obtain cash income. Even though there are almost no remaining trees in natural forests in the study area that can be used as material, there are contractors of timber-felling who go to the east side of the lake, make barks on the spot and sell them to brokers. This includes those who fell trees illegally. Some measures should be taken, therefore, to preserve the remaining valuable natural forests.

### **2-1-6 Commuting farming and migration**

In the study area, there are many cases of commuting farming and migration towards the eastern shore of the 2 lakes. In the Tsiazompaniry zone, with the development of migration, the Ankazotelo fokontany was officially created in November 1998 in the eastern bank of the Lake Tsiazompaniry, with 17 hamlets and 702 villagers. The commuting farming and migration are important factors for understanding the overall socioeconomic situation of the area. This condition was also studied because it may have a socioeconomic effect on the

establishment of the watershed management plan.

Rural communities in which farming away from home is widely practiced are north-west and west of the Mantasoa zone i.e. the Mantasoa rural commune, and the Anosibe Trimoloharano rural commune in the north, and the Tankafatora rural commune in the west of the Tsiazompaniry zone. Migration to the east coast of the lake is hardly the case in the Mantasoa area, but it is frequent in the rural communes of Ambohimiadana and Tankafatora in the west of Tsiazompaniry zone.

In these two areas, the commuting farming and migration developed, urged by the needs to search for rice fields. However, the geographical condition of the hamlets is the essential element for commuting farming and migration, especially access to unexploited land in the eastern shore of the lake. Since the Mantasoa zone is near urban areas such as Antananarivo, the capital, and the Manjakandoriana prefecture, etc., it provides possibilities to find employment in these places. However, in the distant zone of Tsiazompaniry, there is no city close enough to commute to work. This can be considered as one of the reasons for which the commuting farming and migration to the eastern shore of the Lake Tsiazompaniry are more numerous than in the case of the Mantasoa zone. The characteristics of each zone are as follows.

#### (1) Mantasoa zone

A survey was conducted in 6 households commuting farming and 2 households which migrated to the eastern shore of the lake Mantasoa.

The commuting farming, use of the tanety and eucalyptus plantation is more important than the rice fields. This is because there are very few creeks adapted to rice planting around the Lake Mantasoa. For this reason, and because this region has developed its charcoal production, the land use to plant eucalyptus trees in the eastern shore of the lake and the transformation of the tanety into a eucalyptus plantation is relatively important. Agriculture is also practiced on land granted to the villagers by the government and called LAVAUDEN-V. Households which migrated to the western part of the Mantasoa zone in the eastern shore of the Lake Mantasoa are very few, that is, less than 10 families. In this area, there are only 3 principal hamlets, Andranomagatika, Ampantanarina.

The reasons for practicing farming away from home and migration are principally the following:

- ① Families working on leased land wish to obtain their own land
- ② The agricultural land is not enough to ensure food self-sufficiency due to the increasing number of family members
- ③ Agricultural land is insufficient after the reduction of the cultivated surface due to inheritance by division into equal parts of the agricultural land
- ④ Lower yield from the land due to the diminishing fertility of the soil.

## (2) Tsiazompaniry zone

A survey was conducted with 5 households practicing agriculture away from home and 6 households which migrated to the fokontany of Ankazotelo on the eastern shore of Lake Tsiazompaniry.

Principal agricultural activities are rice planting and the tanety (fields). In the rice fields, potatoes are cultivated as an off-season crop, both for family consumption and as a commercial product. The Lake Tsiazompaniry has more creeks than the Lake Mantasoa and offers topographical conditions allowing rice planting through use of the creeks. The commuting farming started in the 1970s and has continued into the 90s.

The survey conducted on 6 households who migrated to the eastern shore of Lake Tsiazompaniry, showed use of the land similar to methods applied by commuting farming families. These are relatively new migrants who have settled in the 90s.

Principal reasons for commuting farming and migration are as follows:

- ① Agricultural land is insufficient after the reduction of the cultivated surface due to inheritance by division into equal parts of the agricultural land
- ② Insufficient rice for family consumption
- ③ Less agricultural production due to the diminishing fertility of the soil.

As described above, it was made clear that the large causes for commuting farming and migration in both zones was decrease in agricultural production. The decrease in agricultural production was caused by a decline of land fertility and reduction of cultivated land area. Therefore, the commuting farming and migration could be mitigated if the land fertility and the agricultural productivity are enhanced. In addition, if the go-and-plough farming and emigration are mitigated, the disordered farm expansion to unused land will be suppressed at the eastern margin of both lakes, especially at the eastern margin of the Lake Tsiazompaniry. As a result, the land will be properly utilized, thereby having a favorable effect on the watershed management.

## (3) Results of the RRA study in the Ankazotelo fokontany

The results of the RRA study conducted on 30 villagers (20 males, 10 females) in the Ankazotelo fokontany in the eastern shore of the Lake Tsiazompaniry show the following characteristics:

- ① The age brackets of the participants in the RRA study are as follows: 35%, from 21 to 30 years old, the highest number, 23% for 31 to 40 years old, and 20% for 51 to 60 years old. The participants were relatively young.
- ② All participants in the study mentioned the lack of agricultural land and the reduced fertility of the soil as the reasons for their migration. More than 70% of the participants established a new family branch after marriage.
- ③ In 60% of the cases, the family had 6 to 10 persons.

- ④ 60% have migrated during the second half of the 80s, 30% before 1983. No household which migrated in the 90s participated.
- ⑤ 85% of the participants formerly lived in the Tankafatora rural commune, and 15% in Ambohimiadana.
- ⑥ More than 60% of the participants do not own cows. The principal source of revenue is made through the sale of potatoes and fish.

## 2-2 Dissemination activity for family planning (Planning Familial)

### 2-2-1 Present situation on dissemination activity for family planning

As organizations to spread family planning (Planning Familial: PF) in the area covered by the investigation, one prefectural medical center (Centre Hospitalier de District: CHD) that is a subordinate organ of the Health Ministry exists in each of Manjakandoriana and Andramasina Prefectures. At least one basic medical center (Centre de Sante de Base: CSB) that is a subordinate organ of the CHD exists in each county and is in charge of spreading the PF. There are two kinds of CSBs: a CSB1 does not have doctors and only gives medical advice to villagers, while a CSB 2 has doctors permanently stationed. The main CSB2s are designated as PF sites where medical staff (Agent de Sante; in some cases, a doctor also holds this post) give counsel regarding PF and spread the PF. CHDs exercise general control over the PF activities of CSB2s in cooperation with the Health Department of the prefectural administration (Service de Sante de District).

There are 9 PF sites in the Manjakandoriana Prefecture and 12 PF sites in the Andramasina Prefecture. The PF sites exist in all the communes in the target area and the names of the communes are listed below.

Manjakandoriana	Ambatomanga (Alarobia), Ambohitrolomahitsy, Ankazondandy, Sadabe, <u>Miadanandriana</u> , <u>Mantasoa</u> , Manjakandriana, Antsahalalina, Ambatomena
Andramasina	Andramasina, Sabotsy Ambohitromby (Anempoka, Manjaka-Ouest), Andohariana, Alatsinainy Bakaro, <u>Fitsinjoyana</u> Bakaro (Ambatomitsangana, Bakaro), <u>Tankafatra</u> , Ambohimiadana, Sabotsy Manjakavahoaka, <u>Anosibe</u> , Mandrosoa

\* The counties underlined are located within the target area.

On PF sites, contraceptive appliances such as the pill, insatiable contraceptive devices (to be replaced by another once in three months) and condoms are sold. As a part of the Population Plan Supporting Program (Appui au Programme de Population: APPROPOP) by the USAID, the purchase of these goods by villagers is made possible at inexpensive prices (500FMG,

1,000FMG, and 50FMG, respectively). Activities to spread PF include giving explanations to women who visit the CSB2 to receive a pregnancy examination or to have a child being vaccinated, delivering cards explaining PF methods in market, and giving explanations at villagers' meetings. As the number of the PF staff and means of transportation are limited, villages are seldom visited for the purpose of spreading activities. As the contraceptive appliances can be bought on PF sites only, interested women are obliged to come to buy them from remote places.

In Manjakandoriana Prefecture, activities to spread PF were started in 1994. About 3% of 40,000 women of child-bearing age in the prefecture practice contraception. On the other hand, in Andramasina Prefecture, activities to spread PF just started in 1997. In Andramasina County, the center of the prefecture, the number of women who use contraceptive appliances regularly was around 300 as of the end of 1999. Though the spreading PF faces strong restrictions related to villagers' consciousness, mentioned below, the number of women practicing PF is increasing little by little.

#### **2-2-2 Villagers' understanding**

As a result of interviewing villagers, doctors and PF staff in the area covered by this investigation, it was found that local villagers generally have the following understanding of PF.

- (1) There are many women who do not want to have a large family. The average number of children per household in the investigation area is about 6 to 8. Many mothers know that having many children results in a harder life and want to control the number of children. Their interest in the PF is strong.
- (2) Some women do not know why they become pregnant. There are not a few women who believe that a child is a heavenly gift and have no idea that pregnancy can be controlled artificially.
- (3) There is consciousness of a taboo regarding sex. Not a few people who are reluctant to hear others' opinions about their sex life.
- (4) There is misunderstanding regarding contraceptive appliances. Some people believe that their body will suffer some bad influence from using contraceptive appliances.
- (5) Men show a lack of understanding: In many cases, even if a woman wants to control the number of children, her husband does not show any understanding of PF. Although condoms are inexpensive and can be easily obtained, many men consider that PF is a women's matter and will not cooperate by using a condom.
- (6) Children are regarded as a source of labor. There are not a few households who believe that, with more children, they will be wealthier.

The Health Ministry realizes well that it is very important as the first step of activities to spread PF in Madagascar to reform villagers' consciousness. Therefore, CSB2s particularly exert themselves for enlightenment activities (Information, Education and Communication: IEC). According to the interview at a CSB2, prices of contraceptive appliances are not an obstacle to purchase because they are kept low, and the distance a CSB is not a big problem since there are villagers who walk more than 10 kilometers to buy contraceptive appliances.

## **2-3 Agricultural development structure**

### **2-3-1 Organization for agricultural extension**

The PNVA (Natural Program for Agricultural Training) established since 1989, is a governmental program to provide orientation and information on agricultural techniques. Agricultural trainers were assigned in the different regions of the country based on this program. Four trainers were assigned to the Mantasoa zone: 1 to the Ambatolaona rural commune, 2 to the Mantasoa rural commune, and 1 to the Miadanandriana rural commune. Two trainers were assigned to the Tsiazompaniry zone, 1 to the Anosibe Trimoloharano rural commune and the other to the Tankafatora rural commune. The trainers provide guidelines and give technical advice for, fertilizer production, the planting of fodder plants for livestock, planting of potatoes etc., which the farmers wish to carry out. They also provide advice for agricultural management and collect information for agricultural statistics, etc. For example, technical instructions are given for grafting, which is presently being practiced in the Mantasoa zone to increase cassava production. Grafting is carried out on cassava which has many leaves in the exposed part with another species whose underground stems grow well. It is considered that this technique is taught to the farmers, because in Madagascar, cassava leaves are often used in cooking and cassava is the second major food product after rice.

This technical training is given to groups of farmers (5 to 10 persons). Every two weeks, trainers come to give technical instructions and information. These agricultural trainers have taken a course on agricultural techniques, organization of farmers, etc., from a superior agricultural technician.

The biggest problem of the PNVA is lack of agricultural trainers. At present, this lack is filled through the cooperation of other public organizations and NGOs.

### **2-3-2 NGO activities**

#### **(1) ECODISM**

Formerly known as FAFI, ECODISM is a NGO providing food aid such as nutritional help to young infants in the Mantasoa zone. However, its activities are presently discontinued.

(2) T.A.F.

T.A.F. is the abbreviation for Tantsaha Andry Fitarata (Farmer beam grass). This NGO, with the affiliation of ANAE (Environmental Action Association) was created in 1995 to organize the farmers. This NGO is based in the rural commune of Ambohimiadana in the Tsiazompaniry zone. Its principal activities are agricultural training, the supply of food products, livestock reproduction, the education of children, environmental protection, and increase of literacy. It trains a select group of farmers who will become head of a group to conduct the above-mentioned activities. At present, there are 17 trained groups, 14 of which are in the Ambohimiadana rural commune, one in Anosibe Trimoloharano, etc. An experimental agricultural forest was established in Iharamalaza in the Ambohimiadana rural commune.

(3) HARDI

HARDI is an NGO providing aid for the creation of the primary school library of Ambohimanjaka, a rural commune in Miadanandriana in the Mantasoa zone. This NGO made promises to many villagers but accomplished little, to the disappointment of the villagers. This NGO is still operating in Ambohimanjaka, but its activities are limited to a minimum.

## **2-4 Land ownership and land use**

### **2-4-1 Land ownership system**

Law no. 60-004 regarding national private property, promulgated in 1960, regulates the ownership of land. It divides goods into 2 categories:

- ① Private fortune invested in public goods, including movables and real estate, used by various public organizations to carry out their tasks.
- ② Private fortune not invested in public goods, including all other movables and real estate property.

Goods not incorporated into the public goods are: ① agricultural village land where individuals exercise the right of usufruct, ② land with the right of usufruct by a group and ③ transfer of other real rights. The clause on the usufruct right of individuals is as follows:

"Article 18: Aside from lands which are registered, cadastered or appropriated by virtue of regular concession titles or according to public or private common law regulations, occupants exercising permanent and evident relative individual acquisition of the land, with the acquisition demonstrated either through constructions or through clear and durable effective development according to the practices at the time, place and purpose of the land, may obtain a property title under the conditions set below within the limit of 30 ha.

Within a period of 5 years counted from the promulgation of the present law, if lands registered in the name of an unknown person are not claimed by their absent owners during



registry operations, an order will be issued and the lands will be returned to State ownership." Legally, individual may register land up to a maximum of 30 ha.

(1) Legal situation in Mantasoa zone

Based on the Ikopa watershed management plan in the Antananarivo plain, land adjacent to the lake subject to legal regulations in the Mantasoa zone, are divided into 4 categories:

- ① State properties given to the Antananarivo region (principally the north-east)
- ② Land registered and sold with resolute clause (principally the north-west)
- ③ Lots already registered (principally the south-west)
- ④ State lands (principally south and south-east)

(2) Legal situation in the Tsiazompaniry zone

Based on the Ikopa watershed management plan in the Antananarivo plain, the biggest part of the Tsiazompaniry zone has become state property as a zone designated for reforestation by the Ministry of Water and Forests on 21 September 1953.

#### **2-4-2 Status of land ownership and land use**

In the study area, the owner (= occupant) of the land used as rice fields, tanety and tree planting, whether registered or not, is designated by mutual agreement among the villagers of the zone. The villagers demand the registration of lands used in the registry of each prefecture through the fokontany office. However, registration requires such a long time (from 2 to 10 years) that many lands covered by a request for registration are left unregistered. Villagers who have obtained an acknowledgement of receipt of the request for registration of lands consider that they have obtained this right and tacit comprehension of mutual inviolability exists in the villages.

There are many lands not exploited such as meadows including the land designated for reforestation in the study area. Customary law dictates that unexploited land will belong to the first person who clears or uses it. Villagers who planted trees on unused land have declared themselves as the owner and have demanded the legal recognition of their property right. This case occurred for lands designated for reforestation in the eastern part of the legally designated 2 lakes. The parallel existence of customary law and modern law is causing problems.

The actual conditions for use of the land and problems in the two areas, including this problem, were compiled as follows based on the preliminary study report.

(1) Mantasoa zone

- a Area owned by the prefecture for reforestation of the northeastern part

In reality, few reforestation was carried out and illegal violations have taken place such as planting on burned land, settling, etc., by the villagers.

In the northern part, aside from tree planting, forests subsist and are scattered between meadows and shrub thistles. Illegal cutting and brushfires take place.

b Registered lots in the northwestern part

The purpose of use has been modified in 1962, and these lands are presently housing lots sold to individuals. All lots are sold and registered.

c Registered lands in the southwestern part

Use of the land mainly consists of agriculture and tree planting. Since the planted trees are flourishing, new ones are useless. Compared to other zones, registration of agricultural lands is more advanced.

d State lands

Formerly waste land without owners, these lands are now kept as properties of the State. Farmers have set up their farms and houses on these lands. Settlement is illegal but the request for registration has been submitted. Tree planting has been very limited and the eastern part is covered by shrubs and the western part by meadows.

(2) Tsiazompaniry zone

a Tree plantings (old tree plantings, reforestation) and natural forests

The Ministry of Water and Forests has issued the authorization for development (cutting) of forests, to provide villagers with a source of revenue. Holders of this authorization claim the right of ownership of limited areas which can be developed. Furthermore, villagers who have migrated during the construction of the dam in 1955 have received indemnity but claim their right to the former afforested land. Illegal cutting and brushfires have occurred in this area.

b Lands without planted trees

The Ministry of Water and Forests has issued certificates of provisional ownership limited to rice planting on low grounds to reduce violations from villagers. Even if this authorization is provisional, it now provides the temporary right to land ownership, subject to relative negotiation. Villagers with a authorization of provisional ownership have applied for the registration of these lands, thus creating a fait accompli for ownership of the lands.

In meadows in the eastern shore of the lake, there are conflicts over land because several villagers claim ownership of the same land (e.g., farmer who planted trees and farmer using land for grazing.).

(3) Status of landowners and tenant farmers

One of the reasons for practicing agriculture away from home and migration to the eastern shore of the two lakes was for the tenant farmers to obtain their own land in the eastern coast. As such, a study on relations between landowners and tenant farmers has become necessary.

Interviews conducted (with 4 tenant farmers and 3 landowners) clarified 3 types of relations as described below.

It also provided the conclusion that there were no big landowners with hundred of hectares of land, but landowners who leased several dozens of hectares. There was no strong owner-farmer system based on an old-fashioned class system and relations between landowners and farmers were generally good.

**Type 1: Conventional owner-farmer relations**

This is a conventional form where the owner receives rent (products or in cash) for rented land, and where the owner and farmer live in the same village (zone). There are 3 landowners in the Masombahiny fokontany. The tenancy period is generally 5 years.

Characteristics: collection of 1/3 of the rental in products (1/3 of the production)

The rental may also be paid in cash.

This standard form is practiced in the Masombahiny fokontany.

**Type 2: Relations between absent landowners and the farmer**

Similar to type 1 where the owner rents out his land and receives rental, but is absent because he does not live in the same area as the farmer. This absence tends to reduce his social influence in the village (zone) and weakens the owner-farmer relations. This type of tenancy for agricultural land is practiced by owners residing in Antananarivo.

At the time of harvest, the owner receives rental in products (1/3 of the harvest).

This is practiced throughout the Mantasoa rural commune.

**Type 3: Form of temporary employment through paid agricultural work**

This is a developed form based on the collection of rental on leased land. Farmers are employed and paid in cash or in products. There are 10 such employers in the Mantasoa hamlets.

Characteristics: since the status of the owner is determined by the meal he provides to employees, this tendency refers to old-fashioned owner-farmer relations rather than modern work relations (employed labor and capital). Landowners consider the farm workers as belonging to a relatively low level in the social scale (especially in the Mantasoa zone).

In the Tsiazompaniry zone, rice and lunch are generally provided aside from the salary. It is noteworthy that the salary in the Tsiazompaniry zone is higher than in the Mantasoa zone. This may be explained as follows:

Mantasoa zone:	Men: 3,500 F MG/ day Women: 3,000 F MG/ day
Tsiazompaniry zone:	Men: 5,000 F MG/ day Women: 3,000 to 4,000 F MG/ day

① In the Mantasoa zone, the supply (agricultural workers) is higher than the demand

(possibility of work) in the local labor market. As such, the salary level is low.

- ② In the Mantasoa zone, the salary level is set based on other paid activities, such as care taking for a secondary residence or carpentry work. Farmers are in the lower salary scale.
- ③ In the Tsiazompaniry zone, many landowners cultivate their land themselves and the salaries of agricultural workers are set relatively high in order to attract these laborers. The provision of rice was also added.
- ④ Power relations between the owner and the farmer based on historical evolution appear in the level of salaries. In other words, owners are relatively strong in the Mantasoa zone, but relatively weak in the Tsiazompaniry zone.

Salary levels for agricultural workers:

The Mantasoa zone is a typical fokontany in Mantasoa. In the Tsiazompaniry zone, this type exists in the fokontany of Ambatamitsaniaga and Tankafatora.

### **2-4-3 Present situation of land inheritance**

#### **(1) Types of land inheritance**

As indicated in paragraph 2-1-6 on Farming away from home and migration, land inheritance (in this case, the inheritance of agricultural land) is one of the principal reasons for farming away from home and migration. Fourteen cases of land inheritance (8 cases in the Mantasoa zone and 6 in the Tsiazompaniry zone) were studied to understand the types of inheritance.

This study showed that there are 4 types of inheritance, as follows:

- ① Inheritance through equal division according to the law on the equality of rights between men and women

(6 cases in the Mantasoa zone and 2 in the Tsiazompaniry zone)

Land is inherited by dividing it into equal parts among the children, without distinction between sexes or seniority. This is frequently applied in the Mantasoa zone.

- ② Inheritance with differences in surface areas between children (2 cases in the Mantasoa zone).

The surface area inherited by the children decreases from the oldest to the youngest child. This method is based on the argument that the oldest child has worked longer with his father in the fields.

- ③ Unequal inheritance between sons and daughters and inheritance by equal division for each sex (3 cases in the Tsiazompaniry zone)

Sons receive a larger portion of land than daughters do but among the sons and among daughters the same portion is appointed. This is the standard method in the Tsiazompaniry zone.

- ④ Inheritance by division into unequal parts based on the selection of agricultural land (1 case in the Tsiazompaniry zone)

The portions of land owned are dispersed, so the children select the portion they want. The agricultural land area inherited finally becomes unequal based on the surface area and their number.

These types of inheritance reduce the cultivated area and income since there several heirs (5 on the average). This may explain the farming away from home and migration to the eastern shore of the lakes. In any case, the division of agricultural lands in smaller portions due to the increase in population constitutes a big problem.

To solve these problems, it is needed to take the direct measures for mitigating the increase of population and enhancing the productivity of the reduced cultivated areas. By taking these measures, the farming away from home and migration will be reduced even under the existing land inheritance scheme, ensuring suppression of the disordered farm expansion and proper land utilization from the viewpoint of watershed management.

## **(2) Land conflicts based on succession**

Interviews conducted in the registered section of the Manjakandoriana prefecture showed that most of land conflicts were conflicts among relatives regarding succession. Legal succession in Madagascar consists of equal division and the right of succession is guaranteed independent of the sex. In general, the villagers wish to inherit an tree planting area, such as an artificial eucalyptus forest, that allows manufacture of charcoal for cash revenue. This is why succession conflicts over rice fields and tenancy are rare in comparison to tree planting area. The tree planting areas also include State land planted by the villagers. In this case, conflicts arise between unrelated persons based on land demarcations.

Interviews conducted in the registered section of the Andramasina prefecture showed that 175 land conflicts were reported between 1972 and 1998 (26 years) by authorities in 4 rural communes in the Mantasoa zone. There were 43 cases in Anosibe Trimoloharano rural commune, 92 in Ambohimiadana, 1 in Tankafatora and 39 in Fitsinjovana Bakaro. Lawsuits declared were studied at the prefecture level and submitted with comments to the prefectural authorities. Based on the gravity of the conflict, the decision will be made by the authorities or it will be submitted to the Court.

## **2-5 Characteristics in hamlets based on the survey**

A survey was conducted on a total of 1,001 households, i.e., or 509 households in 12 fokontany of 4 rural communes in the Mantasoa zone and 492 households in 12 fokontany in 4 rural communes in the Tsiazompaniry zone, in order to conduct zoning in the study area based on its socioeconomic characteristics. Table I-14 indicates the number of households covered by the survey per fokontany. Due to the absence of official statistics concerning the

number of households in Madagascar, we assumed an average number of 7 persons per household based on results of the interview, with the number of households calculated based on the population. The survey showed the following characteristics of the hamlets concerned.

#### **2-5-1 Present living conditions**

The average number of family members per fokontany is 5 to 8 in the Mantasoa zone and 5 to 11 in the Tsiazompaniry zone. The percentage of households residing in their present location for more than 5 years exceeds 80% in almost all the fokontanys. The number of years of residence in the present place is 21 years in average in the Mantasoa zone and 25 years in the Tsiazompaniry zone, thus more than 20 years of residence for the 2 zones. Many families own their homes.

Many households take water from a natural source. In Ambatolaona, many villagers take water from the river. In Angodongodona and Ambohitsoa, many use water from wells. It is characteristic that in Merikanjaka, a manual pump is used.

The principal fuel used is firewood for almost all the homes. Very few use charcoal. The percentage of homes using oil lamps for lighting is high (see annex 15).

#### **2-5-2 Production activities**

A look on principal production activities generating cash revenue shows that the percentage of employed work and the manufacture of charcoal is high in the Mantasoa zone. On the other hand, agricultural production activities such as potato growing, livestock breeding, and fruit cultivation are the major sources of income in the Tsiazompaniry zone. The average rice field surface is large in the Tsiazompaniry zone than in Mantasoa. As such, agriculture, charcoal manufacture and employed work are of similar importance in the Mantasoa zone, while agriculture is the essential activity in the Tsiazompaniry zone.

The percentage of rice put on the market in the two zones is low, which means that most of the rice produced is used for family consumption.

If we consider the percentage of households per type of ownership of rice land, the owners outnumber the tenants in most fokontanys, showing that agricultural landowners are the majority. The exception is the Masombahiny fokontany in the Mantasoa rural commune where the ownership rate is 40%, less than other fokontanys and the tenancy rate is high with 30%. This statistically proves that a conventional owner-tenant relation in Masombahiny still exists.

Table I-14 Number of households covered by the survey per fokontany

Prefecture	Rural commune	Fokontany	Estimated number of households	Number of households covered by the survey
Manjakandoriana	Ambatolaona	Ambatolaona	359	30
		Mahitsitady	113	70
	Mantaso	Andrefanivorona	44	22
		Anjozoro Est	286	26
		Mantaso	289	48
		Masombahiny	167	57
		Miadamanjaka	79	31
	Miadanandriana	Ambohimanjaka	95	44
		Ambohipeno	139	86
	Merikanjaka	Merikanjaka	174	39
		Tsiazompaniry-Kely	100	34
		Miarinarivo	26	22
		Sub-total	1,871	509
Andromasina	Anosibe Trimoloharano	Andriantsiajo	59	25
		Angodongodona	280	61
		Mahatsinjo(Est-)	72	24
		Ambohitsoa	216	23
	Ambohimiadana	Iharamalaza	375	68
		Manandriana	100	32
	Tankafatora	Morarano	380	99
		Analamihoatra	187	24
	Fitsiniovana Bakaro	Ambohijanaka	470	109
		Kelimañana	210	27
		Sub-total	2,349	492
		Total	4,220	1,001

The tanety (farming on slopes) is practiced by almost all the families, with cassava and sweet potatoes as the principal products (see annex 16).

### 2-5-3 Livestock breeding

The proportion of households raising cattle is 37% in the Mantaso zone and 59% in the Tsiazompaniry zone. This figure is higher in Tsiazompaniry. The average number of cattle heads is 2 to 3 in the Mantaso zone and 2 to 5 in the Tsiazompaniry zone. The number of heads is higher in the Tsiazompaniry zone as compared to the Mantaso zone. One family in Iharamalaza raises 54 heads.

The percentage of poultry breeders is more than 80% in the Mantaso zone and more than 90% in the Tsiazompaniry zone. In 19 fokontanys in both zones, the average number of chickens raised is more than 10.

The percentage of households raising pigs is 37% in the Mantaso zone and 34% in the Tsiazompaniry zone. An average of 1 or 2 pigs are raised.

The percentage of households raising rabbits is 23% in the Mantaso zone and 24% in the Tsiazompaniry zone, or 1 out of 4 households.

The percentage of households raising ducks is 28% in both zones.

The percentage of households raising geese is less than 10% in both zones (see annex 17).

#### **2-5-4 Registration of agricultural and forest lands**

The percentage of households owning registered lands is 55% for rice fields, 42% for the tanety and 18% for tree planting. If we consider the percentage of households per zone, the percentage is higher for rice fields and the tanety in the Mantasoa zone as compared to the Tsiazompaniry zone. The percentage is practically the same in both zones for tree planting. (See annex 18.)

The percentage of households applying for registration is 11% for rice fields, 10% for the tanety and 8% for tree planting. If we consider the percentage of households per zone, this percentage for rice fields is equal in both zones. However, for the tanety and tree planting, the percentage is higher in the Mantasoa zone as compared to Tsiazompaniry. (See annex 19.)

#### **2-5-5 Land use on the eastern shore of the two lakes**

The percentage of households using land on the eastern shore of the lake as rice fields is 1% in the Mantasoa zone and 10% in the Tsiazompaniry zone. Per fokontany, this is 9% in Ambohipeno and 2% in Ambohimanjaka in the Mantasoa zone; this is 40% in Andriantsiajo, 28% in Angodongodona and 13% in Mahatsinjo in the Tsiazompaniry zone. This shows that the percentage is higher in the fokontanys of the northern part of the Lake Tsiazompaniry. There are households which use the land in almost all the fokontanys in the Tsiazompaniry zone. The percentage of households using land in the eastern shore of the lake as tanety is 3% in the Mantasoa zone and 6% in the Tsiazompaniry zone. Per fokontany, it is 12% for Anjozoro and 9% for Ambohipeno in the Mantasoa zone; and 24% for Andriantsiajo and 11% for Angodongodona in the Tsiazompaniry zone.

The percentage of households using land on the eastern shore of the lake as artificial forest is 12% in the Mantasoa zone and 1% in the Tsiazompaniry zone. Per fokontany, the percentage is the highest in Andriantsiajo with 16%. (See annex 20.)

The principal reasons why these households use the land on the eastern shore of the lake are: "To increase agricultural production" and "Due to lack of agricultural land", both reasons given by 28% in the Mantasoa zone. In Tsiazompaniry, 42% answered "To increase agricultural production", for greater than the 24% who cited "Due to lack of agricultural land". This shows that in the Tsiazompaniry zone, willingness to increase production is more important than the recognition of lack of land. By adding the two responses "to increase our revenue" and "to increase agricultural production", we obtained 42% in the Mantasoa zone and 52% in the Tsiazompaniry zone, with emphasis placed on the same points in the two zones. (See annex 21.)



#### **2-5-6 Production and sale of charcoal**

A total of 151 households produce charcoal in the Mantasoa zone, or approximately 1 out of 3 households. The percentage of households producing charcoal is high in fokontanys of the Mantasoa zone: 48% in Miadamanjaka, 48% in Ambohimanjaka, 47% in Ambatolaona, 45% in Andrefanivorona, etc. No household produces charcoal in the fokontanys of Tsiazompaniry-Kely and Miarinarivo. In the Tsiazompaniry zone, the percentage of households producing charcoal is as low as 4%. If we consider the fokontanys in the zone, the percentage is highest in Ambohitsoa with 24%, while there is none in the 4 other fokontanys (among those surveyed). With the exception of certain fokontanys in the Mantasoa zone where charcoal is partially used for family consumption, the produced charcoal is all put on the market.

The average number of frequencies of charcoal production per month varies from 19 times in Iharamalaza and to only once in Andrefanivorona.

The method of obtaining the materials varies according to the fokontanys. However, many households buy them in the Mantasoa zone. In the Tsiazompaniry zone, many use materials taken from their own forests.

The tree species used is eucalyptus.

Average annual sale of charcoal per household was highest in Andrefanivorona with 1,542 bags in 1997. While households in 8 fokontanys in the Mantasoa zone sold an average of more than 200 bags in 1997, less than 200 bags were sold in all the fokontanys in the Tsiazompaniry zone.

The average selling price for one bag of charcoal is 6,000 to 9,000 FMG in the Mantasoa zone compared to 3,500 to 8,000 FMG in the Tsiazompaniry zone.

Buyers are almost all middlemen. In 3 fokontanys, Ambatolaona, Ambohipeno and Ambohitsoa, the percentage of households selling to middlemen is more than 80%. On the other hand, this percentage is less with 50% in the 2 fokontanys of Andrefanivorona and Angodongodona. It is between 50% and 70% in the 10 other fokontanys.

Charcoal is sold to the agricultural cooperative in Mantasoa and Miadamanjaka only. The percentage of direct sales to consumers is higher in Tsiazompaniry. Households in 10 fokontanys sell to retailers. Most of the selling points for charcoal are located in Antananarivo, the capital (see annex 22).

#### **2-5-7 Gathering of firewood and honey**

Firewood is gathered almost entirely for family use. The average number of gatherings per week is 1 to 4 times in the Mantasoa zone and 4 to 5 times in Tsiazompaniry zone.

The gathering distance is mostly within a radius of 4 km from the house. The number of fokontanys in which more than 70% of the households gather firewood within 1 km from the house is 2 in the Mantasoa zone and 6 in the Tsiazompaniry zone. Fokontanys with more than

50% of the households gather within 1 to 4 km are 5 in the Mantasoa zone and none in Tsiazompaniry zone. In the Tsiazompaniry zone, gathering is carried out in the neighborhood, while in Mantasoa, it is carried out within a distance of 1 to 4 km (see annex 23).

#### **2-5-8 Tree planting**

The percentage of households owning an artificial forest is 43% in the Mantasoa zone and 47% in the Tsiazompaniry zone. In both zones, nearly half of the households own a planted forest.

The average surface area of these tree planting is 2 to 63 ha in the Mantasoa zone and from 1 to 12 ha in the Tsiazompaniry zone. The owned surface areas are therefore larger in the Mantasoa zone. All planted trees are eucalyptus.

Planting year of tree planting: 55% zone was planted before 1970 in the Mantasoa, while 64% was planted after 1990 in the Tsiazompaniry zone.

The planters are mainly family members, including the head (see Annex 24).

#### **2-5-9 Volumes of agricultural products and prices**

##### **(1) Rice**

Almost all the households produce rice: 83% of households in the Mantasoa zone and 93% of households in the Tsiazompaniry zone.

The average harvest for 10 ares of rice field is 200 to 500 kg in the Mantasoa zone and from 250 to 400 kg in the Tsiazompaniry zone. While harvests vary considerably per fokontany in the Mantasoa zone, it is concentrated between 250-300 kg in the Tsiazompaniry zone. Households in 7 fokontanys in the Mantasoa zone and 10 fokontanys in the Tsiazompaniry zone consume more than 70% of the rice production at household. In the Mantasoa zone, the Mantasoa fokontany is the only one where more than 50% of the rice harvest is put on the market. Therefore, most of the rice produced is used for family consumption. Around 100 households or 10% of the households surveyed in the zone replied that they sold their rice produce last year.

The average selling price for rice is 1,500 to 1,700 FMG in the Mantasoa zone and from 800 to 1,850 FMG in the Tsiazompaniry zone. While the price of rice is within a fixed range in Mantasoa, it is relatively low in Tsiazompaniry (see annex 25).

##### **(2) Cassava**

Around 40% of households produce cassava in the Mantasoa zone and 49% in the Tsiazompaniry zone. In both zones, nearly a half of the farmers produce cassava.

The average planting surface per fokontany is 4 to 41 a in the Mantasoa zone and from 14 to 59 a in the Tsiazompaniry zone. The average harvest per fokontany is 100 to 946 kg in the Mantasoa zone and 214 to 721 kg in the Tsiazompaniry zone.

Households in 6 fokontanys in the Mantasoa zone and households in 8 fokontanys in the Tsiazompaniry zone consume more than 70% of their cassava production at home. The Mantasoa and Merikanjaka fokontanys in the Mantasoa zone are the only fokontanys where more than 50% of the cassava harvest is put on the market. Thus, most of the cassava produced is used for family consumption.

The average selling price of cassava is 213 to 8,600 FMG in the Mantasoa zone and from 275 to 2,500 FMG in the Tsiazompaniry zone. Prices vary greatly (see annex 26).

### (3) Potatoes

Around 38% of the households produce potatoes in the Mantasoa zone and 83% in the Tsiazompaniry zone. The percentage is very high in the latter, as all households in the Analamihoatra fokontany produce potatoes.

The average planting surface in the fokontanys is 4 to 27 a in the Mantasoa zone and from 19 to 58 a in the Tsiazompaniry zone. There are 2 fokontanys in the Mantasoa zone and 9 fokontanys in the Tsiazompaniry zone whose average harvest exceeds 700 kg.

Eight fokontanys in the Mantasoa zone and none in Tsiazompaniry use more than 50% of the harvest for family consumption. Furthermore, no fokontany in the Mantasoa zone and 8 fokontanys in the Tsiazompaniry zone sell more than 70% of their production. 108 households in the Mantasoa zone and 371 in the Tsiazompaniry zone answered that they sell their potato harvest. Therefore, potatoes are cultivated for family consumption in many fokontanys in the Mantasoa zone, but they are a commercial product for many households in the Tsiazompaniry zone (see annex 27).

The average selling price for potatoes is 264 to 750 FMG in the Mantasoa zone and from 297 to 390 FMG in the Tsiazompaniry zone.

### (4) Sweet potatoes

Sweet potatoes are produced in around 30% of the farms in the Mantasoa and Tsiazompaniry zones. Most of these are for family consumption. Three fokontanys in Angodongodona. Iharamalaza and Manandriana in the Tsiazompaniry zone sell an average of more than 50% of their production. The average selling price is from 150 to 750 FMG (see annex 28).

### (5) Maize

Only 7 households in the Tsiazompaniry zone cultivate maize (see annex 29).

### (6) Taro

Only 38 households in the Tsiazompaniry zone responded that they plant taro (see annex 30).

### (7) Legumes

Only 25 households in the Tsiazompaniry zone responded that they plant legumes and 4 said that they "sold beans" (see annex 31).

#### (8) Other vegetables

25 households in the Mantasoa zone and 3 in the Tsiazompaniry zone responded that they plant vegetables such as carrots and green vegetables (see annex 32).

### **2-5-10 Number of cattle heads sold and prices**

The percentage of households selling animals are: cattle 3%, swine 29%, ducks 7%, rabbits 6%, chickens 43% and geese 1%. Aside from rabbitbreeders, the percentage of households selling animals is higher in the Tsiazompaniry zone as compared to the Mantasoa zone. The average number of heads sold per year is 1 to 2 cattle and 3 to 12 chickens. The selling price is 200,000 to 1.4 million FMG for cattle and from 8000 to 10,000 FMG for chickens (see annex 33).

### **2-5-11 Income from forest products**

#### (1) Charcoal

The percentage of households selling charcoal is 29% in the Mantasoa zone and 3% in the Tsiazompaniry zone, or 1 out of 3 in the Mantasoa zone. Fokontanys where the percentage of households selling charcoal is particularly high are Miadamanjaka (52%) and Ambatolaona (50%), etc.

The annual income per household obtained for selling charcoal is from 350,000 to 3.45 million FMG, a difference of 10 times.

#### (2) Firewood

The number of households selling firewood is 10 in the Mantasoa zone and 4 in the Tsiazompaniry zone (see annex 34).

#### (3) Honey

The percentage of households selling honey is 5% in the Mantasoa zone and 6% in Tsiazompaniry zone. The percentage of households selling honey is particularly high in the fokontanys of Tsiazompaniry-Kely (21%), Mahatsinjo (17%) and Manandriana (16%).

The annual revenue obtained per household for selling honey vary from 20,000 to 300,000 FMG.

#### (4) Construction wood

The percentage of households selling construction wood is 3% in the Mantasoa zone and 4% in the Tsiazompaniry zone.

#### **(5) Others**

The number of households selling other forest products such as medicinal plants and mushrooms is 6 in the Mantasoa zone and 8 in the Tsiazompaniry zone (see annex 34).

#### **2-5-12 Other revenues**

Other principal sources of revenue are fishing, shopkeeping and employment wages.

The percentage of households involved in fishing is 7% in the Mantasoa zone and 10% in the Tsiazompaniry zone. Fokontanys where a high percentage of households are in fishing business is Ambohipeno (41%), Morarano (26%) and Angodongodona (20%).

The percentage of households involved in shopkeeping is 8% in the Mantasoa zone and 15% in the Tsiazompaniry zone. The percentage of households where one or more members is a wage earner is 43% in the Mantasoa zone and 30% in the Tsiazompaniry zone.

The fokontanys with over 50% of households where one or more members is a wage earner are the following 5 fokontanys in the Mantasoa zone: Andrefanivorona (64%), Mantasoa (52%), Miadamanjaka (52%), Ambohipeno (50%) and Miarinarivo (50%). The annual average revenue of one household with at least one member as a wage earner is from 150,000 to 940,000 FMG (see annex 35).

#### **2-5-13 Home expenses**

The total amount of annual expenses per household among those interviewed is between 1 and 2 million FMG in most fokontanys. Food expense takes up the largest part. The percentage of expenses for agricultural activities tends to be higher in the Tsiazompaniry zone as compared to the Mantasoa zone (see annex 36).

#### **2-5-14 Result of study on needs**

The study on needs shows that in the Mantasoa zone, 5 fokontanys demand road improvement, 3 fokontanys steady supply of fertilizers, 2 fokontanys improvement of agricultural production, 1 fokontany more employment, and 1 fokontany demand electricity. In the Tsiazompaniry zone, 6 fokontanys gave priority to supply of fertilizers, and 4 fokontanys demanded road improvement.

If we consider the top 5 priorities, we can see that agricultural needs are the most essential. However, needs for social infrastructure such as roads, hospitals, schools and electricity are also important.

Characteristics of needs per zone and per fokontany can be summarized as follows:

- ① Agricultural needs are higher in the Tsiazompaniry zone than in the Mantasoa zone.
- ② Two fokontanys in the Ambatolaona rural commune in the Mantasoa zone, where the source of income for many households is from working wages, indicated their primary needs as more employment, electricity, increased revenue, somewhat different from other

fokontanys.

- ③ The Morarano fokontany in the Tsiacompaniry zone gave the establishment of autonomous rights the second priority. Annex 37 gives details of the results.

## **2-5-15 Reaction of villagers to the survey**

To conduct this survey, meetings were held to explain the orientation, objectives and methods of the survey, to be employees of rural communes, heads of fokontanys and villagers in the area with the collaboration of the personnel of the counterpart. During the meeting, the villagers showed various reactions towards the survey, summarized below.

### **(1) Mistrust of strangers**

While the particular sense of community in agricultural village practicing rice cultivation is strong, the mistrust of strangers is equally strong. In particular, the villagers indicated various suspicions and worries regarding strangers. Major reactions are listed below.

- Did they come to steal our land?
- Did they come to sell cold refreshments?
- Is this a campaign to convert us to a new religion?
- Should the villagers migrate again due to the dam construction?  
(villagers who have already migrated in the past)
- Did they come to exploit the mines?
- Did they come to carry out fishing in the lake?
- Uncertainty about the true reasons for the survey.

We explained our intentions by responding point by point to suspicious. However, time is needed to eliminate misunderstanding as some of their reactions originate from their experience of colonization.

### **(2) Passive needs**

During the explanation of the survey to the fokontany heads and the villagers, the most frequent requests were as follows: "What will you do for us?", "We want you to build a school.", "We want you to repair the bridge.", "Give us fishing nets.". These are all passive needs, asking for things to be given or done. For these questions and suggestions, we asked them to understand, after a simple explanation of the purpose of the participatory type of study, that it is up to the villagers to come up with ideas, establish plans and implement them at their own initiative. In case a meeting did not lead to proper comprehension, we organized follow-up meetings.