Japan International Cooperation Agency
Ministry of Water and Forests
Madagascar

Feasibility Study on the Watershed Management in Mantasoa and Tsiazompaniry in Madagascar

Final Report

Part I Watershed Management Plan

December 2000

Consortium for the Feasibility Study on the Watershed Management in Mantasoa and Tsiazompaniry in Madagascar
Representative : Japan Overseas Forestry Consultants Association

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View of the Lake Mantasoa

View of the Lake Tsiazompaniry

Area of land slide in a part of Tsiazompaniry zone

Pasturage on the east side of the lake

Form of basic land use seen in the study area

Fishery, one of main industries in Mantasoa zone, in the lake

View of Andrefanivorona Village

View of Ambohimanjaka Village

View of Angodongodona Village

View of Analamihoatra Village

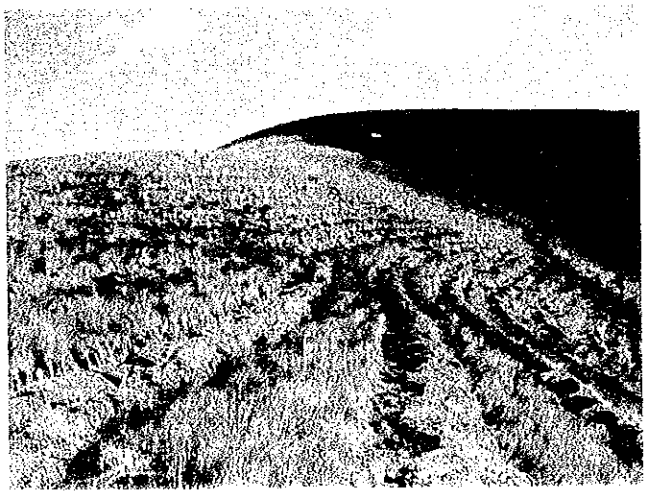
Fish farming in rice fields (Pilot study)

Nursery being prepared by villagers (Pilot study)

Meeting for villagers' evaluation of the participatory watershed management plan

Hedges for erosion control by Tephrosia (Pilot study)

Pineapple plantation (Pilot study)



Forestation by ZODAFARB (Pilot study)

Seminar regarding the method to prepare a participatory watershed management plan (in Antananarivo)

Seminar for technical dissemination participatory watershed management plans (in Andramasina)

PREFACE

In response to a request from the Government of the Republic of Madagascar, the Government of Japan decided to conduct a Feasibility Study on Watershed Management in Mantasoa and Tsiazompaniry and entrusted the study to the Japan International Cooperation Agency (JICA).

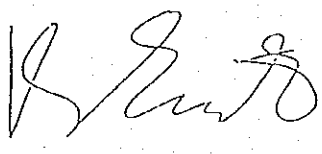
JICA sent to Madagascar a study team headed by Mr. Tsutomu Handa, Japan Overseas Forestry Consultants Association six times from April 1998 to September 2000.

The team held discussions with the officials concerned of the Government of Madagascar, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Madagascar for their close cooperation extended to the team.

December 2000



Kunihiko Saito

President

Japan International Cooperation Agency

Tokyo, December 2000

Mr. Kunihiko Saito, President
Japan International Cooperation Agency

Letter of Transmittal

We are pleased to submit to you the final report on "the Feasibility Study on the Watershed Management in Mantasoa and Tsiazompaniry in Madagascar" that has been completed.

This study was conducted by Japan Overseas Forestry Consultants Association in the consortium with Kokusai Kogyo Co., Ltd. under a contract with JICA during the period from March 1998 to December 2000.

This study was a feasibility study on formulation of the watershed management project to be implemented through active participation of local residents. We have conducted the feasibility study on the resident-participation type watershed management model as a pilot study in order to realize the watershed management by participation of residents in the study area and formulated the project based on the knowledge and views obtained in the study with special consideration for ensuring the project to be developed by the local residents in an effective, independent and sustainable manner.

We wish to sincerely appreciate the close cooperation and guidance that all the concerned officials of JICA, Ministry of Foreign Affairs, Ministry of Agriculture, Forestry and Fisheries and the Forestry Agency have rendered us during the period of this study. In addition, we would also appreciate the valuable advice and cooperation that the concerned officials of Ministry of Water and Forests of Madagascar and the Japanese embassy in Madagascar have given us from time to time.

Finally, we hope that this report will greatly contribute to JICA's further promotion of this project.

Very truly yours,

Tsutomu Handa
Project Manager,
Japan Overseas Forestry Consultants Association on behalf of
Consortium for the Feasibility Study on the Watershed Management in Mantasoa and Tsiazompaniry in Madagascar

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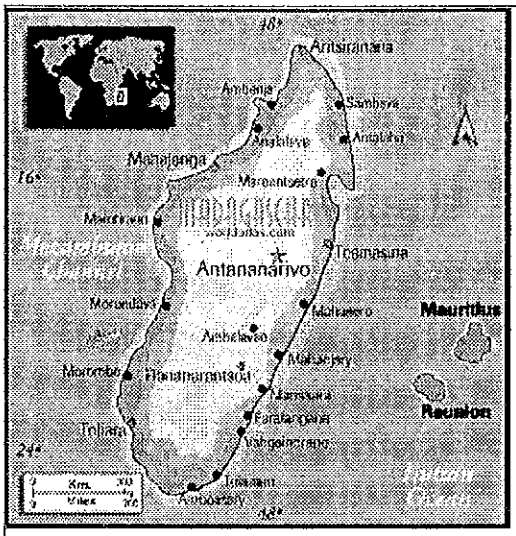
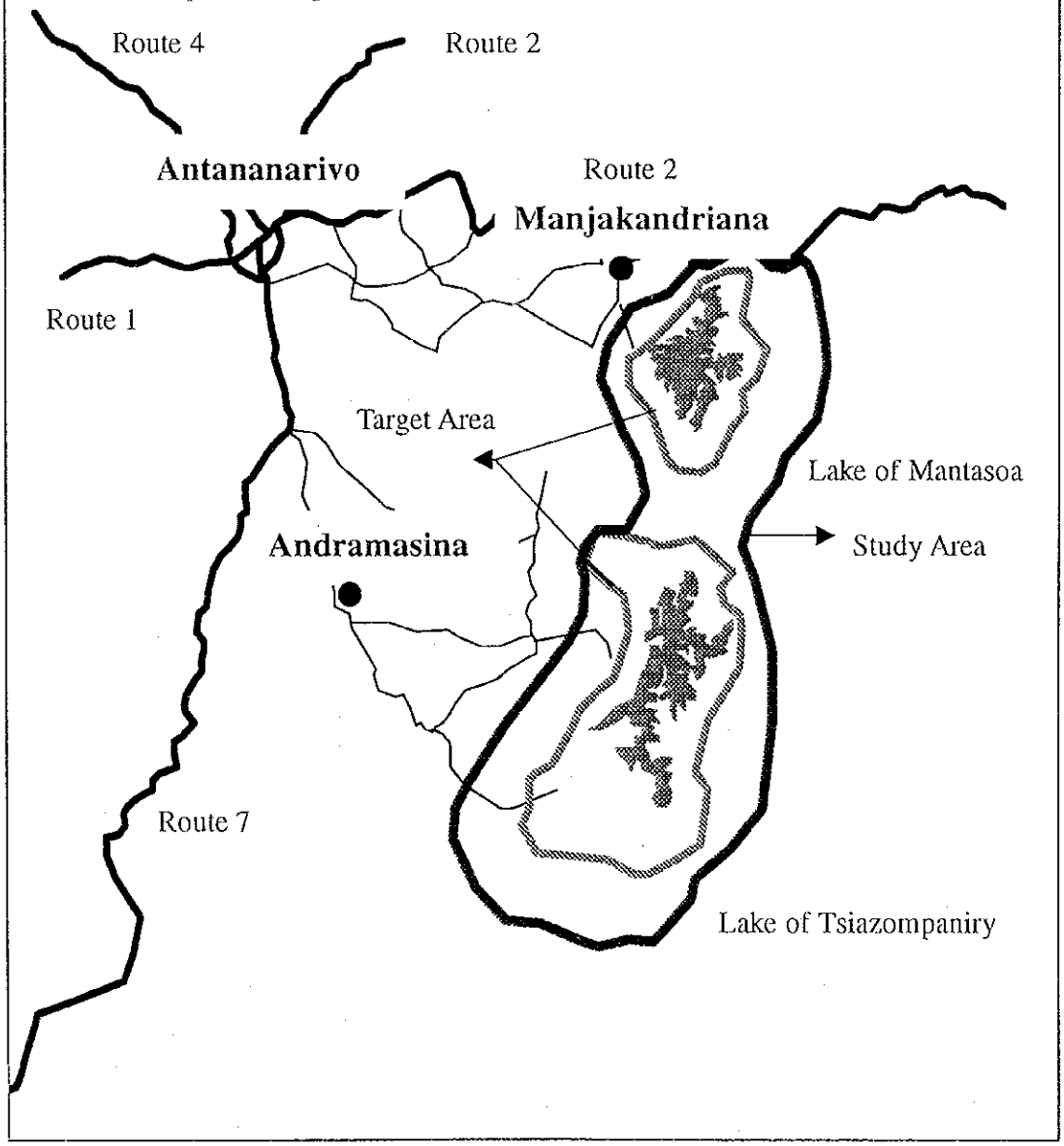
List of abbreviations

a	are = 100 m^2
ANGAP	National Association for the Management of Protected Areas
ºC	Centigrade
CIREF	Local Office for the Management of Water and Forest
CEF	Camp for the Management of Water and Forest
CHD	Prefectural Medical Center
CSB	Basic Medical Center
DIREF	Department of the Management of Water and Forest
FMG	Malagasy Franc 1 US$ = 5.274 FMG (December 1998)
GELOSE	Secured Local Management
ha	Hectare
IEC	(Information, Education , and Communication)
JICA	Japanese International Cooperation Agency
km	Kilometer
m	Meter
mm	Millimeter
ONE	National Environmental Office
PAE	Environmental Action Plan
PE-1	Environmental Action Plan 1
PE-2	Environmental Action Plan 2
PF	Family Planning
PRA	Participatory Rural Study
PS	Pilot Study
RRA	Rapid Rural Study
TEF	Forestry Station
ZODAFARB	Delineated Area for the Safeguarding of Trees

Location of Study Area



Map of Madagascar



This study is a development survey based on the Scope of works (S/W) signed on October 3, 1997. Field study was started in April 1998 and took 3 fiscal years. Studies necessary for planning and determination of the Watershed management plan were completed in June 2000.

This draft final report compiles the results of these studies. The document is composed of two parts. The contents of Part 1 are the various studies and project evaluations with which the Watershed management plan was made. Because the main purpose of this plan is planning and determining watershed management with the participation of villagers, and in order to secure practical effectiveness, a pilot study based on the PRA method was conducted. Part 2 compiles the results of investigations related to the pilot study.

Summary of the results of investigation

The Republic of Madagascar requested the Japanese Government's cooperation regarding determination of a comprehensive watershed management plan around Lakes Mantasoa and Tsiazompaniry located about 60km southeast of Antananarivo, the capital. Both watersheds are important water-source areas for the National Capital region. There is, however, a deterioration of the natural environment resulting from artificial acts such as pressure for development by villagers and inappropriate land use. In response to this request, the Japanese Government conducted two preparatory investigations in 1997 through the Japan International Cooperation Agency. As a result, it was agreed between the Governments of Madagascar and Japan to conduct a feasibility study (F/S) whose main purpose would be a participatory management plan for watershed and which would cover catchment area of Lakes Mantasoa and Tsiazompaniry and their peripheries. (See Annexes 1 and 2.)

Investigations were carried out with two investigation areas classified as follows.

Target area: Watershed management plans for each zone and a general watershed management plan should be made for an area of about 50,000 ha within the watersheds of Lakes Mantasoa and Tsiazompaniry.

Study area: In addition to the above-mentioned watersheds, a general investigation should be carried out in the periphery of about 90,000 ha to prepare the above-mentioned watershed management plans.

Investigations were conducted over three fiscal years, from April 1998 to September 2000. This period was classified into Phase I (from April to December 1998) and Phase II (from April 1999 to September 2000). In Phase I, in addition to basic investigations, the first-term investigation (determination of participatory management plans for watershed) of pilot studies (hereinafter referred to as PS) was carried out. The second-term investigation (execution and evaluation of participatory management plans for watershed) of PSs and investigations to determine the general watershed management plan were mainly executed in Phase II. In particular, as the purpose of these investigations was determination of participatory management plans for watershed, PSs based on the PRA approach were conducted in two separate terms in order to secure practical effectiveness of the plans.

Part 1 Watershed management plan

Chapter I Basic investigation of Mantasoa and Tsiazompaniry watershed

Natural environment

Lakes Mantasoa and Tsiazompaniry are located in the eastern part of the central plateau on Madagascar Island. These artificial lakes were constructed in 1936 and 1955, respectively. The investigation area is 1350 to 1700 m above the sea and forms, a hilly topography rich in gentle relief. The main ridgelines run generally from south to north. The bedrock in this area is granite whose outcrops appear every place and form various peaks. Although few hillside collapses are seen, topography with old collapses exists in the southwestern part of Lake Tsiazompaniry. Laterite soil which is widely distributed.

The climate zone of this area is a highland tropical climate. Trade winds blowing from the Indian Ocean hit upon the Angavo mountain district, which spreads from south to north in the eastern part of the investigation area. The winds then bring about a large quantity of rainfall, especially toward the up country. Seasons are divided into a dry season (for about five months from May to September) and a rainy season (for about four months from November to February). The average precipitation is 1500 mm in Mantasoa zone and 1400 mm in Tsiazompaniry zone. The dry season is slightly more severe in Tsiazompaniry zone than in Mantasoa zone. The average temperature is 17°C. There is no large difference in temperature throughout the year, only 7 to 8°C. In the dry season, many fires break out, which is a problem in terms of forest management. It is considered that many of the fires are caused by Tanety (farming on inclined land).

In the hill zone on the eastern side of the Angavo mountain district, running in the eastern side of the investigation area, tropical rain forests are distributed. This zone is an important treasure-house of flora and habitat of wildlife. In the investigation area adjoining this district, the original vegetation has been destroyed over a wide area and has been replaced by secondary forests. Natural forests remain only locally in ravines and on small-sized slopes. On the other hand, lands afforested with *Eucalyptus robusta* are widely distributed on the western side of the lake. Particularly around hamlets in the western part of Mantasoa zone, such lands are found. Vegetation in the eastern and western sides of the lakes is largely different.

According to the results of forest investigations, many succeeding trees are observed in natural forests, and it is possible to restore forests with proper management. There are two types of shrub forests: those of simple vegetation, mainly made up of *Philippia spp*, and those composed of many kinds of vegetation. In the latter, many species of useful trees are recognized, and it is judged possible to induce the formation of arborescent forest with

management. According to limited investigation, the growth of *Eucalyptus robusta* tree planting is poor. It corresponds to Level VI, the lowest level, of the status classification of Mr. Randriannjafy. *Eucalyptus robusta* tree planting is widely developed by local villagers themselves, and demand for these trees is high as fuel wood partly because the capital, Antananarivo, is near. It is judged that the will to afforest is high due to these circumstances. Therefore, it can be said Tsiazompaniry zone where land in fallow spreads has high potential for promotion of tree planting.

Social and economic environments

In the terms of administration, the investigation area contains 17 villages in four rural communes in Manjakandoriana Prefecture and 12 villages in four rural communes in Andramasina Prefecture, all in Antananarivo State. The populations of the investigation area in Manjakandoriana Prefecture and Andramasina Prefecture are 16,619 (10% of the prefecture) and 17,571 (16% of the prefecture), respectively.

The main industries are agriculture, charcoal making, fishery and apiculture, while some crafts are also conducted. The major kinds of agriculture are double cropping of paddy rice and potatoes and dry field farming on sloping land. Fruit tree culture and pasturage are also carried out. Mantasoa zone is relatively near the market of wage labor and, therefore, people are blessed with opportunities for wage labor. On the other hand, as Tsiazompaniry zone is remote from the urban area, people are not blessed with opportunities for wage labor and depend on the sale of farm products. As a system to spread agriculture, execution of PNVA (Programme National de Vulgaisation Agricole) started as a national program in 1989, and people in charge of the spread of agriculture are stationed in various places. But because of a shortage of necessary personnel, NGOs and others cooperate in these operations.

Activities for the spread of family planning (= Planning Familial: PF) were recently started by the Basic Medical Center (CSB) that exist in each rural commune, but few activities for the spread by visiting villages are carried out. Though restriction due to villagers' consciousness is strong, the participation by women in the PF is slightly increasing.

Occupants of land can acquire rights legally, but registration requires considerable time from the application. Therefore, applicants of land registration understand that they have obtained the exclusive right at the time of acceptance of the written application. Regarding this, mutual inviolable tacit understanding has been formed among villagers in hamlets. According to the customary law, uncultivated land belongs to those who reclaimed wasteland first. Some people insist on exclusive possession of land on the grounds of partial tree planting.

According to the questionnaire (carried out with 1,000 households as the sample), local characteristics in the investigation area are as follows.

Regarding the percentage of completed registration of land in each district based on the number of households, that of irrigated rice fields and Tanety is high in the Mantasoa zone, which is higher than in the Tsiazompaniry zone, while that of tree planting has almost the same ratio. As sources of cash income, the ratios of wage labor and charcoal making are high in the Mantasoa zone, while those of agricultural production of potatoes, livestock, fruits, etc. are high in the Tsiazompaniry zone. The Mantasoa zone is positioned as the mixture type of agriculture and wage labor, and the Tsiazompaniry zone is as the agriculture type. The extent of farmland is greater in the Tsiazompaniry zone than in the Mantasoa zone. The number of people who use land on the eastern side of the lake as irrigated rice fields or Tanety is larger in the Tsiazompaniry zone than in the Mantasoa zone. As reasons of the land use on the eastern side, many people mention an increase of agricultural production rather than a shortage of land. This tendency is stronger in the Tsiazompaniry zone. Tree planting is owned by more than half of villagers. The size of possession differs greatly between these two districts: 2 to 63 ha in the Mantasoa zone, and 1 to 12 ha in the Tsiazompaniry zone. Charcoal making is actively carried out, and its purpose is sale. While there are many people who purchase material wood in the Mantasoa zone, there are many people who use self-owned forest in the Tsiazompaniry zone. The main agricultural products are rice, potatoes, sweet potatoes, maize, taro, leguminous plants and vegetables.

Chapter II The present situation of watershed preservation and the evaluation of watershed

Depending on natural conditions that exist naturally, many of the problems of watershed preservation generally arise due to artificial acts by villagers living in that place. The situation is similar in this investigation area. In consideration of natural conditions and socio-economic conditions, the actual situation of watershed preservation in the investigation area is as follows.

Natural conditions:
The whole investigation area was formed by the erosion and has complicated topology with many folds. It is poor in natural vegetation and mostly covered with grassland. The difference in height above sea level is generally small, and the slope of the valley bed is gentle. Few mountainside collapses are observed. Due to the poor vegetation, accumulation of soil and sand is not observed in places of inflow into the lakes, although outflow of surface soil is seen everywhere. It is judged the accumulation exists moderately in the curving parts of the valley

bed. Both Mantasoa and Tsiazompaniry zones have a large watershed, each in the southern zone. This zone takes an important position in the aspects of prevention of outflow of soil and sand and water conservation. The western zone has extensive *Eucalyptus robusta* tree planting, but, toward the south, afforested land becomes less and land without trees or land little used has greater extent.

Social and economic conditions:
Development of farm villages progresses from the northern part of the investigation area along the western side of the lakes to the south. On the other hand, migratory agriculture and farming away from home are progressing recently from the western side to the eastern side. In the western part of the Mantasoa zone, rational land use are made with consideration given to preservation of water and land. In many areas, it is observed that cultivated land is easily increased, which results from an increase in population and a fall of land productivity, and, in addition, that land is denuded. These phenomena are factors of watershed waste. In natural and artificial forest zones controlled by the Ministry of Water and Forests, illegal felling of forest trees is seen. Tree planting develops from north to south, and a deep-rooted will of tree planting is seen among villagers. Such forest denudation as seen in forests controlled by the Ministry of Water and Forests is not found there.

In the evaluation of watershed, investigation was conducted on two items; function of soil and water conservation, and the degree of risk of collapse. For the function of soil and water conservation, investigation was carried out on permeability classified by vegetation types and the infiltration capacity in small conservation. For the degree of risk of collapse, a mesh map of the degree of risk of collapse, which combined places collapsed before and natural environmental factors, was prepared.

As the function of soil and water conservation, natural forests showed much higher values in regard to both infiltration capacity and the amount of flowing water of small rivers. Those forests play an important role for preservation of watershed. Infiltration capacity of grassland is the lowest. The higher the ratio of grassland occupation, the more the amount of flowing water of small rivers decreases. In this sense, it can be said that the significance of the presence of natural forests distributed collectively in the Tsiazompaniry zone is large, located on the east side of the lake. The degree of risk of collapse is considered high in the area from the southern part to the eastern part in both the Mantasoa and Tsiazompaniry zones.

The most important subjects of watershed preservation are land uses and restoration of forest vegetation, particularly with preservation of water and land taken into consideration. What is considered important for these purposes is ① improvement and generalization of land uses

taking example by the method of rational land uses seen in the Mantasoa zone, ② work on family planning with the active participation of women in watershed management activities, and ③ protection of remaining natural forests and restoration of vegetation by natural power.

Chapter III Initial environmental investigation

Contents of activities under watershed management plans to be made in these investigations are promotion of the method of rational land uses with preservation of water and land taken into consideration. These are not plans to basically change villagers' life, but those to improve the existing scheme of land uses. Therefore, the contents of projects will not change the existing environment fundamentally, but will contribute to improvement of the natural environment with biological sources. Potential influences to be exerted upon the existing environment that will accompany the execution of projects are judged small.

Chapter IV Watershed management plans

Watershed management plans were approached from two points of view. One is watershed management division from the viewpoint of the whole watershed, and the other is watershed management from the viewpoint of the life of villagers who live on that land. Particularly important viewpoints for the subjects of watershed preservation as a whole are control of population and appropriate land use leading to improvement of land productivity. Namely, watershed management plans were made while seeking harmony between the whole and individuals.

Watershed management plans were made with two divided areas, that is, the area for participatory watershed management and the area for forest preservation, while taking the density of residence into consideration. For the area of participatory watershed management, watershed management plans with villagers as the nucleus of projects were made. On the other hand, for the area of forest preservation, forest management plans to be executed with the Ministry of Water and Forests as the main body were made.

From the viewpoint that factors of watershed waste are caused by increase in population and inappropriate land use, the basis of participatory watershed management plans is to promote the improvement of villagers' lives through solution of population problems by taking measures against them and improvement of land productivity by appropriate land use. On the other hand, it is indispensable that watershed management activities will be anchored and executed in the daily lives of villagers. For this purpose, the improvement of women's participation and status is important. Only when this is achieved, the practically effective family plan and continuous watershed management can be realized.

Participatory management plan for watershed:

As a result of pilot studies ("PSs"), it was judged that planning in a narrow unit based on villages and not in a wide unit based on zones (zonal divisions) would make participatory management plans suitable for the actual conditions. Therefore, villages to be covered by the plan were divided (grouped) into three types with the factors of village formation and structure of working as indexes. Then, a total participatory plan was made with each type of area as a unit. Factors of village formation are evacuation for dam construction and spontaneous formation. The structure of working is a simple type of agriculture or fishery, and a mixed type of agriculture and wage labor or charcoal making.

Projects to be covered by plans were determined with consideration given to the degree of villagers' interest (participation) in each type of village. These operations can be executed by women. In order to also improve women's status through their active participation in watershed management activities, it has been determined that projects should be executed with the target ratio of women participating in each project set up. Plans should be executed for each village in the plan period of three years. In the first year, plans should be made (by PRA method), and the next two years, the second and third years, should be the period of execution. Judging from the results of PSs, a period of repetition is required to become skilled in organizational activities. For this reason, the execution period of two years is expected. The final goal of this plan is that each project incorporated in the plans will become fixed as daily activities through the self-management of villagers in and after the fourth year. For this purpose, in the promotion of improvement of women's status, the development of independence of villages is intended.

Execution schedules for each fiscal year were made as shown in the table below by setting an efficient sphere of action because the area to be covered by the plan spreads over two zones, Mantasoa and Tsiazompaniry. One round of all villages involved will be made five years after the plan starts. At that point in time, the situation of execution will be evaluated, and minimum measures for follow-up will be discussed if they are necessary for achievement of independence.

Village type	Number of villages	0 year	1st year	2nd year	3rd year	4th year	5th year	6th year and after
I	Two villages (320)		Planning	Execution	Execution	Independent execution	Independent execution	Independent execution
II	Two villages (200)		Planning	Execution	Execution	Independent execution	Independent execution	Independent execution
III	Three villages (310)			Planning	Execution	Execution	Independent execution	Independent execution
	Three villages (770)			Planning	Planning	"	Execution	"
	One village (100)				Execution	"	Independent execution	"
	Analamihoatra	Independent execution	Independent execution	Independent execution	Independent execution	Independent execution	Independent execution	Independent execution

Note) Analamihoatra of Type III should be out of the scope of this plan because it includes two villages, Anovondriana and Kelialina, and independent execution is expected from the results of PSs. The figures in parentheses are the number of households.

Project plans for the year are based on households. The quantity of operations must be feasible for each household without any strain. Based on this, annual quantity of operations are planned based on the rate of households/interest in each project, quantity of operations per household, labor required for a unit project, etc. Quantities of total operations in the two-year period of execution classified by village types are as shown in the following table.

Village type	Agriculture		Agroforestry		Forestry			Fishery
	Fruit tree (1000)	Compost (unit)	Hedge (kg)	Fodder production (100 trees)	Production of young plants (1000 trees)	Tree planting (1000 trees)	ZODAFARB (1000 trees)	Fish farming in rice fields (100 fishes)
I	1.72	510	34	34	136	112.2	23.8	68
II	2.40	250	180	—	90	90	—	—
III	17.00	1,771	1,063	780	1,770	295	295	708
Total	21.12	2,531	1,277	742	1,996	1,677.2	318.8	776

If villagers continue a similar project independently in and after the fourth year, the size of tree planting after ten years is expected to be as shown in the table below. The size of tree planting after ten years is expected to be around 5,000 ha.

Village type		I	II	III	Total
Amount of production of young plants (1,000 trees)		612	405	6,503	7,520
Tree planting (ha)	Lands owned by individuals	316	253	3,387	3,956
	ZODAFARB	67	Not applied	677	744
	Total	383	253	4,064	4,700

Note: Size is calculated on the assumption that planting space is 2.5 m x 2.5 m. 10,000/6.25 m^2 = 1,600 plants/ha

The purpose of this plan is watershed management, and the main point is preservation of watershed through appropriate land use in order to improve land productivity. Even if appropriate measures/ways for land use are taken, however, it is difficult to achieve the purpose of watershed management. As one of the major means for watershed management, family planning (Planning Familial: PF) is also important. Therefore, with the active participation of women in watershed management activities, family planning should be executed on women's initiative while cooperation should be obtained from men.

Execution system:

A participatory management plan for watersheds has comprehensive contents covering various fields. Even if the Ministry of Water and Forests takes the initiative, it is indispensable to execute the plan by establishing an organization where the organs concerned are united at the central and local levels. For this reason, a Watershed Management Promotion Council to be composed of the ministries concerned will be established at the center level, while a

Watershed Management Office will be set up in the country (in two places, i.e., Manjakandriana and Andramasina). The desirable execution system is one in which these organizations will take charge of affairs for management and supervision, and the main body of on-the-spot affairs will be assumed by NGOs. The Watershed Management Committee will be established in each village. The target constitution ratio of women in the Committee should be 50%.

Forest management plan:
The plan has been made focusing on management affairs that are practically executable within the range of the present execution of affairs.

Execution expenses:
The total operating expenses are expected to be about 2,639 million fmg for five years. In the execution of this plan, however, the authorities concerned are in the circumstances where bearing the financial burden independently is difficult. It is judged that the introduction of financial resources from the outside will be unavoidable.

Chapter V Evaluation of projects

For the evaluation of projects in watershed management plans, projects were qualitatively valued from the viewpoints of villagers' technical ability, the legal system, operation of organization and natural and social environments, and quantitatively valued with expenses and benefits as financial affairs. Then the appropriateness of watershed management plans was judged.

In qualitative valuation, there are no factors to hinder appropriateness related to execution of plans. It is shown in financial analysis that production of compost and hedge planting have projects where the total of labor expenses and those of materials and mechanical equipment exceed benefits because expenses of materials and mechanical equipment will be doubled in the first year. However, the incentive for villagers' participation is judged strong because benefits will exceed expenses in fish farming in rice fields and tree planting in and after the second year. It is also judged that the effect of investment under watershed management plans will be sufficiently reasonable because it is possible to obtain from execution of these projects outside economic effects such as prevention of outflow of soil and improvement of the function of soil and water conservation, although economic results are difficult to value with pecuniary inputs and outputs. In any case, success or failure depends on the performance of villagers' participation and proper local guidance.

Suggestions

This plan has contents of projects that extend over various fields. It is self-evident that the plan will not be able to be executed only by the Ministry of Water and Forests. Execution with relevant organs united is indispensable for this reason. Therefore, what is necessary and vital in the execution of this plan is "decision-making by organs (ministries) concerned regarding execution of this plan and confirmation of cooperation among them." Analamihoatra Village is excluded from the plan. This is because the village will reach the goal of independence with very little support. It is also because we expect that the Ministry of Water and Forests will continue some support for PS projects.

Organs (ministries) concerned with this plan are under the severe financial conditions, and in reality financial sharing by them cannot be expected. In order to secure watersheds covered by this plan, an unavoidable important matter is discussion on "the appropriate load from beneficiary groups" as a future matter.

Part 2 Pilot study

1) Preparation of participatory watershed management plan

In order to make participatory management plans for watershed suitable for local features, the target area was zoned (divided into five zones, A to E; see Part 2) based on local characteristics. Three zones (excluding Zones B and E) of the five were selected because they were judged appropriate for determination of watershed management plans by villagers. Furthermore, among these zones, pilot studies (herein after referred to as "PSs") were conducted for two villages each in the Mantasoa zone and the Tsiazompaniry zone. These villages are, in the Mantasoa zone, Andrefanivorona and Ambohimanjaka, and in Tsiazompaniry zone, Angodongodona and Analamihoatra.

In one of the two villages in the Mantasoa zone, agriculture and wage labor exist, and mixed and intensive land use are made, while extensive land use are made in the other village. Both villages in the Tsiazompaniry zone have a form of extensive land use. Agriculture, fishery and livestock industry are carried out in one of them, and the other has agriculture and livestock industry as the nucleus. Although traditional organizations exist in both districts, it can be said that the Mantasoa zone is developing from a purely agricultural society to a society with various opportunities to find work, while the Tsiazompaniry zone is still the purely an agricultural society, and traditional organizations are kept there.

In the first-year investigation, watershed management plans were made by the villagers themselves by the PRA approach as the first-term investigation of PSs. The main projects taken in these plans for action plans are as follows.

Agriculture	:	Planting of fruit trees
Forestry	:	Planting and culture of eucalyptus and other trees, improvement of germinating forests and improvement of charcoal-making technique
Agroforestry	:	Prevention of soil erosion (with hedgerows), soil improvement (tree production with leguminous plants) and planting and culture of trees for fodder
Fishery	:	Fish farming in rice fields
Others	:	Small-sized waterpower generating devices

These projects were executed for one year in the second-year investigation.

2) Results of the execution of PS projects

Projects with a low rate of execution on the whole are planting of fruit trees, fodder production and tree planting. Although planting of fruit trees is a project in which villagers have high interest, the rate of execution (participation) was low because the tree species that villagers wanted to use were not suitable for local conditions and the number of young plants prepared was insufficient. Interest in the fodder production is not so high as many people use grassland or agricultural leftovers. As for tree planting, although villagers were highly interested, the rate of execution was low. Many people did not practice it because the start of rainfall was delayed and young plants were too small in the period of planting (which is a problem of the technique to raise young trees). Unexpectedly, the production of compost had a low rate. It is considered that, although they expressed the will of participation, villagers did not participate in this project because it is operations routinely carried out, apart from the quality of compost. According to individual investigation (interviews), the interest of villagers who participated in this project is extremely high, and they strongly expect improvement of land productivity and substitution for chemical fertilizer.

Improvement of charcoal-making technique had unfavorable results in villagers' response because it takes time and labor. Technical lecture classes in germinating forests were not conducted because villagers showed disapproval of tools to be used as well as due to shortage of time.

Fish farming in rice fields is conducted in the fallow period after harvesting of paddy rice. It is a project to which attention was paid by the Joint Executive Committee, in the strategic sense to heighten interest in forests in order to secure water sources. Villagers' interest was also high. There occurred, however, problems of failure in the production of fry and damage by a cyclone in some places (in February 2000). This project will require further technical guidance.

Seeing rates of execution classified by villages, the village with the much higher rate is Analamihoatra. In comparison with the other three villages, it is backward in development because it is located in the back region and information does not reach well from other areas. Villagers are still simple and honest, and have strong consciousness of union and the active attitude toward introduction of new technique.

The high or low rate of PS projects depends on villagers' zeal and the functioning of the Watershed Management Committees. Villagers' zeal is not uniform but differs according to environmental conditions. Of course, the functioning of the Watershed Management Committees is subject to members' attitude toward and zeal for their missions. In addition, geographical features where members reside cannot be overlooked. In villages (two in the Mantasoa zone) with geographical features such that members live at a long distance from each other and each valley is dotted with two or three homes, in addition to operation as the Committee, it was actually difficult to make contact with participants and carry out joint work (young plant work). What was necessary is considered to be execution in the realistically feasible scope, even if the scale is small, with consideration given to geographical conditions instead of regarding a village as a unit in the planning stage.

As an unusual example, small-sized power generating devices were introduced in Analamihoatra Village. This is highly popular among villagers and results in contribution to heightening of all villagers' consciousness of union.

3) Evaluation

Evaluations of PSs were made twice, as an intermediate evaluation and a final evaluation, and then a comprehensive evaluation was finally made. In the two evaluations, investigations were conducted on the following six items: the degree of achievement of projects and effects, efficiency, social and natural influences, impartiality regarding participation, appropriateness of projects and possibility of continuance and independence. Comprehensive evaluation was made with a view to judgement of the possibility that projects would be independently continued.

In order that the four villages which conducted PSs will continue projects independently, follow-up and assistance for the organization of the Committees, technical support and supply of materials and mechanical equipment will be continuously necessary in all villages, regardless of differences in the amount of materials and labor. Therefore, it is judged that the time is not yet mature for becoming independent. Analamihoatra Village (including Kelialina and Anovondriana), however, has the highest possibility of independent continuance, and its independent ability is also judged to be high.

Content of the Study

1. Background of the study

The Republic of Madagascar is an insular country considered very important from a biological viewpoint due to the presence of various and highly particular animal and vegetal species. In order to safeguard this precious natural environment, the Malagasy Government established a 15-year Environmental Program in 1988, subdivided into 3 phases of 5 years each. Phase 1 of the Environmental Program (PE-1) was implemented in 1990. Subsequently, Phase 2 of the Environmental Program (PE-2) was established, emphasizing regional development and participation in the watershed management, defined on the basis of results obtained during Phase 1. This Phase started in January 1997.

In December 1995, the Malagasy Government submitted a request to the Japanese Government for conducting a development study concerning the establishment of an overall management plan for watersheds in the Anjozorobe zone located at around 90 km north of Antananarivo, the capital, and the Mantasoa/Tsiazompaniry zone, located at around 60 km south-east. These zones including Antananarivo are part of the central plateaus where population density is highest in the island and where the destruction of forests through the cutting of trees and slash and burn planting methods have increased, leading to major erosion.

In response to the Malagasy request, the Japanese Government, through the Japanese International Cooperation Agency (JICA) sent a preparatory research team twice, in April and September 1997 to conduct a study in the zone concerned. Following this study, the Japanese Government made an agreement with the Malagasy Government to conduct a feasibility study (abbreviated hereinafter as F/S) for the plan to develop the watersheds. The principal goal is participation in the management of the areas around the two lakes of Mantasoa and Tsiazompaniry.

These watersheds are water sources for the capital and ensures the production of hydroelectricity and irrigation. Aside from the pressing demand of the villagers around the two lakes for the development of the region, the rapid destruction of the natural environment continues with the reduction of forest areas, soil erosion, etc., caused by human activities such as forest clearing and slash and burn cultivation, unaccepted to the soil characteristics. This has led to problems such as a drop in agricultural production, the degradation of water quality, the sinking of rice fields, the rising of riverbeds. Population increase and incorrect use of the land were considered as the principal cause for these environmental degradations. To protect these watersheds, it will be essential to develop watersheds with the full participation of the villagers called participatory watershed management, rather than safeguarding the biological diversity.

The present study was conducted based on this survey, according to the scope of works (S/W) and the minutes signed on 3 October 1997 between the Japanese International Cooperation Agency and the Ministry of Water and Forests (see annexes 1 and 2).

2. Objectives of the study

This feasibility study (F/S) was conducted in order to formulate a participatory management plan for watersheds around the two lakes of Mantasoa and Tsiazompaniry, located at around 60 km south-east of Antananarivo, the capital of Madagascar. These lakes are important since they constitute the water sources for the capital.
Technology transfer will simultaneously be ensured to the Malagasy counterparts through this study.

3. Area covered by the study

The present study will cover the watersheds of the two lakes of Mantasoa and Tsiazompaniry and the surrounding areas, and will be divided into two zones.

① Target area: establishment of an overall watershed management plan, per zone, based on local conditions, covering around 50,000 ha of watersheds in the two lakes of Mantasoa and Tsiazompaniry

②. Study area: in addition to the above-mentioned watersheds, an overall study will be conducted covering 90,000 ha including surrounding areas, to establish the watershed management plan (1) mentioned above.

4. Overall study plan

The present study covers the points given below in the mentioned zone.

Phase I:

① Aerial photographs of the study area (scale: 1/20,000)
② Collection and analysis of existing data and in-situ study
③ Establishment of topographical maps for the target area (scale: 1/20,000)
④ Establishment of maps for land use and the vegetation in the study area (scale: 1/20,000)
⑤ Clearing of obstacles for watershed conservation, including identification of the causes of these obstacles
⑥ Definition of the objectives and the strategy for the watershed management
⑦ Formulation of a pilot study for the participatory watershed management

⑧ First part of the pilot study

Phase II:

① Second part of the pilot study

② Supplementary study (collection of additional data), analysis of natural conditions, and a detailed study

③ Establishment of pedological maps (soil) of the target area (scale: 1/20,000)

④ Detailed study of the socioeconomic conditions in the communities concerned

⑤ Establishment of a watershed management plan (target area) based on the participation of the villagers, etc.

⑥ Evaluation (feasibility) of the watershed management plan

⑦ Establishment of maps for the watershed management plan (target area) (scale: 1/20,000).

The above-mentioned activities will be conducted for 3 years, broken down per year as follows.

Year	Study period	Phase	Study activities
1st year	April-December 1998	I	First study (study of the site and operations in Japan) Second study (study of the site and operations in Japan)
2nd year	May-December 1999	II	Third study (study of the site and operations in Japan)
3rd year	May-September 2000	II	Fourth study (study of the site and operations in Japan) Fifth study (study of the site and operations in Japan)

This study is conducted according to the above-mentioned schedule. Figure 1 is the functional diagram for the concrete implementation of these operations.
Emphasis is given to the points below for conducting this study.

① Study of the watershed management plan from a realistic and efficient viewpoint on the part of the villagers.
Land problems including the customary possession-use, considered as one of the causes for the degradation of the study area environment. A watershed management plan, both realistic and efficient at the same time from the viewpoint of the villagers, will be established with consideration for the institutional aspect.

② Watershed management according to local conditions
The natural and socioeconomic conditions are different according to the zones. As such, a uniform approach will not be advantageous and an approach based on local conditions will be necessary. Within the framework of this study, zoning according to local conditions will be established. Cause and effect relations for the degradation of the environment per zone will be clarified. Measures to safeguard the corresponding watersheds will be studied.

③ Participatory watershed management

The area covered by the study is highly populated. The interest of the villagers, including the customary use of the land, appear to be complex. A pilot study (hereinafter abbreviated as PS) will be conducted in the study area to ensure the realistic implementation of the watershed management plan under this study. During this PS, the watershed management plan will be established, implemented and evaluated, based on local conditions, with an active participation of the villagers, and using an adapted approach to eliminate their fears and resistance.

④ Improvement of the living conditions of the villagers through general measures

The various activities of the villagers principally consist of rice growing, field cultivation, livestock breeding and wood production. As such, we must study not only reforestation, but also the general and organic management of the watersheds in cooperation with rural development agencies.

⑤ Collaboration with other aid organizations

Other aid organizations such as the UNDP, FAO, are also collaborating for the management of the watersheds. Any overlapping of their activities must be avoided. Their results and know-how must be gathered to ensure an efficient study.

⑥ This study defines an overall safeguard plan for the watersheds. Collaboration with the NGOs working in this zone will be necessary. The participation of these NGOs will be indispensable if this project will be conducted in the future. As such, this study will also be conducted with the collaboration of the NGOs.

Flow chart of the project implementation

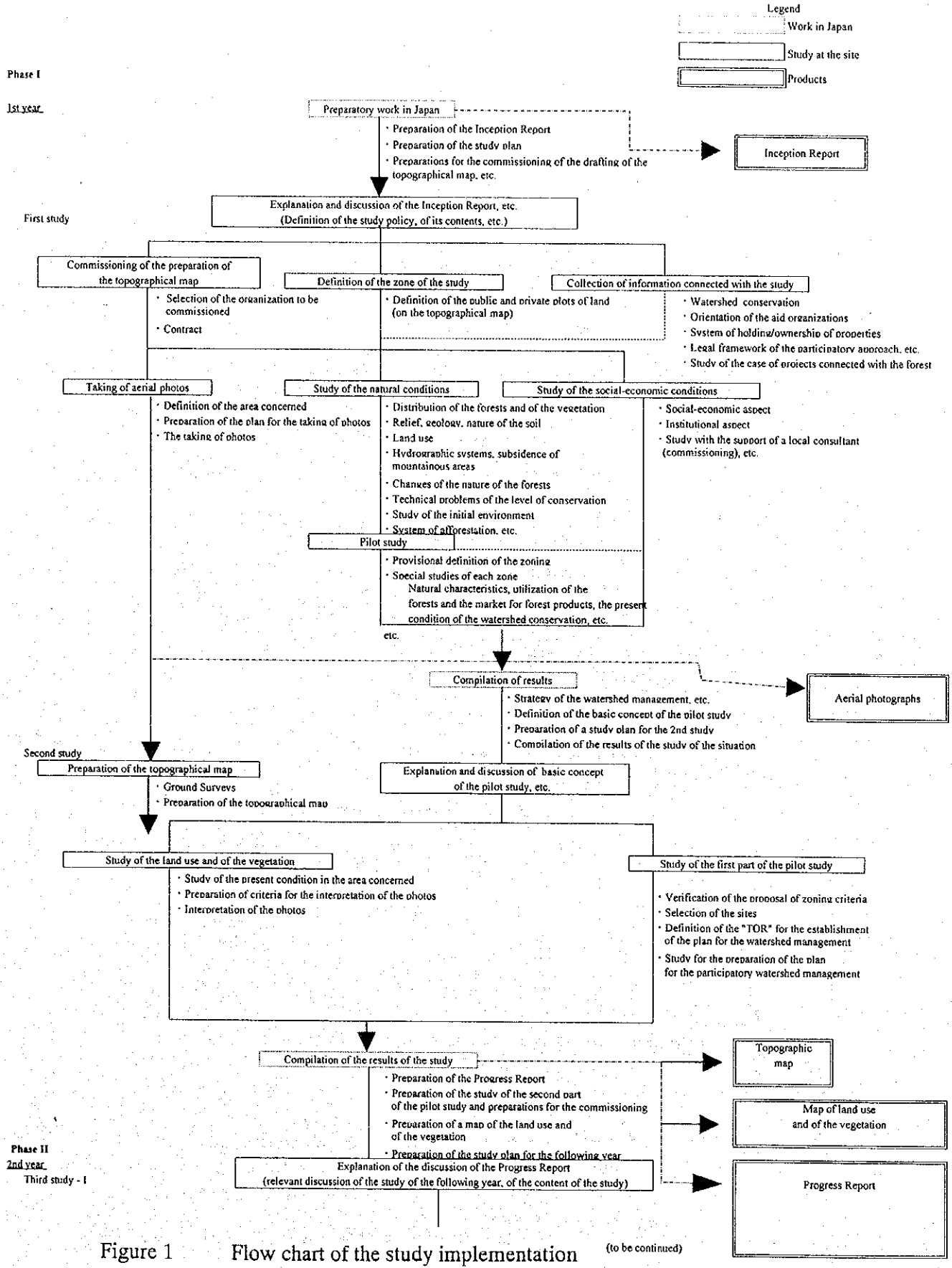
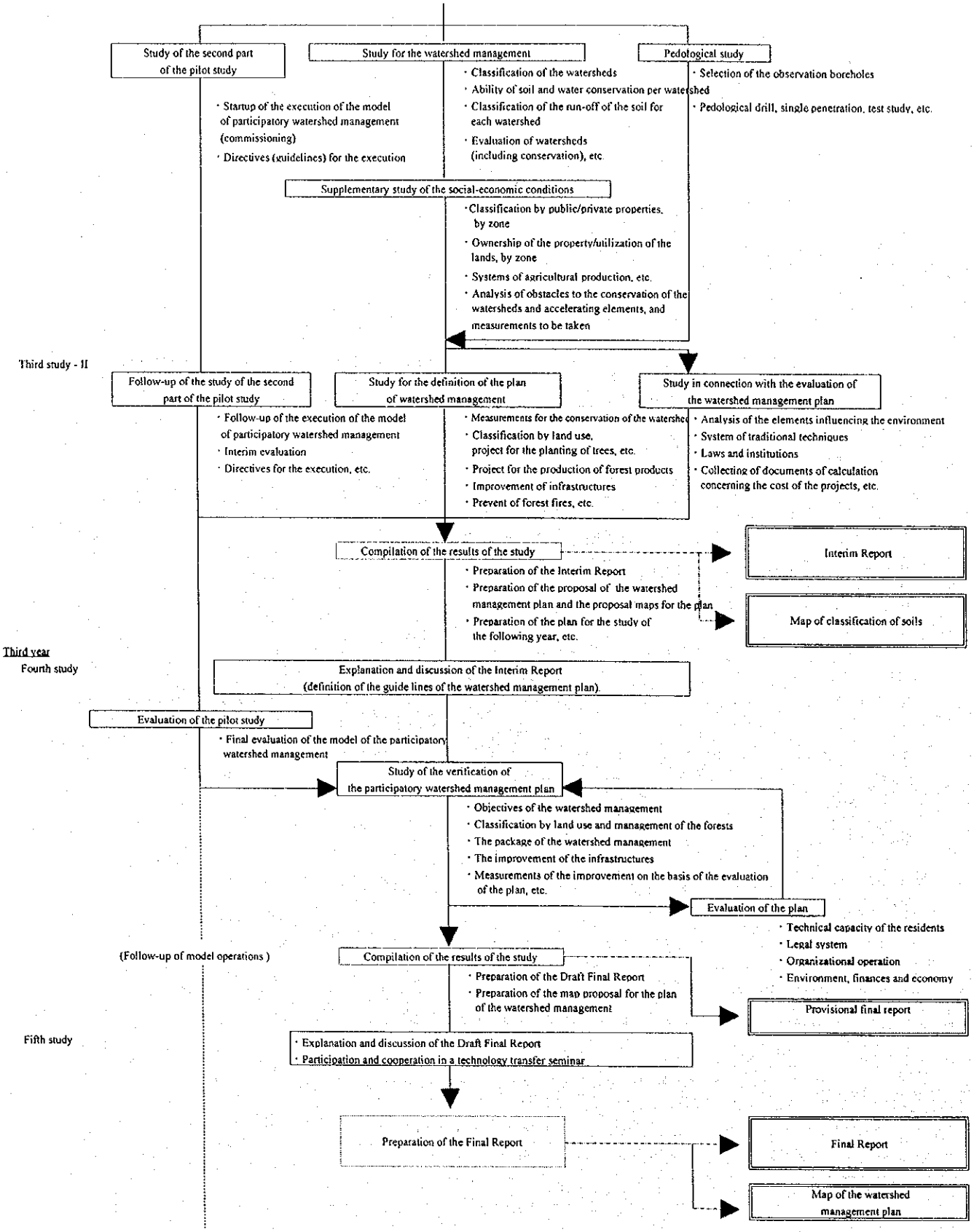


Figure 1 Flow chart of the study implementation

(to be continued)


Study of the second part of the pilot study
Study for the watershed management
Pedological study
· Classification of the watersheds
· Ability of soil and water conservation per watershed
· Classification of the run-off of the soil for each watershed
· Evaluation of watersheds (including conservation), etc.
· Selection of the observation boreholes
· Pedological drill, single penetration, test study, etc.
· Startup of the execution of the model of participatory watershed management (commissioning)
· Directives (guidelines) for the execution
Supplementary study of the social-economic conditions
·Classification by public/private properties, by zone
· Ownership of the property/utilization of the lands, by zone
· Systems of agricultural production, etc.
· Analysis of obstacles to the conservation of the watersheds and accelerating elements, and measurements to be taken
Third study - II
Follow-up of the study of the second part of the pilot study
Study for the definition of the plan of watershed management
Study in connection with the evaluation of the watershed management plan
· Follow-up of the execution of the model of participatory watershed management
· Interim evaluation
· Directives for the execution, etc.
· Measurements for the conservation of the watershed
· Classification by land use, project for the planting of trees, etc.
· Project for the production of forest products
· Improvement of infrastructures
· Prevent of forest fires, etc.
· Analysis of the elements influencing the environment
· System of traditional techniques
· Laws and institutions
· Collecting of documents of calculation concerning the cost of the projects, etc.
Compilation of the results of the study
· Preparation of the Interim Report
· Preparation of the proposal of the watershed management plan and the proposal maps for the plan
· Preparation of the plan for the study of the following year, etc.
Interim Report
Map of classification of soils
Third year
Fourth study
Explanation and discussion of the Interim Report (definition of the guide lines of the watershed management plan)
Evaluation of the pilot study
· Final evaluation of the model of the participatory watershed management
Study of the verification of the participatory watershed management plan
· Objectives of the watershed management
· Classification by land use and management of the forests
· The package of the watershed management
· The improvement of the infrastructures
· Measurements of the improvement on the basis of the evaluation of the plan, etc.
Evaluation of the plan
· Technical capacity of the residents
· Legal system
· Organizational operation
· Environment, finances and economy
(Follow-up of model operations)
Compilation of the results of the study
· Preparation of the Draft Final Report
· Preparation of the map proposal for the plan of the watershed management
Provisional final report
Fifth study
· Explanation and discussion of the Draft Final Report
· Participation and cooperation in a technology transfer seminar
Preparation of the Final Report
Final Report
Map of the watershed management plan

This pilot study will be conducted in order to establish the overall watershed management plan, to verify (establishment, implementation and evaluation) the watershed management plan with the participation of the villagers concerned in the study area, and to define the guidelines for the participation of the community/villagers in the watershed management plan. It will be subdivided into the preparatory study and the first and second parts of the studies, scheduled as indicated below.

Preparatory study:	Clarification of the reasons for the reduction, degradation-destruction of forests; a study of the watershed measures with participation according to local conditions (zoning); definition of the basic design of the pilot study (First study).
First part of the study:	A participatory watershed management plan will be established after dialogue with the villagers, according to the participatory watershed management measures with their participation and based on local conditions. This plan will be drawn up for implementation by the villagers themselves and continuously sustained in the future (Second study).
Second part of the study:	The watershed management plan will be implemented and evaluated. The participatory management plan for watersheds and the implementation procedure (guidelines) will be compiled during implementation (Third and Fourth studies).

5. Progress of execution of the investigation

1) General progress of the investigation

This investigation, which started in April 1998, has been carried out step by step according to the total investigation plan aforementioned. In June 2000, the entire study was finished.

Prior to the start of the investigation, the Inception Report prepared by JICA was explained and discussed in the Joint Executive Committee composed of persons concerned from the Madagascar Government, the Japanese Embassy in Madagascar and the investigation committee. A rough frame of the total investigation plan over three years was then determined, including the policy, method, contents, and schedule of the investigation. The progress of these explanations and discussions is shown as proceedings of discussions in Annex 3. Although the method and contents of the investigation were basically agreed to in that conference, it has been proposed as an item of concern that "This investigation should be carried out in relation to Environment Program Phase II (PE-2) and relevant programs."

In this investigation, field surveys were started jointly together with the counterpart of the Ministry of Water and Forests. Surveys have been carried forward so far, while details have

been discussed in the process of execution of the survey at need. In Phase I, two field surveys were conducted. What was done in the first-year field survey (April to June 1998) includes taking of aerial photos, preparation of a topographical map, investigation of natural conditions and investigation of socioeconomic conditions. In the second-year field survey (September to December 1998), field surveys were carried out focused on the PS former-period investigation. For the PS investigation, the basic conception was discussed and a basic frame related to the way of carrying forward the PS was determined in the Joint Executive Committee basic before the start of field surveys. (For the result of discussions, see Annex 4.) Based on this, the following four villages were selected as villages to execute the plans:

Mantasoa zone: Andrefanivorona and Ambohimanjaka

Tsiazompaniry zone: Angodongodona and Analamihoatra.

Then, participatory management plans for watersheds were made by the PRA method (PS former-period investigation). When the first-year investigation was finished, the results of the investigations were compiled by the Joint Executive Committee, and unification of both parties' recognition was aimed at. At the same time, it was confirmed that the Ministry of Water and Forests would follow up on this investigation so that the second-year investigation would be able to be executed smoothly. (See Annex 5.)

Before the start of the second-year investigation in Phase II, the Progress Report compiling the results of investigations in Phase I was submitted to the Joint Executive Committee. Confirmation was then made on the results of execution and the way of carrying forward the plans thereafter. (See Annex 7.) In this report, it was proposed as efforts to be made thereafter that "Recovery of watersheds requires time because their devastation results from poverty, and the participatory watershed management plans are effective for preservation of lakes and cooperation of local administrative authorities is indispensable for the execution of them."

For PS latter-period investigation, project plans were discussed among the Ministry of Water and Forests, NGOs and the JICA investigation team. They concluded an agreement regarding the three parties' share of the responsibility, quantity of projects and operating expenses. Projects were then started by villagers based on this. (See Annex 8.) In the progress of execution of PS, meetings of the Joint Executive Committee were held every time the state or stage changed, and the proper execution of the PS was striven for (See Annex 9 and 10) through the confirmation of the progress and the discussion about problems. In the second-year investigation, the overall conception of watershed management was discussed. (See Annex 10.) Based on this, investigations to determine the total watershed management plan were carried forward. Conducted investigations include agronomical surveys, watershed evaluation investigations, and various kinds of investigations concerned with the evaluation of watershed management plans. After the completion of the second-year investigation, the results of the investigation were summarized in the Interim Report. Then, before the start of the third-year investigation, the Report was explained and discussed in the Joint Executive

Committee. (See Annex 12.) At these meetings, the results of the investigation and matters concerned with the determination of watershed management plans were confirmed. The final-year investigation was carried out based on these confirmations. The main points of discussions are as follows: ① In order to spread participatory plans, a village watershed management committee should be positioned as a public organ, ② fish farming in rice fields has a strategic importance from the viewpoint of proper land uses, and ③ the spread of family planning is important for watershed management. Concrete contents of the examination are summarization of the results of execution of PSs, the final evaluation of PSs and final verification of watershed management plans.

Preparation of topographical maps in these investigations, investigations of socioeconomic conditions and the investigation of PSs were executed by entrusting them to local companies and NGOs. Topographical maps were prepared with the cooperation of the National Mapping Institute (FTM), while investigations of socioeconomic conditions were carried out with the cooperation of Universite D'Antananarivo Ecole Superieure Des Sciences Agronomiques Departement Des Eaux Et Forets (ESSAFORET). The PS investigation was carried out with the cooperation of a local NGO, Gasy Ory Azo Ikarohan Kevitra Ampivoarana (GOAIKA).

2) PS investigations

PS investigations were carried out by the Ministry of Water and Forests, the JICA investigation team and local NGOs in one united body. Particularly, local affairs were taken under charge of the NGOs. Under their guidance, watershed management plans were made, executed and evaluated by villagers themselves. In particular, these operations were carried out mainly by the Watershed Management Committees organized for each village.

The subject matter of the PS former-period investigation was preparation of plans by villagers themselves. This work was hard for both the NGOs and villagers because it was done in the intervals of farm work or after the end of farm work and in the limited investigation period. The subject matters of watershed management plans in the PS latter-period investigation were execution and evaluation of watershed management plans by villagers themselves. As the start of the rainy season was unusually late, problems related to operations in the suitable time period arose and work was partly not executed in some cases as a result.

The PS latter-period investigation was conducted as follows.

① Workshops for confirmation and refresher training of projects of watershed management plans were held in four villages that would execute them. The purpose and contents of projects were re-confirmed there.

② At the first or second workshop, discussions were held on villagers' initiative, mainly on the way of carrying forward projects, establishment of the organizational system, the period of projects and execution schedules for each project.

③ Whenever a problem or change occurred, a meeting was held with the Watershed

Management Committee and representatives of the village attending.

④ In the execution of each project, without being restrained by the original plan, flexible responses such as changes were taken with respect to the situation of daily life of villagers and opinions of the Watershed Management Committee.

⑤ In all processes of execution of PS projects, it was aimed at endeavoring to conduct work through villagers' voluntary will.

For summarization of the results of the execution of PS activities, workshops of participants in PS activities were mainly investigated. To supplement this, interviews with villagers and fields surveys were carried out to investigate the spread of PS activities, skillfulness of technique, villagers' responses and so on.

As the first step of the evaluation of PSs, participatory evaluation meetings were held in each village where PSs were executed. Based on these results, discussions were made by the three parties, the Ministry of Water and Forests, NGOs and the JICA investigation team, and then comprehensive evaluation was made.

3) Watershed evaluation investigation

Watershed evaluation investigation was carried out to determine matters to be considered for land uses from the viewpoint of watershed preservation. This investigation consisted of two items: a soil survey and a hydrologic investigation. For the soil survey, the soil section by trench cut was observed (30 points) and soil solidity was surveyed using the simplified penetration tester (62 points). For the hydrologic investigation, infiltration capacity of the ground surface (41 points) and the flow in small watersheds (27 points) were investigated.

Based on the soil survey, a soil map of the target area was prepared with consideration given to existing soil maps and vegetation maps based on the results of investigation. Based on the hydrologic investigation, the function of soil and water conservation was analyzed from the relation between infiltration capacity and vegetation and the relation between the flow and land uses /vegetation classification. In order to examine the landslide potential, multivariate analysis was carried out regarding the combination of natural environmental factors that seemed to be related to landslides, with places having slide land found in air photos as an external criterion. Based on this, a landslide potential map (of the target area) was prepared as a mesh map. A soil map was formulated based on the result of soil survey.