THE FOREST RESOURCES MANAGEMENT STUDY IN THE REPUBLIC OF COLOMBIA

PROGRESS REPORT I

AUGUST 1990

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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Summary

This progress report I is a summing-up of the results of the field investigations carried out in February and March, 1989 as part of the forest resources management study in the the Republic of Colombia.

1. Purpose of the Study

The Purpose of the Study is to set forth a guideline for forest management plans and draw up a model plan in the forested region of Caldas Province in the the Central Forest Reserve of Colombia and assist in the establishment of a proper system for the management of forest resources in the country. This is a preliminary investigation for the Study.

2. Areas Covered by the Study

① Study Area: 1,600,000 ha of the the Central Forest Reserve

② Intensive Area: 200,000 ha of Caldas Province

③ Model Areas: Marked off in three places, covering a total of 20,000 ha, the national forest on the backbone of the the Central Forest Reserve within the Intensive Area, the Manizales headwaters forest and the man-made forest at the piedmont of the Central Forest Reserve

3. Results of the Study

(1) Analysis of Remote Sensing Data

In order to get an accurate picture of the status of land use and vegetation in the Intensive Area and their temporal changes, we carried out a survey for the establishment of the criteria for image interpretations and a ground cover classification survey. Their findings were incorporated in a report on the remote sensing data analysis.

(2) Aerial Photography and Mapping

We decided to take aerial photographs on a scale of 1:20,000 to prepare forest base maps and get a precise picture of land use and vegetation distribution. To that end, we concluded an agreement to commission Colombian SADEC to take the photographs.

However, bad weather stood in the way of the operations, and the aerial photography remains yet to be completed. As of July 15, 1989, 40% of the planned aerial photographs were taken. As for mapping, control point surveying was conducted in 14 places by the satellite observation method as it was necessary for the preparation of forest base maps by the aerial triangulation survey method. Leveling and detailed field investigations were carried out to make the survey as accurate as possible.

(3) Forest Management Plan Study

① Collection of Survey Data

Interviews were condueted to get information on the situation, while necessary data for the investigation were collected from the agencies concerned.

② Preliminary Field Investigation

A field investigation was condueted in the Intensive Area on the basis of the existing topographic maps and aerial photographs, which produced a sketch of land use, vegetation, soil, topographic features and denuded land. Given below are its findings:

a. Sketch of the Intensive Area

- The Intensive Area comprises nine cities in Caldas Province, is located at Long. 75° 5' 27" W. - Long.75° 33' 20"W., covers an area of 204,700 ha.
- Its altitude ranges from 750m to 3,850m.
- Its annual average temperature is 16.4° in Nouvou and 21.1° in San Félix, with a relatively little change.
- Its annual precipitation is between 1,000mm and 4,000mm, with much rainfall on the eastern side of the Central Range and little on its western side.
- Drainage systems are divided into the Magdalena River basin to the east and the Cauca River basin to the west by the Central Range.
- Paved national highways account for two-thirds of the main routes

surrounding the Intensive Area, but its inside traffic situation is far from good.

- Its population is about 495,000.
- Cattle totals about 100,000 head, accounting for the far largest share of the livestock raised. Also kept are pigs, horses, fowls, bees, and so on.

b. Outline of Land Use

The existing materials show that forests account for 27% of the land, farmland 6%, pastureland 57%, and others 10%.

C. Vegetation

Forests are classified into a hilly rain forest, a lowmountain rain forest, and a mountain rain forest. The existing data show that man-made grassland accounts for 1.3%, improved grassland 1.9%, natural grassland 54%, man-made forests 3.1%, natural forests 19.7%, and secondary growths 4.7%. A total of 159 plant species were identified in this survey.

d. Soil

Widely distributed are soils whose parent materials are strata of volcanic ejecta with different sedimentation periods traced back to past volcanic activities.

e. Topography

The topographic features are structural relief, eroded by the rivers flowing down east and west, separated by the Andes Central Range which extends north and south in the center.

f. Geology

There are nine kinds of geological features in the Intensive Area, of which the most widespread layers are very old mixtures of gneiss, quartz, and mica.

g. Denuded Land

The following are likely causes of denudation and devastation:

- Natural erosion caused by the steep configuration of the land(slide,

collapse)

- Rain erosion because of much precipitation(gully)
- Erosion accelerated by felling, road construction, and the flow of sewage on the land surface(man-caused)

③ Forest Inventory

A preliminary forest inventory was undertook for the purpose of obtaining information on the status of forests in the model area and examining the method and process of investigation for a basic survey to be carried out next time for forest management plans. A total of nine plots were set up in three model areas, three each. In the natural forests we carried out both an every-tree measurement and a natural regeneration survey. In the natural forest survey we came across a total of 59 species of trees, those trees with diameter breast height of 10cm or more numbered 700-1,350 per ha. In the survey process a nine-member team took one day to investigate 1 ha of a man-made forest and 1.5 days to survey as much of a natural forest.

④ Survey for establishment of Criteria for Interpretation of Land use, Vegetation Distribution and Denuded Area

The status of land use, vegetation and denuded land was explored with a view to establishing items for identification of land use, vegetation, and denuded land, which are necessary for aerial photo interpretations. The consideration of identification items is as described in the text. Some of the identification items for each category will be modified by using aerial photographs to be taken later.

⑤ Soil Survey

A soil Survey was conducted to identify the types and properties of soils distributed throughout the model area. Its sites were around the plots for a forest survey. As the investigation was preliminary in nature, its results will be used to work out the aims of the next round of sample survey.

⑥ Local Socio-Economic Survey

Twenty-one households were interviewed in order to draw a picture of the way of life, and customs of inhabitants in and out of the model area, the local industrial structure, the forms of agriculture and livestock breeding and land ownership. Their average length of settlement is 8.5 years; their average household size is 5.4 people, and younger people aged 5-19 account for 47.5% of the local population. A probe was made of their forms of employment, the family circumstances, and resident's consciousness.

(4) Decision on Model Areas

Model areas were marked out in the following three places after careful consultation with the INDERENA side:

① National forest zone on the backbone of the Central Forest Reserve

9,650 ha of the Tapias River basin with La Christalina as its center

② Manizales City Headwaters

4,343 ha of the Blanco River basin

③ Pensilvania Man-Made Forest

6,370 ha in the vicinity of Pensilvania City

4. Technology Transfer

Since this was the first round of survey, we made it the main objective of technology transfer to give the INDERENA side with a better understanding of the aims and method of the survey and the way of analyzing its results. We provided the counterparts 'on-the-job training' through each operation. It seems that technology transfer as a preliminary survey achieved its desired results.

5. Study of Environmental Impact

This preliminary investigation involved the classification of those factors likely to produce an impact on the environment and those in the physical and social environments which are supposed to be adversely affected. In the next round of investigation, we plan to make an environmental impact assessment, whose approach was put in order.

6. Future Schedule

The future schedule is largely dependent on when aerial photography will be wound up. Suppose the work will be completed by the end of July, a field survey is scheduled for two months from late October to late December, this year, as a basic survey for forest management plans.

If the aerial photography will not be completed, it is necessary to consider modification of the schedule.

I Introduction

I – 1 Background of the Study

The Republic of Colombia covers an area of 1.139 million sq.km. The forests consist of 53.18 million ha, accounting for 47% of the total area of the country. The geographical distribution of these forests, however, significantly varies in different localities as comparably seen in the case with Amazon district (81%), the Pacific Ocean district (75%) and Andes district whose forest cover rate is as low as 26%.

This is mainly because of an early modernization and formation of several major cities in the Andes region. Due to a rapid development of these cities and increase in their population, the pressure has increased on land for production of more food leading to clearing of land, especially forested land, for the establishment of farms and pastures. This has resulted in the destruction of forests.

The reduction of the forest cover not only created ecological problems but also gave rise to the risk of floods and insufficiency in the supply of drinking water at the mid and down stream areas. Inasmuch as the greater part of the Andes region is comprised of steep slope, except for gentle mountain slopes or highlands, the excessive development of lands including conversion into pastureland conduced to the erosion of soil and deterioration of capacity of headwaters areas, thus adversely affecting the livelihood of inhabitants and industrial activities in the area. Taking into consideration these circumstances, it is urged that necessary measures be promptly taken to rationalize land use, conserve forests, improve wood industry, improve forests and develop forest land by establishing plantations.

With these factors taken into account, the government of the Republic of Colombia hsa requested technical cooperation and technology transfer of the government of Japan to :

* select and officially designate Central Forest Reserve in the Andes district as a model area to conduct the most proper forest management so as to scientifically comprehend distribution of forests, actual situation and aspects of land use, and annual changes in land cover by means of processing and analyzing remote sensing data obtained through Landsat, and establish technical procedures and methods necessary to apply to that study.

* prepare guideline for forest resources management, based on which a model plan for forest resources management in the model area, which will be selected in the study area, will be formulated.

* correctly comprehend the actual situation of Rorest resources with the aid of aerial photographs and topographic maps, which will be drawn using these photographs.

* obtain basic data and information necessary to conduct the most appropriate forest management.

To meet the request from the government of the Republic pf Colombia, Japan International Cooperation Agency (hereinafter called "JICA") sent a preliminary survey team in February 1988 and a S/W survey team in July 1988 to Colombia to study the background of the request made, ascertain the basic system for the implementation of the study and to study procedures and schedules of a full-scale study to be conducted by Japan in future. Thus, after studies were carried out and discussions were made between the two parties, the S/W was prepared and mutually signed by the parties concerned.

This progress report summerised the results of analysis of remote

sensing, aerial photographs, mapping and preliminary study of forest management plan which were carried out from February 14 to March 30,1989 in relation to this forest resources management study.

I – 2 Purpose of the Study

The purpose of this study is to analyze Landsat data of Central Forest Reserve in the Andes region of Colombia, to prepare base maps using newly taken aerial photographs and to formulate guideline for forest resources management as well as a model forest management plan to be conducted in the forested regions of Caldas Province with the aim of setting up the most appropriate system of implementing the forest resources management in the Republic of Colombia.

I – 3 Areas Covered By the Study

Areas covered by the study refers to areas related to Central Forest Reserve in the Andes region of the Republic of Colombia which consist of the following three areas:

① The Study Area

This covers an area of 1.6 million ha. extending in a northsoutherly direction (Fig. 1.). Here state of forest and land use will be studied using Landsat data. This area is called "the Study area".

② The Intensive Area

This is located in the northern extremity of the study area and consists of 200,000 ha. Aerial photographs of this area will be taken based on which topographic maps will be prepared and the guideline for forest resources management will be formulated (Fig. 2.). This area is called "the intensive area".

③ The Model Area

In the Intensive Area about 20,000 ha is marked out for a model forest management plan to be worked out with an eye to translate the forest management plan guideline into practice in an exemplary fashion. This area is called the Model Area, which comprises the national forest zone at the ridge of Central Forest Reserve, the headwaters forest zone of Manizales City, the artificial forest at the foot of Central Forest Reserve. Their boundaries were determined in this survey, as shown in II-4-(3).

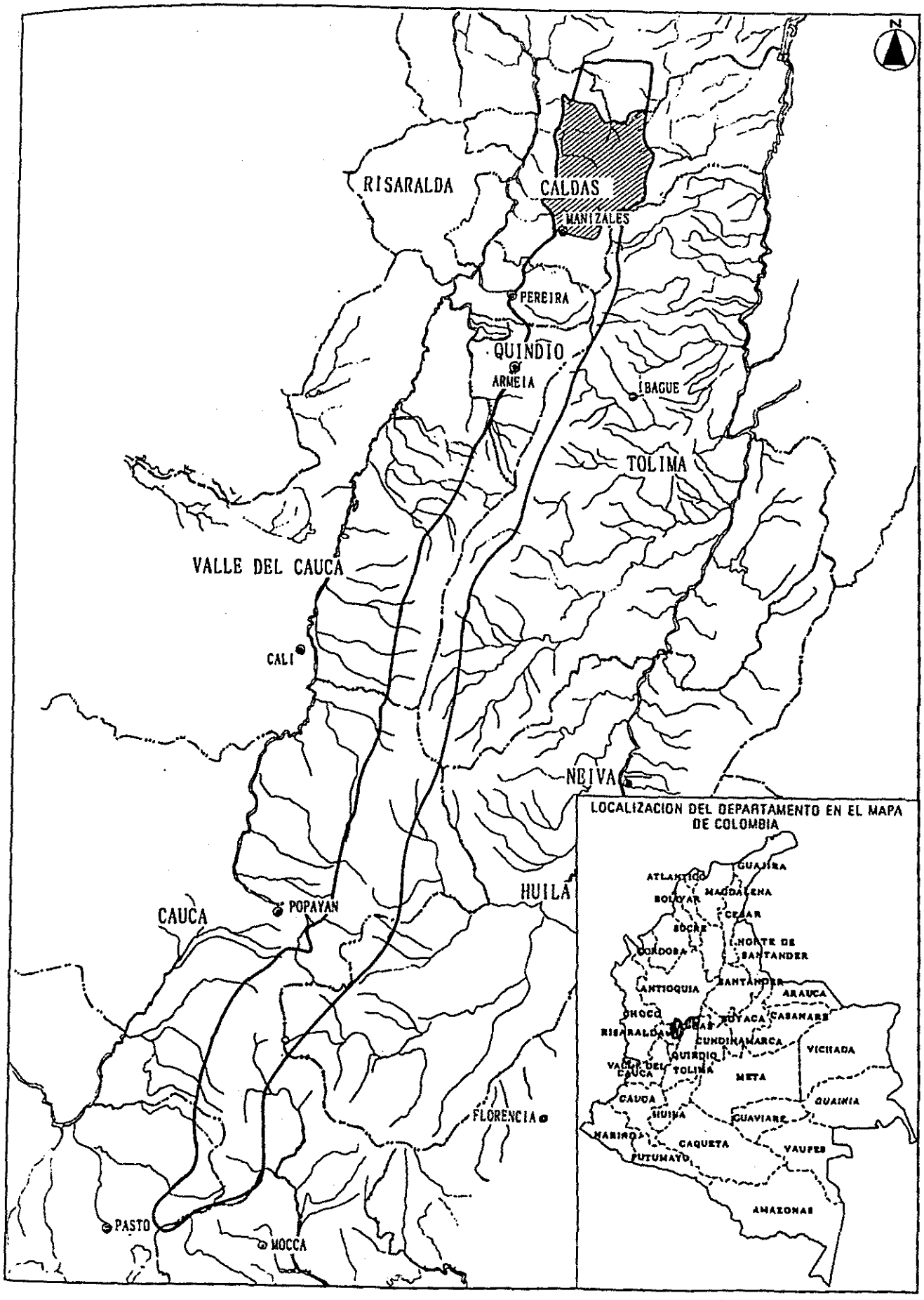


Fig. 1 The Study Area

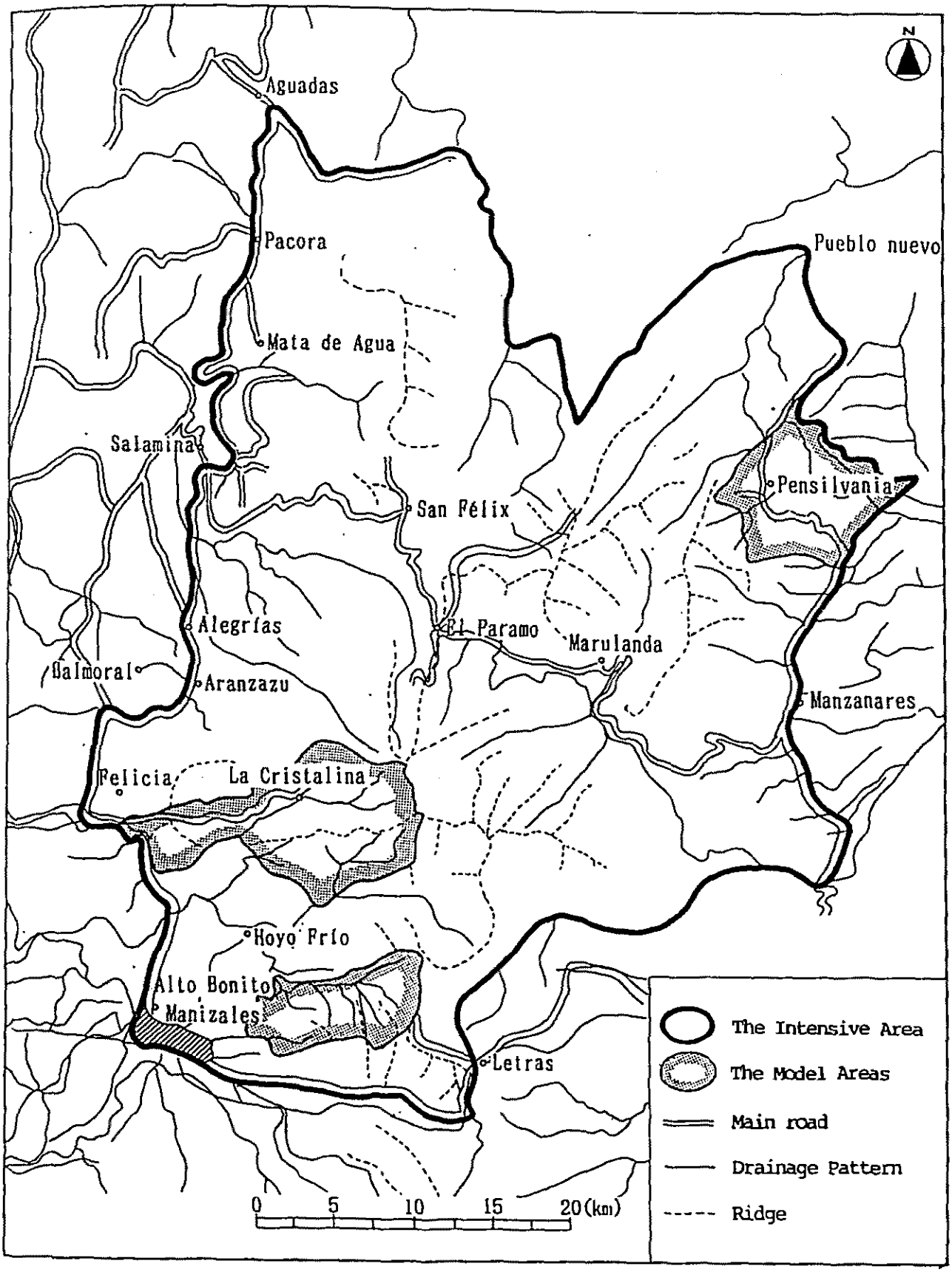


Fig. 2 The Intensive Area

I – 4 Basic Policy of the Study

With a deep awareness that the forest management plan guideline to emerge from this study will play an important role in the efforts of Colombia to achieve its national goals in forest management, it has been decided that the study shall be conducted in pursuit of the following basic policies:

① To work out a plan guideline which will serve as a standard for the formulation of a forest management plan at the level of a master plan in the region and help to establish a rational forest resources management system in Colombia, since this is the first study under which the criteria (basis) for the formulation of a comprehensive forest management plan in the country will be established.

② To conceive possible standards for forest conservation, forest improvement, restoration of the denuded area, forest management, forest roads and others as part of a forest management plan and to draw up a guideline suitable for each of them.

③ To conduct a detailed investigation pertatining to forest conservation and forest management and other related aspects and establish a guideline suitable to the local conditions.

④ To choose a Model Area and formulate a model forest management plan as an example to be emulated when the Colombian Government proceeds with the work of mapping out a forest management plan in line with the guideline.

⑤ To grasp precisely the change in forest cover rate to be used as a basis for formulation of a guideline and a model plan for forest management. Also to conduct an investigation of land use, vegetation, and soil and a survey of landownership system, farming types and the socio-economic conditions, and to use the scientific data thus derived of the physical environment to prepare a plan to match the socico-economic environment.

⑥ To grasp as accurately as possible the local situation during the field

survey and make the maximum possible efforts to assess the technological requirements of fundamental importance with highest possible accuracy.

⑦ To consult with INDERENA, the counterpart organization of Colombia, and related agencies as occasion demands and achieve mutual understanding and coordination in regard to the contents of the plan guideline and the model plan, while the survey is under way or while the guideline is being drafted, considering that the guideline and the model plan are to serve as standards under which Colombia will formulate a forest management plan.

⑧ To strive for the on-the-job transfer of technology involved to the counterpart group of Colombia in order to see to it that the plan guideline is made the most of by the country and that plans are easily established in other areas than the Model Area after the conclusion of this study.

I − 5 Contents of the Study

This study is planned to be carried out over a three-year period form 1988 to 1990 and is divided by operation into remote sensing analysis, aerial photography, mapping, and a forest management plan survey. Listed below are main items of the study, whose flow chart is illustrated on Figure 3. However, as described later, there is some likelihood that the operation of taking aerial photographs will not be wound up by the time set because of bad weather.

(1) Fiscal 1988

① Preparatory Work in Japan

a. To classify and assess the data and information obtained in the Preliminary investigation and those pertaining to the study area.

b. To draw up the plan for the conduct of the full-scale study, while making preparations for the field investigation.

c. To prepare an inception report.

② Field Investigation

a. Remote-Sensing Analysis

To conduct the following surveys in the study area.

(a) Survey for establishment of the criteria for image interpretation

(b) Survey for classification of ground cover

b. Aerial Photography and Mapping

To conduct the following surveys in the intensive area.

(a) Control-point survey and survey for confirmation of pass points

(b) Contract, guidance and supervision with regard to taking aerial photographs (on a scale of 1 to 20,000), development and printing (a local consultant firm appointed to do the job)

c. Forest Management Plan Survey

To collect data and materials regarding the following aspects of the study area as a whole and carry out a field survey (hereinafter, the fiscal 1988 forest management plan survey shall be referred to as the preliminary survey for the forest management plan:

(a) Natural conditions: topography, weather, geology, soil, vegetation, etc.

(b) Social conditions: national and regional development plans, regional socio-economy, forms of popular employment, etc.

(c) Forest and forestry: environmental impact assessment, forest policy, forest protection, forest conservation policy, the status of forest industry and related industries, land use, the investigation of growing stock and increment volume etc.

③ Analysis to Be Conducted in Japan

To conduct the first round of ground cover classification and temporal change analysis as part of remote sensing analysis.

④ Preparation of Field Report

To sum up data and information collected in the field and prepare a field report.

(2) Fiscal 1989

① Preparatory Work in Japan

a. Aerial Photography and Mapping

To draw up a basic forest map (Model Area on a scale of 1 to 5,000 and the Intensive Area on a scale of 1 to 20,000) on the basis of aerial photographs taken and findings of the survey conducted the previous year and to examine the aerial photographs and maps.

b. Forest management Plan Survey

To draw up the plan for the implementation of the survey for this fiscal year on the basis of data and information collected the previous fiscal year.

② Field Survey

To investigate the following items in the field in fiscal 1989 (hereinafter, the forest management plan survey for fiscal 1989 shall be referred to as the basic survey for the forest management plan):

a. Matters Pertaining to Socio-economic Survey in the Intensive Area

(a) General socio-economic survey

(b) Investigation of relationships between the local inhabitants and the forest

(c) Market distribution investigation

(d) Investigation of the state of farming areas

(e) Investigation of the demand-supply condition of forestry products

b. Matters Pertaining to the Production of Soil Map, Land Use Plan map, and Forest Type Map

(a) Soil Survey

(b) Survey on the state of land use

(c) Forest type and vegetation survey

c. Matters Pertaining to the Drawing Up of Guideline and Model Plan for Forest Management

To make a detailed investigation and collect and analyze data and

information mainly regarding the following matters:

(a) Soil classification survey

(b) Forest resources survey

(c) Survey of right sites for reforestation

(d) Survey for the establishment of the standard for forest type improvement

(e) Survey for the production of volume table

③ Analysis to Be Conducted in Japan

a. Remote-Sensing Analysis

(a) Summing up and analysis of the field survey conducted a year earlier

(b) To analyze the data on the basis of the classification of ground cover and the criteria for the interpretation of images and prepare a report on the results of the remote sensing data analysis.

b. Aerial Photography and Mapping

(a) To sum up the results of the control point survey and photographs taken.

(b) To draft a basic forest map (aerial triangulation survey, detailed mapping, editing: a basic forest map of the 200,000 ha, Intensive Area on a scale of 1 to 20,000, a basic forest map of the 20,000 ha Model Area on a scale of 1 to 5,000).

c. Basic Survey for Forest Management Plan

(a) Matters Pertaining to the Whole of the Study Area

ⓐ To classify and analyze data and other materials gathered in the survey.

ⓑ To set forth a fundamental course of action to be followed in the preparation of a guideline and a model plan for forest management.

(b) Preparation of Maps

To prepare the following maps after an assessment of the results of the

field survey:

ⓐ Forest type map (20,000 ha Model Area, 1/20,000)

ⓑ Draft soil map (")

ⓒ Draft map for land use plan (")

(c) Matters Pertaining to the Drawing Up of Guideline and Model Plan for Forest Management

ⓐ To analyze the findings of the field survey.

ⓑ To draft an outline of a guideline for forest management plan.

ⓒ To draft an outline of a model plan for forest management.

④ Preparation of Progress Report

a. Preparation of Progress Report I

To examine and analyze the various data collected in the preliminary survey for forest management a year ago and prepare progress report I.

b. Preparation of Progress Report II

To sum up the data and information collected in the basic survey for forest management and the results of an analysis made in Japan and prepare progress report II.

(3) Fiscal 1990

The forest management plan survey to be conducted in fiscal 1990 shall be hereinafter referred to as the survey for the preparation of a forest management plan.

① Preparatory Work in Japan

To classify and examine the data and information collected in the survey for fiscal 1989 and the findings of the analysis done in Japan and draw up the plan for the implementation of the survey for this fiscal year.

② Field Survey

To consult with the Colombian side the contents of the field survey to be conducted in conformity with the above plan and conduct a survey for the preparation of a guideline and a model plan for forest management,

while collecting supplementary information and making on-the-spot verification.

③ Analysis to Be Made in Japan

a. To draft a soil map, a map for land use plan and prepare forest inventory books.

b. To work out both a guideline and a model plan for forest management on the basis of the findings of the field survey and prepare a draft final report.

④ Explanation of Report

To brief the Colombian side on the contents of a draft final report thus prepared and see whether there is anything left to be changed or or modified.

⑤ Preparation of Final Report

To make whatever necessary change or modification with attention to the comments made by the Colombian side on the draft final report and complete the final report.

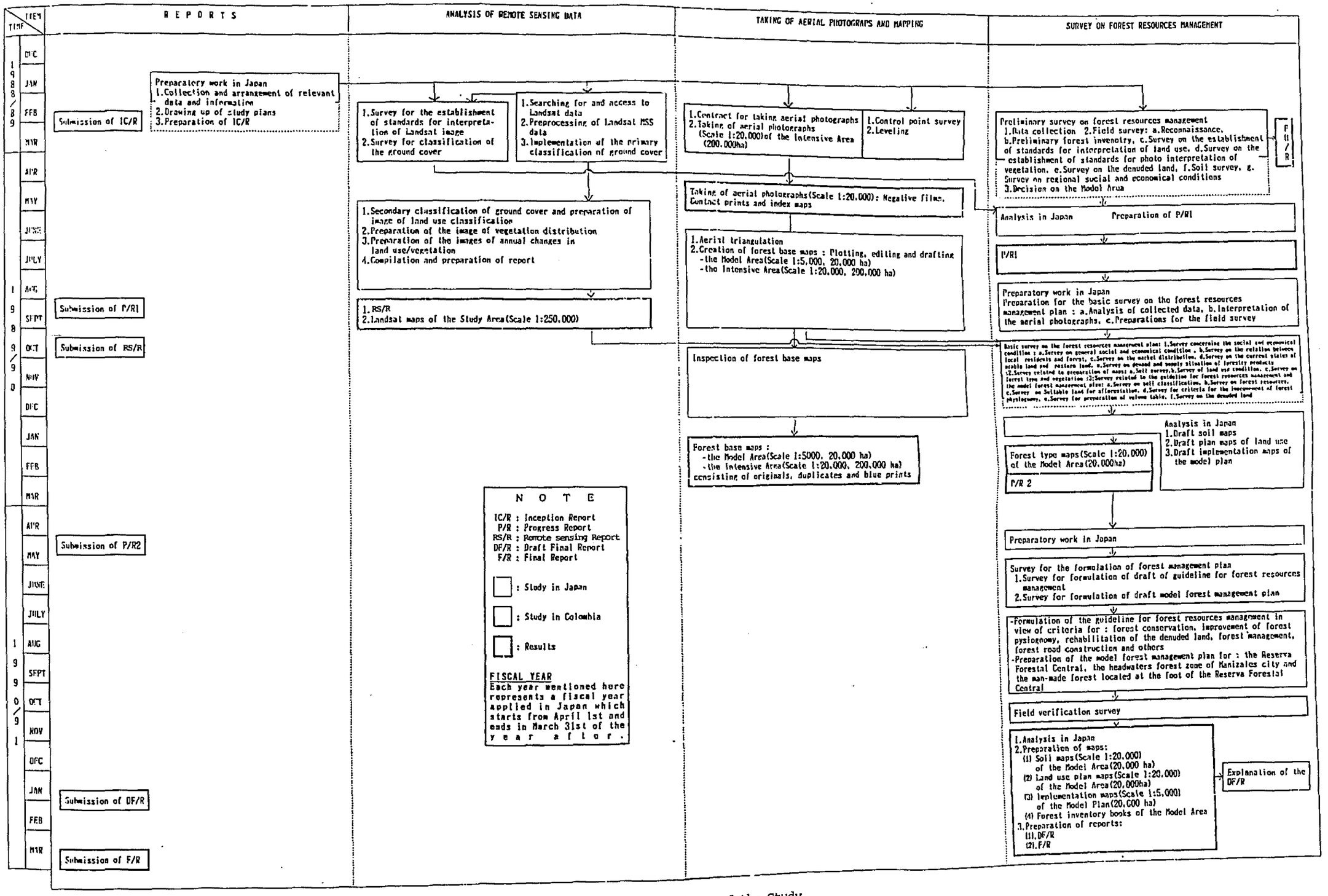


Fig. 3 Flow Chart of the Study

I – 6 Composition of Study Team

Described on Table 1 and Table 2 are the composition of the study team and the advisory team for the field survey conducted in fiscal 1988, the period of the survey and other details.

Table 1 Composition of Study Team

Study Team	Name	Responsibility	Period of survey in Colombia	No. of days
Forest managment plan	Hiroshi Watanabe	Supervision and plan standards	Feb.14,1989 ~ March 5,1989	20
	Shigeki Koike	Supervision assistance and forest management plan	Feb.14,1989 ~ March 5,1989	40
		forest management plan		
	Shinichi Hayashi	Soil survey	〃	〃
	Hiroaki Masui	Reforestation	〃	〃
	Sumio Ichikawa	Socio-economic survey	〃	〃
	Shuichi Kobayashi	Forest survey	〃	〃
	Toru Sekine	Vegetation survey	〃	〃
Remote sensing analysis.	Iwao Nakajima	Remote sensing analysis	〃	〃
	Kazuyoshi Kageyama	〃	〃	〃
Aerial Photography	Yoshiro Hayashi	Aerial photography management	Feb.14,1989 ~ March 30,1989	45
Control point survey	Shun Takagi	Control point survey supervision	〃	〃
	Mitsuo Saito	Control point survey	〃	〃
	Makoto Sueto	〃	〃	〃
	Kazuhiro harada	〃	〃	〃

Table 2 Composition of Advisory Team

Name	Responsibility	Period of survey in Colombia	No. of days
Kanji Koori	Team leader/supervision	Feb.20,1989 ~ March 3,1989	12
Kunihiko Ishizaki	Conservation	〃	〃
Kooji Makiguchi	Work coordination	〃	〃

I – 7 Schedule for the Study

Table 3 shows the schedule of study in Colombia for fiscal 1988 conducted from February 14 to March 30, 1989.

Table 3 Schedule of Study in Colombia

Study team			Forest management plan						
No. of days	Day of month	Day of week	Watanabe	Koike	(Shinichi) Hayashi	Masui	Ichikawa	Kobayashi	Sekine
1	2/14	Tue.	Tokyo →Los Angeles	The same as left	The same as left	The same as left	The same as left	The same as left	The same as left
2	15	Wed.	→Bogota						
3	16	Thur.	Courtesy call at IGAC, INDERENA, Japanese Embassy	〃	〃	〃	〃	〃	〃
4	17	Fri.	Courtesy call at INP and IGAC and consultation at INDERENA	〃	〃	〃	〃	〃	〃
5	18	Sat.	Internal consultation, survey preparation and collection of data	〃	〃	〃	〃	〃	〃
6	19	Sun.	〃	〃	〃	〃	〃	〃	〃
7	20	Mon.	Coordination of schedule with INDERENA	〃	Bogota →Manizales	The same as Watanabe's	The same as (Shinichi) Hayashi's	The same as Watanabe's	The same as (Shinichi) Hayashi's
8	21	Tue.	Collection of data and other materials	Collection of data and other materials	Consultation at regional INDERENA office and survey preparation	〃	〃	〃	〃
9	22	Wed.	Accompany Advisory Team on courtesy call	〃	Field reconnaissance	Collection of data and other materials	〃	Collection of data and other materials	〃
10	23	Thur.	Briefing and consultation with IC/R	The same as left	〃	The same as Watanabe's	〃	〃	〃
11	24	Fri.	Collection of data and other materials	〃	〃	〃	〃	〃	〃
12	25	Sat.	Classification of data and other materials	〃	〃	〃	〃	Classification of data and other materials	〃
13	26	Sun.	Bogota →Manizales	〃	Classification of data and other materials	〃	〃	The same as Watanabe's	〃
14	27	Mon.	Field reconnaissance	〃	Field investigation	〃	〃	Field investigation	〃
15	28	Tue.	Consultation at regional INDERENA office, Manizales Bogota	Consultation at regional INDERENA office and field investigation	〃	The same as Koike's	〃	〃	〃
16	3/1	Wed.	Classification of data and other materials	Field investigation	〃	〃	〃	〃	〃

Table 3 (continued)

Study team			Forest management plan						
No. of days	Day of month	Day of week	Watanabe	Koike	(Shinich) Hayashi	Masui	Ichikawa	Kobayashi	Sekine
17	2	Thur.	Report at INDERENA, DNP, JICA prior to return home						
18	3	Fri.	Bogota →Washington						
19	4	Sat.	Washington	Consultation at regional INDERENA office	The same as left	The same as left	The same as left	The same as left	The same as left
20	5	Sun.	Tokyo	Mnizales →Pensilvania	〃	〃	〃	〃	〃
21	6	Mon.		Field investigation	〃	〃	〃	〃	〃
22	7	Tue.		〃	〃	〃	〃	〃	〃
23	8	Wed.		Field investigation (Pensilvania ↓ Manzanares)	〃	〃	〃	〃	〃
24	9	Thur.		(Manzanares ↓ Manizales)	〃	〃	〃	〃	〃
25	10	Fri.		Collection of data and other materials	Field investigation	The same as Koike's	〃	The same as Hayashi's	〃
26	11	Sat.		Classification of data and other materials	The same as left	〃	〃	〃	〃
27	12	Sun.		〃	〃	〃	〃	〃	〃
28	13	Mon.		Collection of data and other materials	Field investigation	〃	〃	〃	〃
29	14	Tue.		〃	Classification of data and other materials	〃	〃	〃	〃
30	15	Wed.		Report at regional INDERENA office Manizales Bogota	The same as left	The same as left	〃	The same as left	
31	16	Thur.		Consultation at INDERENA and report at JICA	The same as left	The same as left	The same as left	The same as left	The same as left
32	17	Fri.		Collection of data and other materials	〃	〃	〃	〃	〃
33	18	Sat.		Classification of data and other meterials	〃	〃	〃	〃	〃
34	19	Sun.		〃	〃	〃	〃	〃	〃

Table 3 (continued)

Study team			Forest management plan						
No. of days	Day of month	Day pf week	Watanabe	Koike	(Shinichi) Hayashi	Masui	Ichikawa	Kobayashi	Sekine
35	20	Mon.		Preparation of field report	The same as left	The same as left	The same as left	The same as left	The same as left
36	21	Tue.		〃	〃	〃	〃	〃	〃
37	22	Wed.		Report at INDERENA, MNP, Japanese Embassy, and JICA prior to return home	〃	〃	〃	〃	〃
38	23	Thur.		Bogota	〃	〃	〃	〃	〃
39	24	Fri.		↓	〃	〃	〃	〃	〃
40	25	Sat.		Tokyo	〃	〃	〃	〃	〃

Table 3 (continued)

Study team			Remote sensing analysis		Aerial photography	Control point survey			
No. of days	Day of month	Day of week	Nakajima	Kageyama	(Yoshiro) Hayashi	Takagi	Saito	Sueto	Harada
1	2/14	Tue.	Tokyo → Los Angeles	The same as left	The same as left	The same as left	The same as left	The same as left	The same as left
2	15	Wed.	→ Bogota	〃	〃	〃	〃	〃	〃
3	16	Thur.	Courtesy call at JICA, INDERENA and Japanese Embassy	〃	〃	〃	〃	〃	〃
4	17	Fri.	Courtesy call at DNP and IGAC and consultation at INDERENA	〃	〃	〃	〃	〃	〃
5	18	Sat.	Interal consultation, collection of data and other materials, survey preparation	〃	〃	〃	〃	〃	〃
6	19	Sun.	〃	〃	Bogota → Manizales	〃	〃	〃	〃
7	20	Mon.	Coordination of schedule with INDERENA	〃	Receipt of aerial photography cost estimate	Courtesy call at regional INDERENA office, survey preparation	〃	〃	〃
8	21	Tue.	Coolection of data and other materials	〃	Collection of data and other materials	Consultation with INDERENA, survey preparation	〃	〃	〃
9	22	Wed.	〃	〃	Preparation to sign contract for aerial photography	Selection of control points	〃	〃	〃
10	23	Thur.	〃	〃	〃	〃 (Manizales ↓ Salamina)	〃	〃	〃
11	24	Fri.	Bogota → Manizales Conclusion of aerial photography agreement	〃	Field investigation	〃	〃	〃	〃
12	25	Sat.	Field investigation	〃	Survey preparation	〃	〃	〃	〃
13	26	Sun.	〃	〃	Bogota → Manizales	Salamina → Manizales	〃	〃	〃
14	27	Mon.	Aerial photography on standby	〃	〃	Survey preparation	〃	〃	〃

Table 3 (continued)

Study team			Remote sensing analysis		Aerial photography	Control point survey			
No. of days	Day of month	Day of week	Nakajima	Kageyama	(Yoshiro) Hayashi	Takagi	Saito	Sueto	Harada
15	28	Tue.	〃	〃	〃	Selection of control points (Manizales ↓ Pensil-vania)	〃	〃	〃
16	3/1	Wed.	〃	〃	〃	〃 (Pensil-vania ↓ Manizales)	〃	〃	〃
17	3/2	Thur.	〃	〃	〃	GPS observation test	〃	〃	〃
18	3	Fri.	〃	〃	〃	GPS observation test	〃	〃	〃
19	4	Sat.	〃	〃	〃	〃	〃	〃	〃
20	5	Sun.	〃	〃	〃	Classification of data and other materials	〃	〃	〃
21	6	Mon.	〃	〃	〃	Manizales → Salamina	〃	Manizales → Salamina	〃
22	7	Tue.	〃	〃	〃	GPS observation (Salamina ↓ Aguadas)	〃 (Salamina ↓ Aguadas)	〃	〃
23	8	Wed.	〃	〃	〃	〃	〃	〃	〃
24	9	Thur.	〃	〃	〃	〃	〃	〃	〃
25	10	Fri.	〃	〃	〃	Aguadas → Manizales	〃	Salamina → Manizales	〃
26	11	Sat.	〃	〃	〃	Observation data calculation, observation preparation		The same as left	
27	12	Sun.	〃	〃	〃	Manizales → Presno	〃	〃	〃
28	13	Mon.	〃	〃	〃	GPS observation (Presno ↓ Pensil-vania)	〃	〃	〃
29	14	Tue.	〃	〃	〃	〃	〃	〃	〃
30	15	Wed.	Report at regional INDERENA office	〃	The same as left	Pensilvania → Manizales	〃	〃	〃
31	16	Thur.	Collection of data and other materials	The same as left	Consultation With JICA	Leveling	The same as left	The same as left	〃

Table 3 (continued)

Study team			Remote sensing analysis		Aerial photography	Control point survey			
No. of days	Day of month	Day of week	Nakajima	Kageyama	(Yoshiro) Hayashi	Takagi	Saito	Sueto	Harada
32	17	Fri.	Collection of data and other materials	The same as left	Colection and preparation of data and other materials	Leveling (Manizales ↓ Salamina)	The same as left	The same as left	〃
33	18	Sat.	〃	〃	〃	〃 (Salamina ↓ Manizales)	〃	Leveling (Manizales ↓ Salamina)	〃
34	19	Sun.	〃	〃	〃	Aguadas → Manizales	〃	〃 (Salamina ↓ Manizales)	〃
35	20	Mon.	Preparation of field report	〃	〃	Manizales → Bogota	〃	The same as left	〃
35	21	Tue.	〃	Collection of data and other materials	〃	Consultation at INDERENA, collection of data and other materials at IGAC	Classification of GPS observation data and sketch map	〃	〃
37	22	Wed.	Report to INDERENA, DNP, Japanese Embassy, and JICA before return home	The same as left	〃	GPS observation data analysis adn calculation	〃	〃	〃
38	23	Thur.	Bogota ↓	〃	Preparation of field report	〃	〃	〃	〃
39	24	Fri.		〃	〃	〃	〃	〃	〃
40	25	Sat.	Tokyo	〃	〃	〃	〃	〃	〃
41	26	Sun.			Classification of field report	Classification of data and other materials	The same as left	〃	〃
42	27	Mon.			Report to INDERENA, Japanise Embassy, and JICA before return home	The same as left	〃	〃	〃
43	28	Tue.			Bogota ↓	〃	〃	〃	〃
44	29	Wed.				〃	〃	〃	〃
45	30	Thur.			Tokyo	〃	〃	〃	〃

I－8 People Concerned in Colombia

(1) Japanese Side

① Japanese Embassy in the Republic of Colombia

Name	Title
Rikio Shikama	Ambassador Extraordinary and Plenipotentiary
Hitoshi Miyamoto	First Secretary
Tadashi Iijima	First Secretary
Yoshitaka Nagashima	Second Secretary

② Office of Japan International Cooperation Agency in Colombia

Name	Title
Nobutetsu Enoshita	Director
Takashi Ito	Vice Councilor

(2) Colombian Side

① Departamento Nacional de Plaeación

Name	Title
DRA.MARTHA CECILIA BERNAL DE ARRIETA	Director, Division of International Technical Cooperation
DR.GUILLERMO AUGUSTO CORREA CASTAÑEDA	Division of International Technical Cooperation

② Baco de La República

Name	Title
DR.FERNAN MACIA SANABRIA	Chief Administrafor of Agriculture and Livestock Credit

③ INDERENA

Name	Title
DR.GERMAN GARCIA DURAN	Director General
DR.POMPILIO ANDRADE BONILLA	Director of Forest and Water Administration Bureau
ING.ERNESTO JIMENEZ LOPEZ	Assistant Director of Forest and Water Administration Bureau
ING.JOSE MIGUEL OROZCO MUÑOZ	Director of Forestry Administration Division
ING.ALEJANDRO COPETE PERDOMO	Director of Natural Forest Department
ING.DAVID YANINE DIAZ	Director of Man-made Forest Department
ING.EDGAR OTAVO RODRIGUEZ	Director of Mapping Department
ING.FRANCISCO POSADA ARREDONDO	Technician of Forest Administration Division
ING.LOMBARDO TIBAQUIRA C.	Technician of Forest Administration Division
ING.EDEAR FERNANDO CORTES SAENS	Technician of Forest Administration Division
DR.ALBERTO RUIZ GARCIA	Director of Local Affairs Bureau, Caldas Province
ING.GUSTAVO VALENCIA ROJAS	Director of Forest Project, Local Affairs Bureau, Caldas Province
ING.JOAQUIN MORA PERALTA	Technician of Reforestation Project, Cundinamarca Province

④ Estación Forestal la Florida, INDERENA

Name	Title
DR.NESTOR M. MEJIA PIZARRO	Director of Forest Protection, Estacion Forestal la Florida

⑤ Corporación Nacional de Investigación y Fomento Forestal

Name	Title
DR.LUIZ FERNANDO JARA N.	Director of Technical Affairs

⑥ Empresas Públicas de Manizales

Name	Title
ING.EDUARDO LONDOÑO PULGARIN	Director of Water Supply and Drainage

⑦ Pensilvania Municipality

Name	Title
DR.JAIME ALONZO ZULUAGA A.	Mayor

⑧ Pro-Oriente S.A.

Name	Title
DR.UBALDO FRANCO ARISTIZABAL	President
DR.AURELIO A. RAMIREZ R.	Director of Administration

⑨ Maderas de Oriente S.A.

Name	Title
DR.RAMIRO ESCOBAR A.	President
ING.HELI RIVERA CASTILLO	Forest engineer

Ⅱ Results of the Study

Ⅱ-1 Preparatory Work in Japan

(1) Classification of Existing Data and Materials

We classified and analyzed those existing data and materials which had been collected in Japan and in the field in connection with the survey and strived to piece together an accurate picture of the forestry situation in Colombia. Given below are the data and materials collected and classified:

National Administration

- National Development Projects of the Republic of Colombia(translated by JICA)

  Japanese translation of the 1983-1986 National Development Project of the Republic of Colombia
- Mapa Politico Administrativo(IGAC) (Map of Political Administration)

Socio-Economy

- The present state of the Colombian economy and society

  (Association for Promotion of International Cooperation)

  Data and statistical materials on the general conditions of Colombia

Forests

- Bosque de Colombia(IGAC) (The state of forests in Colombia)
- Mapa de Bosques: A 1:1,500,000 chart of forest distribution in Colombia

Forest Administration

- Código Nacional de Recursos Naturales Renovables y de Protectión al Medio Ambiente (National Rules on Renewable Natural Resources and the Protection of the Physical Environment)
- Reglamentación en Materia de Aprovechamientos Forestales (Rules on Forest Use)

Geography

- Atlas de Caldas (Atlas of the natural environment, agriculture and socio-economic situation in Caldus Province)

(2) Formulation of the Study Plan

In order to achieve the aims of the survey and carry out a field investigation without a hitch, we formulated a master plan for the three-month survey on the basis of the results obtained in the analysis of the data described above.

Given below are main items of the plan:

a. Aims, contents and method of the survey, etc.

b. Preparation of survey schedules by fiscal year and operation.

The results are summed up in the aims and contents of the survey as described in section I −4,5.

(3) Preparation of Inception Report

An inception report was prepared for consultation with the INDERENA side in connection with the execution of the survey. Main items of the inception report are given below:

a. Objectives of the survey, the areas to be surveyed, and the basic policy line of the survey

b. Items, contents and execution method of the survey by year

c. Work process

d. Personnel plan

e. Method of technology transfer

f. Scope of work on the part of INDERENA and matters where to ask for facility

g. List of necessary data and materials

(4) Comparison of the Study Plan and Its Prosecution

As stated in the contents of the survey in I −5, the items of the field investigation carried out this time are analysis of remote sensing data, taking of aerial photographs, control point survey, and preliminary survey for forest management plans. Most of them were executed as scheduled except for aerial photography. However, as described later, clouds constantly interfered with the taking of aerial photographs because of the mountainous topography of the area,

until the photography operations failed to be completed by the end of the field survey. Aerial photographs are still being taken.

Ⅱ-2 Analysis of Remote Sensing Data

(1) Outline of the Study

This study involved the following operations designed to gain basic data and information needed for the drafting of a forest management plan and to efficiently draw up its guideline and a model plan:

-To get a precise picture of vegetation, land use and the physical environment in the Study Area (1,600,000 ha);

-To collect basic data and information wherewith to draw up a classification map on land use;

-To collect data and information wherewith to pinpoint temporal changes in vegetation and land use.

We brought to the Colombia false color images of four Landsat scenes covering the study area and images with primary classifiction of ground cover and verified them in the field so as to do the following assignments:

-To examine tone expressions on the false color images and the interpretation of the images;

-To establish training areas as datums for the interpretation of images to make a secondary classification of the ground cover.

-To get a precise picture of the status of land use and the physical environment to help classify and analyze land use.

-To investigate and confirm those points on the ground which were left unclarified because of the clouds.

(2) Survey for Establishment of Criteria for Image Interpretation

① Establishment of Training Area

a. Each training area was marked off where it can be clearly located on the map and where a good view of the surrounding areas can be commanded.

b. Each training area had a representative ground cover of not less than 5 ha around each observation point.

c. Six-point requirements were set to demarcate a training area: a grassland, a natural forest, a man-made forest, a pasture,a farm

forest and farmland.

d. Each training area was assigned a serial number and marked out on the map. A total of 37 training areas were established with 60 items of land use clarified.

② Survey of Training Areas

To begin with, a geographical identification of each training area thus marked off was made, including its location and altitude. Then, the vegetation, forests and land use in the surrounding area were surveyed and recorded, with necessary photograps taken.

③ Study of Identification Data

In proceeding with the work of making a secondary classification of ground cover, we set forth interpretation items, such as rocky area, barren (denuded) land, cities and villages and streams, besides the items required of a training area. No particular training area was marked out for them, whose location was confirmed on synthesized images and the map and whose photographs were taken to be used as interpretation data.

④ Others

The initial plan called for the establishment of 60 training areas within the study area in accordance with a formula of four scenes x five items x three places. However, the number was changed by giving up the originally set line of selection by area classification in favor of selection mainly by means of identification items. One of the reasons for the switch was that it was not possible for the study team to enter and survey the mountain areas in Cauca Province and east of Cali City, both situated in the south of the country. Another was that it was found necessary to prepare six interpretation items instead of the originally set five in light of the status of the natural environment and land exploitation.

In consequence, stress was laid on the Intensive Area supposed to be the site for the project. Thirty-one observation points were selected

within the area and another 29 points in other areas, which was more than enough as the number of observation points by item necessary for interpretation work.

(3) Survey for Classification of Ground Cover

On each observation point the false color images and the images of primary land use classification were checked against the actual status of local land use, vegetation and woodland. While flying over the areas between the observation points the survey team observed the surrounding areas and monitored the basic conditions of ground cover classification and the environmental situation.

The survey discovered that the state of ground cover and land use in the study area has very much to do with its altitude in question among others.

In other words, most of the farmlands were located on level country from 1,000 to 1,200 meters in altitude, mainly cropped with sugar canes, with rice paddyfields found in the south. There were farm forests on the hillside slopes between 1,200 and 2,000 meters above sea level. Non-shade trees, bamboos and bananas were growing together and much of the land cultivated with sugar canes and coffee plants.

Man-made forests cover the mountain area from 1,500 to 2,800 meters in altitude, with natural forests found only in valleys in the lowland and on the top of the mountains, most found on the highland 2,500 meters or above in altitude.

Pastureland extend from 1,000 to 3,600 meters in altitude, with grassland sprawling over the natural tableland at an altitude of 3,000 meters or more.

To know the altitude and topography of the area concerned from such conditions and check them against the false color images makes it possible to estimate the state of land use, vegetation type, main crops and other features of the area.

(4) Others

To look at tone expressions on false color images, both a high forest and a man-made forest are indicated in deep red and therefore can be discriminated from pastureland. But, there is so close a similarity between a farm forest and a second growth-like forest where shrubs are also found that it is impossible to distinguish one from the other. It is is assumed, however, that there is little need to identify and extract the latter, which accounts for a fragment of the study area.

A hillside collapse over an area of approximately three ha can be identified, but in a secondary classification of the ground cover it needs to be scrutinized in a process using a wavelength zone because its tone resembles that of a city or a village.

On the other hand, many "slash-burn" prepared plots (maize and soybeans) are found amidst lowland fields under cultivation. Most of them are square-shaped that they are quite unlikely to be mistaken for swamps simply because of their resemblance in tone.

Next, in primary ground cover classification images, natural forests, man-made forests and farm forests are lumped together, and no clear difference noticed between farmland and pastureland, and all their shadows caused by the land's direction were left out. We had difficulties in checking them in the field.

II-3 Aerial Photography and Mapping

(1) Aerial Photography

① Contract on Commissioning Aerial Photography

a. Selection of Aerial Photography Firm

There are three major bodies specialized in taking aerial photographs in Colombia: one is government-affiliated IGAC (Geographical Survey Institute) and two private firms, FAL and SADEC.

Several rounds of negotiations were held with the three to choose one. The two private firms were invited to submit their estimates, on the grounds that IGAC has too many projects to contract the business.
(February 16, 1989) Name of the Firms Requested to Prepare Estimates:

Fotogrametria Analitica LTDA (FAL)

Servicio Aeroftogramentrico de Colombia (SADEC)

b. Conclusion of Contract

The estimates, which were submitted on February 20 by FAL and SADEC, were compared. SADEC was found qualified in terms of equipment and instruments, including aircraft and cameras, and past performance.
An agreement was signed with the firm on February 24, commissioning it to take aerial photographs.

② Aerial Photography

a. Arrangement in the field

Immediately after the conclusion of the contract, SADEC began preparing for the aerial photography work. After obtaining a flight permit from its competent authorities, IGAC, SADEC moved its aircraft, cameras and crew to Manizales Airport and had them standing by for a photography mission.

Table 4 Conditions of Aerial Photography Mission

Area to be photographed	2,000 km^2 (200,000 ha)
Photographic scale	1 : 20,000
Number of flight courses	17 Courses
Number of aerial photographs to be taken	About 450 photographs
Aircraft: Cessna TU-260HK 1445E	CESSNA TU-260HK 1445E (Climbable altitude: 8,000 m)
Camera	Wild RC-8 (Lens Aviogon f:150 mm).

Fig. 4 indicates flight courses.

b. Local Weather Conditions

Initial weather information indicated that normally the site to be photographed would remain affected by the dry season for a period up till early March. Therefore, if the weather conditions were as usual, naturally it was predicted that it would be possible to go on a photograph-taking flight on or after February 26. However, as it happened that somewhat abnormal weather visited Colombia, too, this year, the local weather conditions were very nasty one day after another, making it impossible to take photographs during the perid.

Moreover, there were many regular services by small aircraft from Manizales Airport, our standby base, to other cities of the country, including daily eight flights to the capital of Bogota and an unspecified number of flights to Medellin and Cali. Observations by those aircraft of the weather conditions over the site were constantly accessed as necessary information, but unfortunately the weather conditions remained too foul to permit photographing.

③ Future Response

HIMAT, the Meteorological Agency of Colombia, sums up weather data for Caldus Province for the past several years: Best time for photography (dry season) December-February Second best time for photography (minor dry

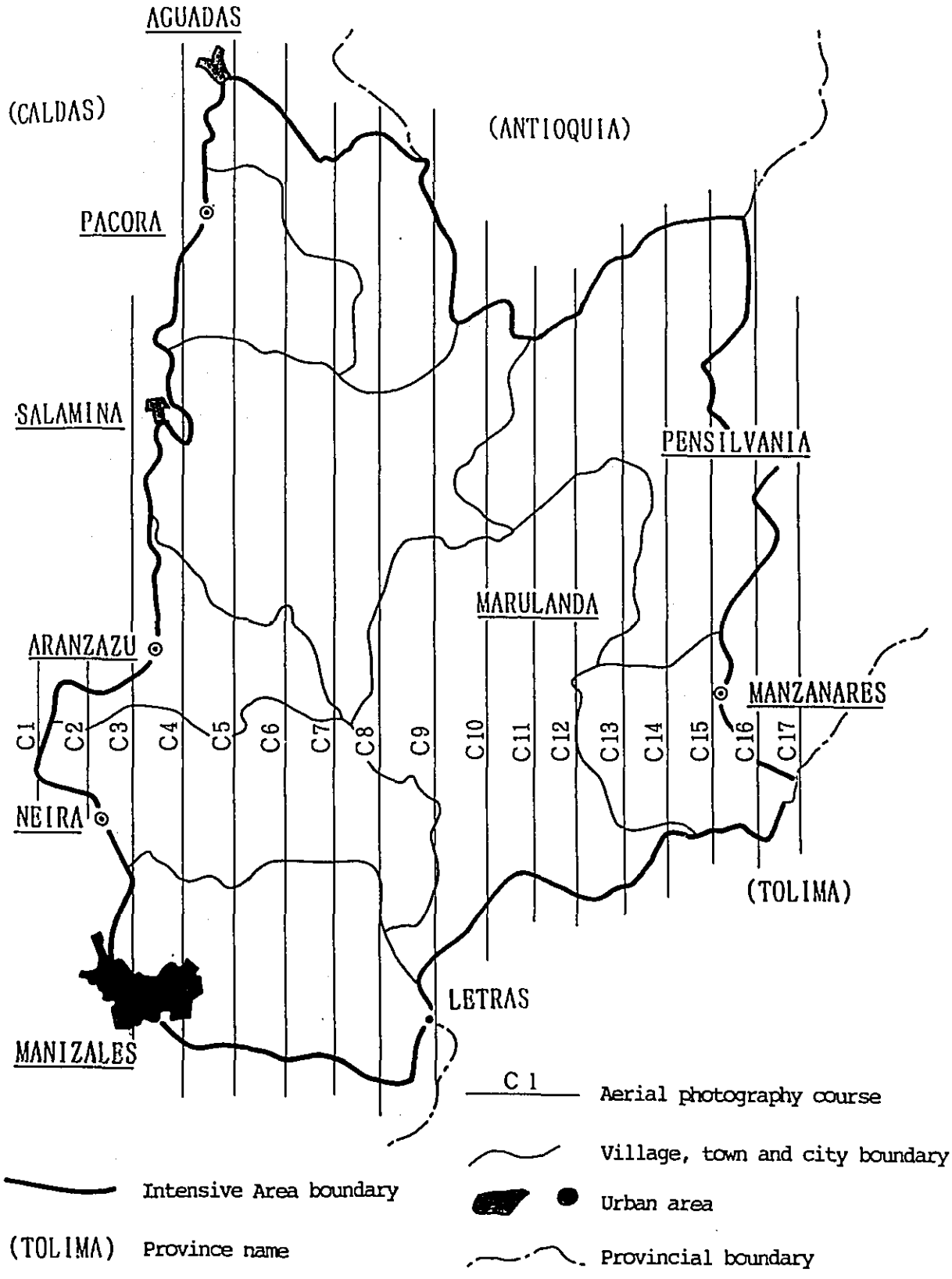


Fig. 4 Aerial Photography Plan Map

season) June-July

Since the weather forecast predicts an earlier-than-usual rainy season for 1989, the efforts are being made to complete the operations of taking aerial photographs as early as possible, while getting a precise estimte of when the next time for photographing will come.

(2) Control Point Survey

① Outline of Control Point Survey

Aerophotographic surveying is used to prepare a topographical map of the Intensive Area. It is more efficient to utilize ten national control points (points of known coordinates and altitude) in the Intensive Area as standard points for aerial triangulation survey necessary for the operation.

However, most of the datum points are located in the mountain areas 3,000 meters or more above seal level, making it difficult to reach the spots for field survey or to stick needles into the photographs.

Considering these circumstances, three of the national datum points where the operation were judged possible were chosen as standard points and additional 14 points which were needed to keep the survey accurate were newly set up by observing the satellites (GPS: global positioning system).

② Results of Control Point Survey

a. Selection of Points for GPS

Observation points were chosen on the spot in accordance with the premeditated plan. Normally GPS observation requires that the sky field of view should be open at 15 degrees or more on the horizon. In order to get an effective field of sight, we had to make some on-the-spot change in the position of a number of observation points.

b. GPS Observation

This time we used three sets of Trimble-made GPS 4,000 SL surveyors to make the observations by the relative positionining method which involved simultaneous observation of three points, one an already known point and

the two newly-set points.

Though we were informed that one o'clock to three o'clock at midnight are the best hours on the spot to observe as many satellites as possible, we were afraid that the operations would be difficult for security reasons. Since it was predicted that the second best observation hours were from eight o'clock to ten o'clock in the morning, we made the observations mostly in this time zone.

c. Analysis of Observation Data

We brought the derived data to the spot every day and checked the closing difference among the above named three points with a laptop computer to see whether the observation data were correct or not. The accuracy of the closing difference among the three points were sufficient to pass first grade in the JICA work standards.

d. Results of Analysis Made in Japan

The GPS data obtained in the field observations were brought to Japan, where they were converted into the geodesic network of Colombia to compute the longitude, latitude and UTM coordinates of the surveyed area. The results are tabulated on Table 6 "Table of Results of the Control Point Survey." The position of each control point is given on Fig. 5 "Position of Control Points."

Table 5 Geodesic Standards of Colombia

Origin: Latitude	4° 35′ 56″ 570 N
Longitude	74° 04′ 51″ 370 E
Ellipsoid: Long radius	a = 6,378,388m000
Short radius	b = 6,356,911m940
Original scale	1 : 1,000,000

e. Others

Sketches were drawn up, showing the position of all the control points observed this time, and they were classified as necessary data for future use with needles stuck onto the existing aerial photographs.

(3) Leveling

① Establishment of Bench Marks

As for bench marks necessary for leveling, the data collected showed that there were national bench marks at the average interval of two km along about 70 km of a national highway between Manizales and Fresno and along about 100 km of a national highway between Manizales and Aguadas. We made an investigation to use them and found that many, set up in the 1950s, had been lost in landslides or road improvement works. Only 25 bench marks were identified and indicated with needles sticked on the map.

② Results of Leveling

Altitudes calculated in GPS observations were distances from the geocenter of a satellite ellipsoid WGS-84 and therefore different from those obtained in field surveying with sepoid plane as the standard.
In order to modify these differences and obtain precise figures to coincide with the actual altitudes in Colombia, leveling was conducted between the GPS observation points in Padua, Letras, Manizales and Salamina and the existing national bench marks.

③ Results of Analysis in Japan

GPS observation data were brought to Japan for analysis. It was found that the difference between WGS-84 altitude and the Colombian datum level was -31.24 in Manizales in the southwest, -30.56 in Padua in the southeast, and -29.77 in Aguadas.

Altitudes on GPS points were modified from these three points and the altitude of the Colombian datum level computed.

Table 6 Results of Control Point Survey in Forest Resources Management Study in Colombia

Name of Point	Latitude	Longitude	Coordinate		Altitude
			X	Y	
1 Δ 1100	5° 4' 15.30800"	-75° 30' 52.08000"	1052357.001	841015.669	2143.72
2 101	5° 1' 54.65446"	-75° 28' 22.52185"	1048025.122	845614.662	2081.27
3 102	5° 2' 46.34443"	-75° 20' 11.54153"	1049582.638	860746.334	3680.79
4 103	5° 6' 6.27272"	-75° 14' 21.85831"	1055705.279	871531.418	2574.07
5 104	5° 8' 50.36005"	-75° 7' 1.63844"	1060723.410	885101.510	1996.59
6 105	5° 21' 48.40578"	-75° 7' 7.13330"	1084627.582	884971.904	1932.62
7 108	5° 24' 29.35792"	-75° 29' 29.96650"	1089655.822	843629.685	1789.84
8 109	5° 35' 0.13353"	-75° 21' 47.43339"	1109005.387	857914.930	2526.59
9 111	5° 22' 46.68560"	-75° 22' 30.07144"	1086472.350	856553.676	2835.03
10 112	5° 17' 12.78019"	-75° 15' 49.77712"	1076188.265	868861.099	2855.30
11 Δ 113	5° 37' 10.20221"	-75° 28' 4.31779"	1113028.340	846321.680	2268.68
12 Δ 115	5° 10' 31.85551"	-75° 2' 28.90936"	1063828.439	893507.376	1800.17
13 117	5° 25' 11.07680"	-75° 7' 52.64347"	1090856.682	883581.197	2627.44
14 118	5° 10' 19.57699"	-75° 31' 11.25471"	1063551.378	840449.943	1929.96
15 1110	5° 11' 46.09171"	-75° 26' 41.46479"	1066191.347	848767.177	2355.87

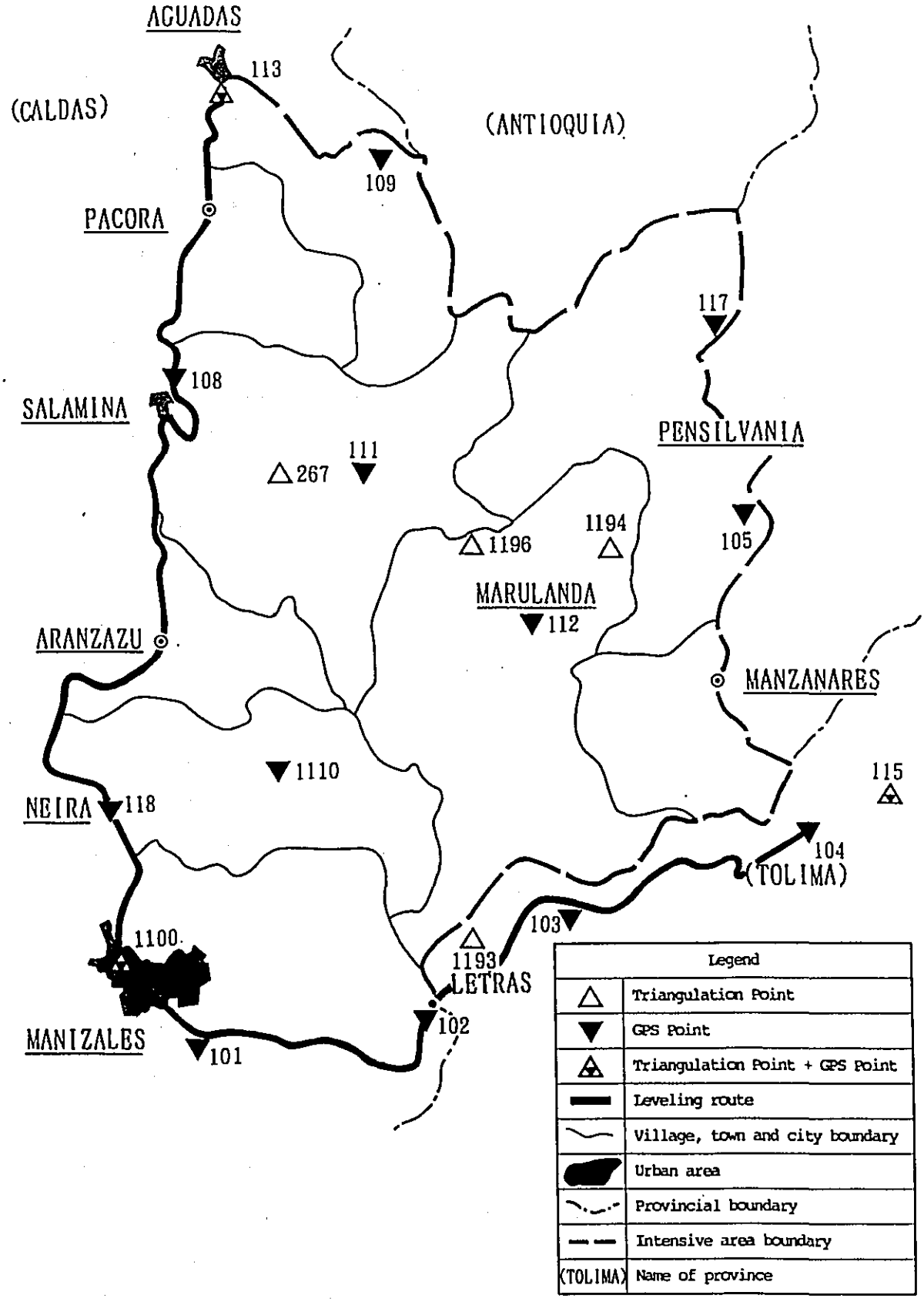


Fig. 5 Map Showing the Location of Control Points

(4) Detailed Field Survey

A further survey was conducted to identify the topographical and land features necessary for the production of a forest base map. Consequently, the following items were confirmed for reference in future mapping operations:

① Topography: The terrain is generally complicated within the Intensive Area, with many steep slopes. However, we must watch out for a possible use of too many topographical signs of land collapses which is likely to leave the contour lines obscure.

② Vegetation: Relatively clear boundaries can be noted between forests and pastures on the areas over 2,000 meters in altitude and it can be thought easy to identify and indicate vegetation belts.

However, in the areas under 2,000 meters in altitude and in particular in Neira, Salamina and Aguadas regions, many of banana fields cultivated side by side with coffee plantations are difficult to identify as such, which requires much care in mapping operations.

③ Roads: Generally there are few narrow paths, such as footpaths, and roads laid through the mountainous areas are as wide as 3 meters, which look open to vehicular traffic on aerial photographs. However, as it is, a great majority are for horses, donkeys and cows. In making a map it is necessary to use a different road sign from that for a roadway.

④ Rivers: As stated in the topography section, there are intricate crossings of V-shaped valleys, with cities, towns, villages and roads situated along the ridges or on the mountain sides. This is why there are few river structures like an embankment along the main river systems.

⑤ Cities, Towns and Villages: Every urban area is found developed with the church as the center. Most of the structures facing the highways are of the continuous type. Therefore it is impossible to depict them as independent buildings on a map to be drafted. The structures along the roads ought to be described as cluster buildings.

II-4 Forest Management Plan Study

(1) Collection of Study Materials

Study materials were collected in various ways, including interviews at the agencies concerned which were organized in accordance with the prearranged study plan. Table 7 is a list of the organizations visited for interviews and those data and other materials collected thus are listed at the end of this report.

(2) Results of Intensive Area Survey

① Results of Field Survey

An Intensive Area survey was conducted with reference to the existing topographic maps and aerial photographs of Colombia and a general picture was obtained of its land use, vegetation, soil, terrain, geology and denuded land. The fidnigns are given below:

When drawing the following figures and tables the sources mentioned below were consulted:

※ Atlas de Caldas (Ministerio de Agricultura Gobernación de Caldas 1987)

※※ Caltas estadistíca de Caldas 1987

※※※ Mapa de Bosque 1983 IGAC

a. Outlook of the Intensive Area

(a) Administrative Division

The Intensive Area belongs in Caldas Province, Colombia and comprises nine cities as Fig. 6 shows.

① Manzanares ② Neira ③ Aranzazu ④ Salamina ⑤ Pacora

⑥ Aguadas ⑦ Marulanda ⑧ Manzanares ⑨ Pensilvania

(b) Location

The Intensive Area is located in the Central Mountain Range areas of Colombia and extends from long. 75° 05′ 27″ to 75° 33′ 20″ W. and from lat. 5° 00′ 45″ to 5° 36′ 37″ N.

(c) Area

The Intensive Area runs about 49 km east and west and about 65 km

Table 7 List of Organizations Visited for Investigation

Place	Date	Interviewee	Interviewer	Questions put
ACOFORE (Asociación) Colombiana de reforestadores	2/21	Alvaro Jose Puerla C. (Gerente)	Watanabe Masui	Contents of Acofore Status of forests in Colombia Status of reforestation Present state of forest diminution Tasks of forestry
Banco de la República	2/22	Fernan Macia Sanbria (Jefe Administrativo Crédito Agropecucario)	Masui	Status and background of reforestation financing Reforestation policy
Estación la Florida (INDERENA)	2/22	Nector M. Mejia P;Zamo (Jefe Div. Fomento Forestal)	Masui	Status of reforestation Felling 〃 Kinds of trees to be planted State of experiments with kinds of trees to be planted Supply of seeds Preservation of seeds Forest protection
CONIF (Corporación Nacional de Investigación y Fomento Forestal)	2/23	Luis Fernando Jara N. (Director Técnico)	Masui	Contents of CONIF State of forestry experiments in Caldus Province Data search by means of a computer
DNP	2/24	Guillermo Augusto Correa Caistañeda	Watanabe Masui Kobayashi	Contents of forestry assistance from foreign countries Outline of projects
Aceria Piamonte (Maderas de Oriente Lumber mill) (Pensilvania)	3/6	Workers	Koike Masui Ichikawa	Machines Timber volume Lumbering method Product specifications Employment
Muebles Pensilvania (Furniture-making woodworking plant)	3/7	Juaquin Pamprona Betancur (Owner)	Koike Masui Ichikawa	Scale Kinds of trees used Method of obtaining timber Sales method Status of forest industry in Pensilvania Education in forestry
Acerio Pro-Oriente (Lumber mill of Pro Oriente)	3/7	Field technician Aurelio A. Ramirez R. (Administador General)	Koike Masui Ichikawa	Scale Machines Procurement of timber, kinds of trees used, volume of logs Products, yield Demand Labor force Cost Timber standards Problems

Table 7 continued

Place	Date	Interviewee	Interviewer	Questions put
Pensilvania City Office	3／8	Jaime Alonzo Zulunga A. (Mayor and others)	Koike Masui Ichikawa Kobayashi Sekine Hayashi	Sketch of the city (area, population and industries) Local industrial structure Jobless rate Dependence on forestry Extent of contributions of Pro Oriente and Maderas Oriente to the city Headwaters forests of the city City's important task Status of various infrastructure
(Pro Oriente and Maderas de Oriente)	3／8	Aurelio A. Ramirez R. (Pro-Oriente) Heli Rivera Castillo (Maderas de Oriente)	Koike Masui Ichikawa Kobayashi Sekine Hayashi	Outline of Pro Oriente and Maderas de Oriente Procurement of seeds, seeds and seedlings, nursery State of land to be reforested Reforestation method Tending Forest roads Damage by blight and noxious insects Example of reforestation, successful and unsuccessful Predicted harvest for the cutting season Price of timber
La Gloria (INDERENA nursery)	3／10	Ing.Gustavo Valencia Rojas (Counterpart)	Koike Masui Ichikawa	Scale Kinds of trees produced and goals Nursing method, demand-supply relations
CENICAFE (Centro Nacional de Investigaciones de Café)	3／10	Alvaro Gomés Aristizábal 他	Koike Masui Ichikawa	Outline of this center History of coffee production in Colombia Relationships between coffee plantations and forests Non-shade trees in coffee plantations Soil conservation Erosion control
INDERENA At office of this mission Chief administrator of city headwaters forests	3／3	Dr. Eduardo 他	Koike Masui Ichikawa	Organization for water source forest management Status and future of city headwaters and demand History of reforestation in headwaters forests Status of pastures for use by employees Kinds of trees planted Reforestation method Preservation and management of reforested land Future use of trees planted
Campañia Forestal de Colombia S.A.	3／13	Ramiro Salazar B. (Gerente) Andres Rodrigues (Technicians)	Koike Masui Ichikawa	Outline of company Kinds of trees planted Status of livestock breeding Status of pastureland afforestation

Table 7 continued

Place	Date	Interviewee	Interviewer	Questions put
CRAMSA (Corporación Regional Autonoma Manizales Salamina Aranzazu)	3/14	Jaime Calderon G. (Gerente)	Koike Kobayashi	Objectives of this corporation Outline of its business line Future plan for business operations Cause of erosion in the area concerned Erosion control method
CHECH (Central Hidroeléctrica de Caldas) Electric power company	3/14	Alberto Naranjo A. (Director)	Koike Kobayashi	Powewr demand in the area Power supply in the area Status of hydro power generation Plan for hydro power generation Status of company-owned forests Management policy for company-owned forests
Federacion Nacional de Cafetero	3/17	Rodolfo Correa (Forestry chief)	Masui	Outline of the Coffee Association Relations between coffee plantations and forests Status of forests in Caldus Province Lumbering in Caldus Province Soil survey in Caldus Province Forest survey in Caldus Province Policy of encouraging reforestation
Maderas de Oriente S.A. Pro-Oriente S.A.	3/17	Ramiro Escobar A. (Gerente) Ubaldo Franco A. (Gerente)	Koike Kobayashi	Outline of the company Status of company-owned forests Policy of company-owned forests Contents of man-made forests

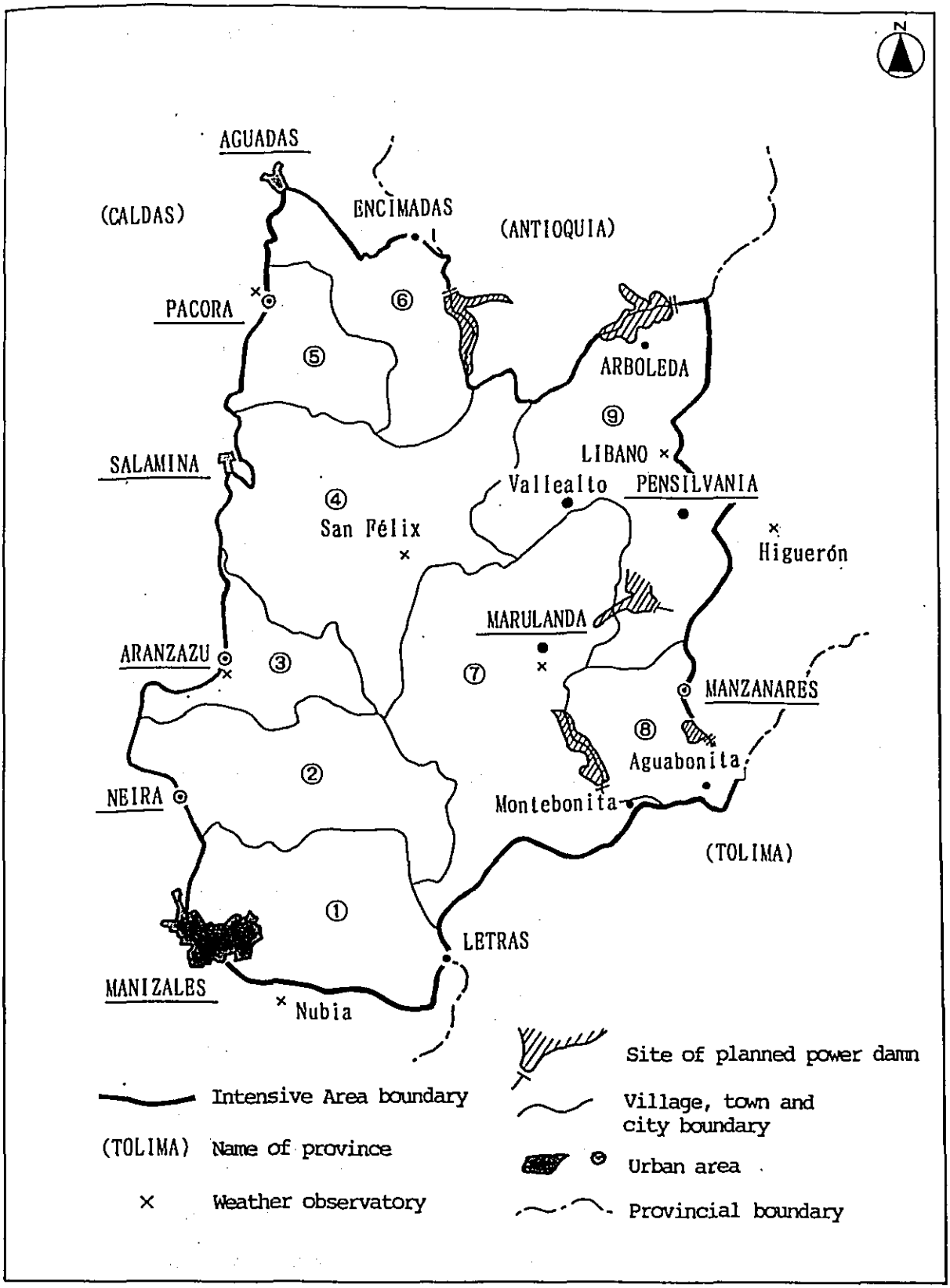


Fig. 6 Administrative Map of the Intensive Area

north and south, covering an area of about 240,000 ha. Given below is an estimated area by city:

Table 8 Estimated Area by City

Name of city	Area (1000ha)	Name of city	Area (1000ha)
Manizales	19.0	Aquadas	14.1
Neira	23.3	Marulanda	40.4
Aranzazu	12.9	Manzanares	10.9
Salamina	33.5	Pensilvania	39.9
Pacora	10.7	Total	204.7

(d) Altitude

The lowest altitude of the Intensive Area as shown in fig.7 is about 750 m in the La Samaná River basin located northeast of Pensilvania City. The highest altitude is about 3,850 m on the main ridge of the Central Mountain range situated on the border separating Neira City from Marulanda City.

The following table shows area ratio by altitude:

The simple average altitude is 2,780 m.

Table 9 Area Ratio by Altitude

Altitude range	Share	Altitude range	Share
0～ 500 m	—	1,000～1,500 m	32.2 %
500～1,000 m	1.2 %	1,500～2,000 m	18.5 %
1,000～1,500 m	2.3 %	2,000～2,500 m	7.0 %
1,500～2,000 m	12.3 %	4,000m over	—
2,000～2,500 m	26.5 %	Total	100 %

(e) Temperature

The temperature in the Intensive Area as indicated in table 11 is observed in two places, Nubia airfield in Manizales in the south and San

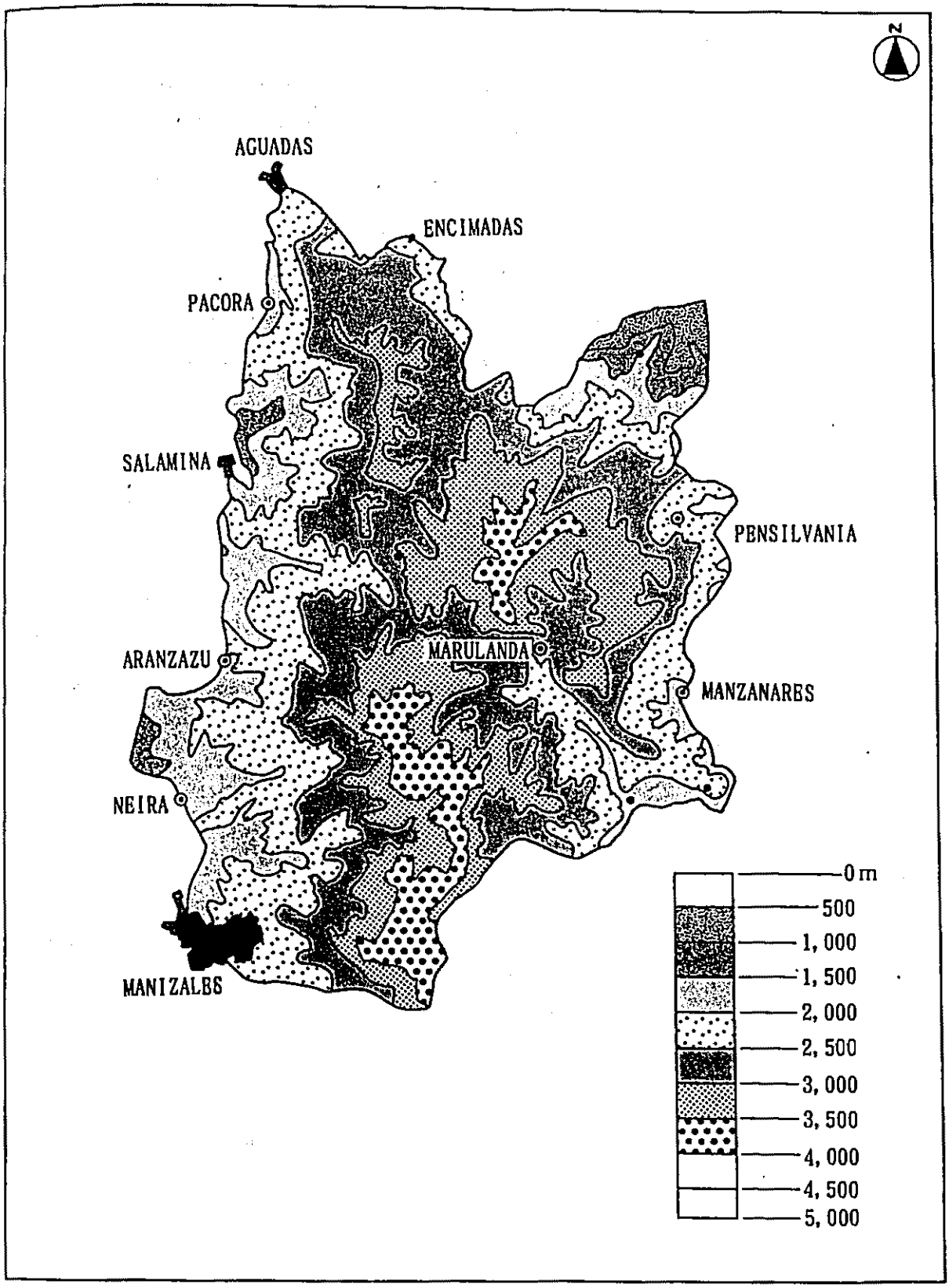


Fig. 7 Map Showing Classification of Zones by Altitude

Félix in Salamina in the center (Fig. 6).

As this area is situated in the tableland of the low latitude zone, generally there is a small change in temperature throughout the year, 16.4℃(8.6℃ - 25.0℃) in Nubia low in altitude and 21.1℃(-0.4℃- 20.7℃) in San Félix with a higher altitude.

To infer from these data and local interviews, the high temperature in the area is estimated never to exceed 30℃ and the low temperature to to hover around -3℃ - -5℃ in the central ridgeline. Therefore, some snowfall is observed in the highest area but no snow-covered zone is found.

The annual average temperature has to be used within the range of some fluctuation as illustated by Table 10, since there are two or more views of climatic zone division in this area.

Table 10 Table of Climatic Zone Divisions

Climatic zonezone	Height above sea level	Annual average temperature	Climatic features
Tropical zone	(a) 0 ~ 1,000m	24℃	Yearly rainfall 2,000~6,000mm
〃	(b) 0 ~ 1,100m	27℃	Dry season November-March (82.5% of national territory)
Temperate zone	(a) 1,000 ~ 2,000m	17.5℃	Yearly rainfall 1,000~3,000mm
〃	(b) 1,100 ~ 2,000m	18~21℃	Yearly rainfall 1,000~2,500mm (8.2% of national territory)
Frigid Zone	(a) 2,000 ~ 3,000m	12℃	Yearly rainfall 1,000~4,000mm
〃	(b) 2,100 ~ 4,600m	18℃ Below	Rainy season March-May, September-November (6.3% of national territory)
Frigidest zone	(a) 3,000 ~ 4,000m	7 ℃	Yearly rainfall 500~2,000mm
Snow-covered zone	(b) 4,600m Over	7 ℃ Around	(3.0% of national territory)
Snow-covered zone	(a) 4,000m Over	—	—

* One theory puts the height of the snow line at 4.700 m at lat. 10 degrees N. in Colombian Andes.
* Two major views, (a) and (b), are given here.

(f) Rainfall

It seems that HIMAT statistics as tabulated on Table 11 indicate the most reliable data on the rainfall within the Intensive Area. Findings of the field investigation based on such data suggest that the annual precipitation in this area is in the range from about 1,000 mm to 4,000 mm. Much of the distribution is on the eastern side of the Central Mountain Range and the western side registers a somewhat lower figure. The maximum daily rainfall is estimated to be in the range between 12.0 mm and 85.0 mm. In this distribution the eastern side of the Central Mountain Range gives a higher value than the western side. However, there is little difference noted between the eastern and western sides in terms of the yearly number of rainy days. Rainfall intensity is judged higher in the eastern side than in the western side.

Such rainfall information is incorporated into the plan for the construction of hydro power stations in the area. All the chosen sites of power-generating dams to be constructed in the Intensive Area are located on the eastern side of the Central Mountain Range.

Fig. 8 shows a diagram of monthly rainfall in the Intensive Area and Fig. 9,10 the climatic chart of Manizales and Salamina.

Table 11 Weather in the Intensive Area

Observatory (altitude)	Item		Month 1	2	3	4	5	6	7	8	9	10	11	12	Annual average	Remarks
Apto.,La Nubia Chinchina. Manizales (2,080m)	Temperature (℃)	Average	16.3	16.6	16.7	16.5	16.4	16.5	16.5	16.4	16.1	15.7	15.7	15.8	16.3	1969~1986
		High	24.9	25.0	25.0	24.5	24.2	23.9	24.3	24.5	24.5	24.2	24.0	23.9	24.4	
		Low	8.6	9.1	9.2	9.3	10.4	10.5	9.2	9.6	9.8	9.4	8.9	8.7	9.4	1970~1986
	Humidity (%)		81	80	82	85	85	84	81	82	84	86	86	84	83	1969~1986
	Rainfall (mm)		94.5	90.6	130.5	166.7	159.5	84.1	64.8	87.2	140.2	208.3	173.7	128.0	1,528.0	1968~1986
	Number of rainy days (day)		13	14	19	22	23	19	17	17	21	26	20	16	227	
	Maximum daily rainfall (mm)		24.5	22.9	27.5	34.1	30.2	22.2	19.3	21.8	29.8	36.7	40.0	36.5	28.8	
San Félix San Félix Salamina (2,821m)	Temperature (℃)	Average	10.5	10.9	11.4	11.3	11.4	11.4	11.3	11.1	11.0	10.9	10.8	10.6	11.1	1970~1986
		High	19.0	19.2	19.6	19.1	19.1	19.1	18.7	20.7	19.1	18.7	18.3	18.5	19.1	
		Low	0.4	0.4	2.1	2.9	3.4	2.9	1.7	1.8	2.0	2.2	2.7	0.7	1.9	
	Humidity (%)		87	86	87	88	88	85	81	81	85	88	89	88	86	
	Rainfall (mm)		89.9	90.2	136.3	195.0	179.1	85.6	62.6	95.1	135.3	219.7	198.1	114.4	1,601.8	
	Number of rainy days (day)		14	15	21	22	23	15	11	16	19	24	23	17	220	
	Maximum daily rainfall (mm)		22.1	21.6	25.4	32.9	29.9	21.9	16.0	21.5	24.8	35.2	28.3	23.7	25.3	
Sub Aranzazu Chamberi, Aranzazu (1,870m)	Rainfall (mm)		108.4	108.6	191.0	234.4	239.4	138.0	95.2	110.5	199.1	276.7	214.0	117.9	2,033.0	1977~1987
	Number of rainy days (day)		11	13	16	21	22	14	12	13	20	24	19	14	198	
	Maximum daily rainfall (mm)		29.9	28.2	40.6	39.1	39.9	38.1	29.0	26.8	32.3	41.1	46.3	24.9	34.7	
Pacora Plaza Feria Pacora, Pacora (1,890m)	Rainfall (mm)		137.5	154.3	231.9	326.2	345.3	223.5	172.1	243.1	300.1	357.5	284.6	174.3	2,950.2	1970~1987
	Number of rainy days (day)		12	14	18	20	23	19	15	18	22	24	22	15	223	
	Maximum daily rainfall (mm)		31.7	44.3	51.0	58.5	53.5	45.1	32.5	52.7	46.3	53.3	61.1	43.0	47.7	
Marulanda Guarino, Marulanda (2,825m)	Rainfall (mm)		56.8	85.2	121.5	223.5	270.2	144.4	147.6	155.7	246.8	232.3	149.8	82.5	1,916.2	1974~1987
	Number of rainy days (day)		9	12	16	21	22	14	14	13	18	21	18	12	190	
	Maximum daily rainfall (mm)		12.8	22.1	24.2	34.4	41.7	28.0	32.5	31.9	36.1	36.0	26.8	15.6	28.5	
Higueron Pensilvania, Pensilvania (1,610m)	Rainfall (mm)		151.9	227.1	347.5	408.7	474.9	193.9	172.4	227.2	327.9	497.1	391.1	254.0	3,673.3	1977~1986
	Number of rainy days (day)		9	12	15	18	20	11	10	9	15	19	17	13	168	
	Maximum daily rainfall (mm)		49.1	45.6	70.9	71.0	68.0	56.3	40.4	68.8	56.8	82.2	76.1	56.5	63.6	
Libano Q. Libano, Pensilvania (2,270m)	Rainfall (mm)		243.1	305.4	402.7	474.0	386.2	240.8	175.1	222.4	368.8	441.8	402.5	293.8	3,956.5	1973~1986
	Number of rainy days (day)		14	17	21	22	19	13	10	12	18	22	21	16	204	
	Maximum daily rainfall (mm)		52.3	56.4	59.7	64.2	58.5	55.8	40.8	52.2	61.6	57.2	64.8	55.7	56.6	

Source : H I M A T

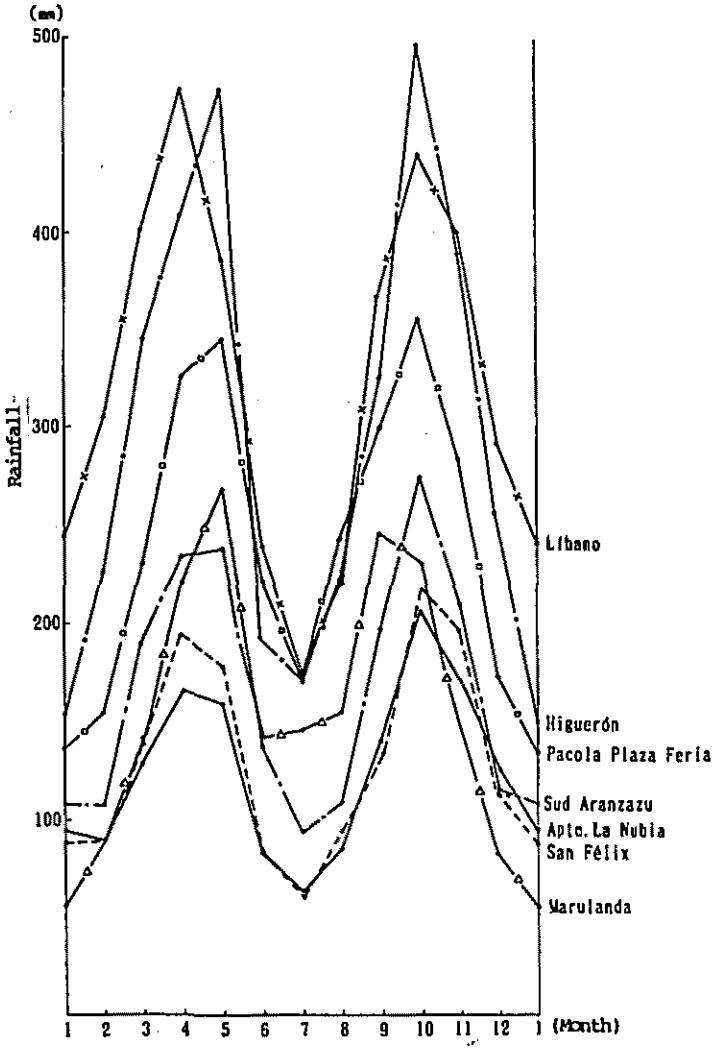


Fig. 8 Monthly Rainfall in the Intensive Area

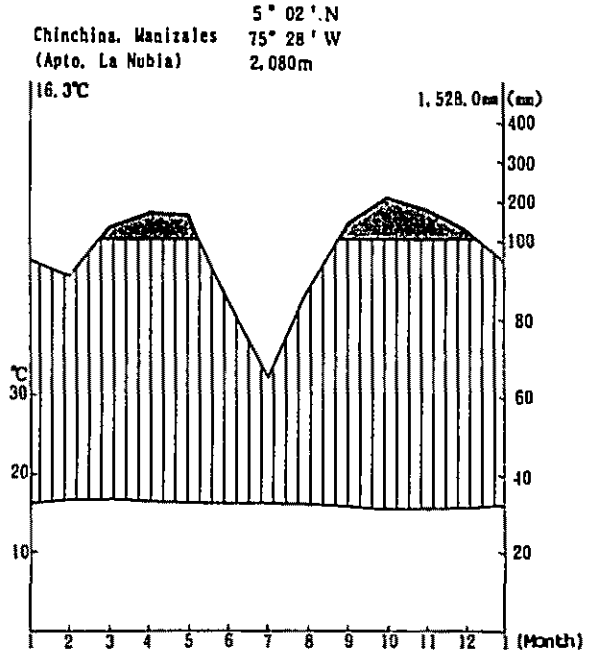


Fig. 9 Climatic chart of Manizales

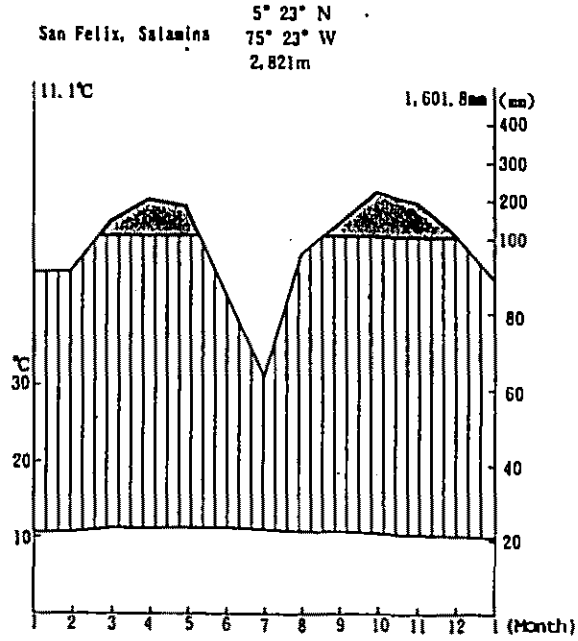


Fig. 10 Climatic Chart of Salamina

(g) Drainage System

This Intensive Area is divided into two main river systems, separated by the central mountainous districts: the Magdalena River basin in the east and the Cauca River basin in the west. To take a closer look, the eastern and western basins are subdivided into three minor valleys each. As Fig. 11 shows, there are six river systems.

None of them has any distinct features. They all have carved out deep V-shaped valleys through the Andes Mountains.

The area covered by each basin is shown on Table 12:

Table 12 Basin Area by River

Magdalena River			Cauca River		
River system	Basin Area(ha)	Share(%)	River system	Basin Area(ha)	Share(%)
South Samaná River	27,116ha	13.2 %	Arma River	27,807ha	13.6 %
La Miel River	14,203	6.9	Tapias, Chambery and Pozo Rivers	59,259	29.0
Guarino River	46,901	22.9	Chinchina River	29,423	14.4
Total	88,220	43.1	Total	116,489	53.9
Grand Total		204,709ha	100%		

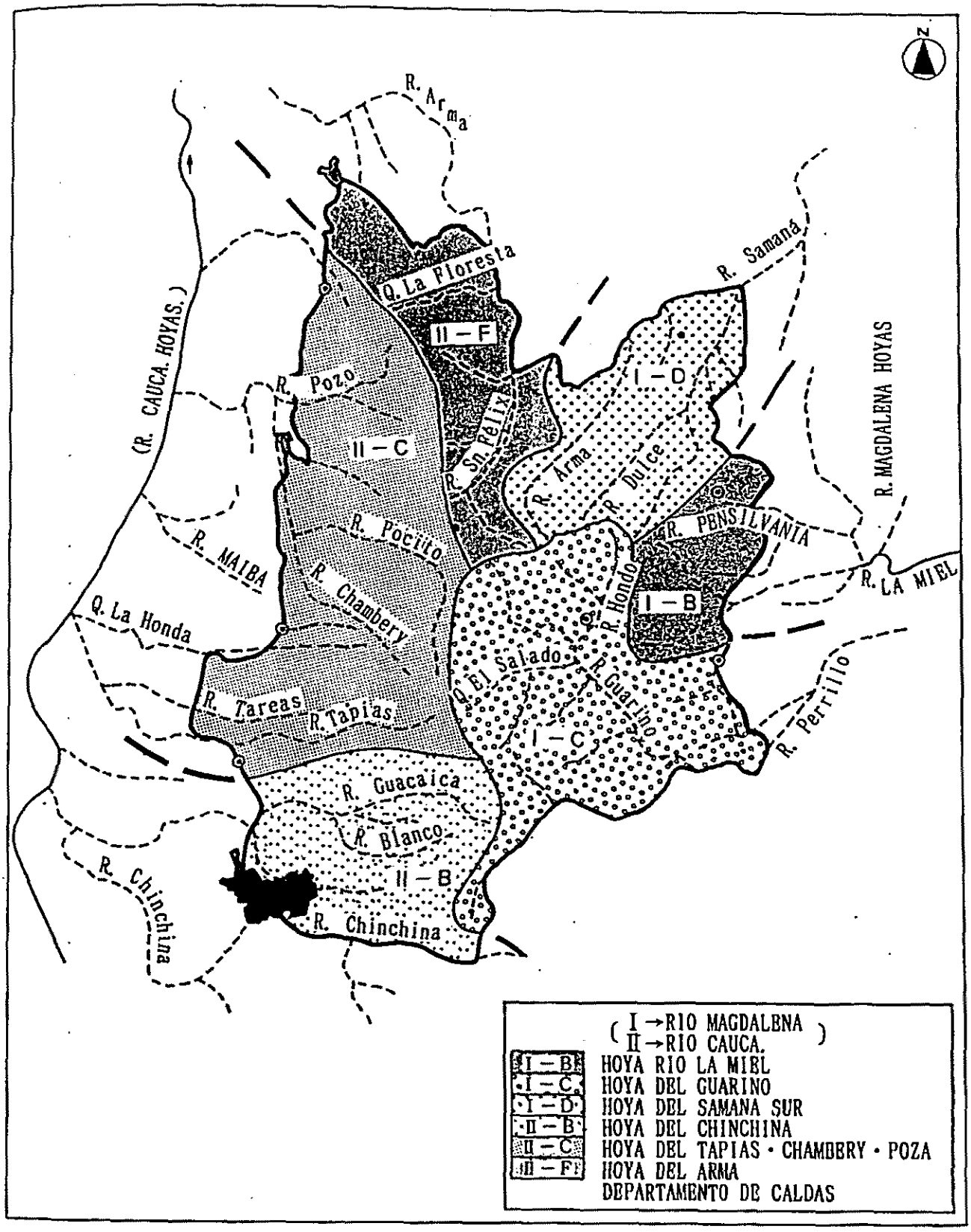


Fig. 11 Map of River Systems and Basins

(h) Traffic

The traffic situation in the Intensive Area is as illustrated by Fig. 12. The paved national highways account for two-thirds of the boundary of Intensive Area but none is found within the Intensive Area. Provincial roads are laid through the area in proportion to its population, but none are paved. Municipal or lower-class roads are scattered in a haphazard way and are usable only in times of emergency. Without routine maintenance provided, it is difficult to get an accurate picture of them.

The Intensive Area as a whole shows a complicated rugged mountainous terrain, which accounts for the poor traffic situation.

(i) Population

The nine cities related to the Intensive Area have a combined population of about 495,300 as of 1987. Of them about 358,000 or 73.3% are urban dwellers and about 137,300 or 27.7% are residents in the countryside. However, the actual residents within the limits of the Intensive Area are estimated at a maximum 51,000, or about 30% of the urban population in two cities of Marulanda and Pensilvania and of the rural population.

Therefore, the populational density of the Intensive Area is 0.25 persons per ha and one resident occupies 4 ha on the average: a thinly populated area.

A populational trend in this area is similar to that for the whole of Colombia: the urban population is on the increase while the urban population is on the decrease. To look at statistics for 15 years from 1973 to 1987 (Table 13), the urban population of Manizales visibly grew from about 210,000 to about 300,000 and remarkably the urban Salamina population shoot up from about 4,000 to some 120,000. A significant decrease is noted in two areas: the rural population of Salamina fell from about 26,000 to about 12,000 and that of Marulanda shrank by about 42% from 4,200.

Nevertheless, there is one exception. Manzanares City's population grew by about 67% both in its urban and rural districts.

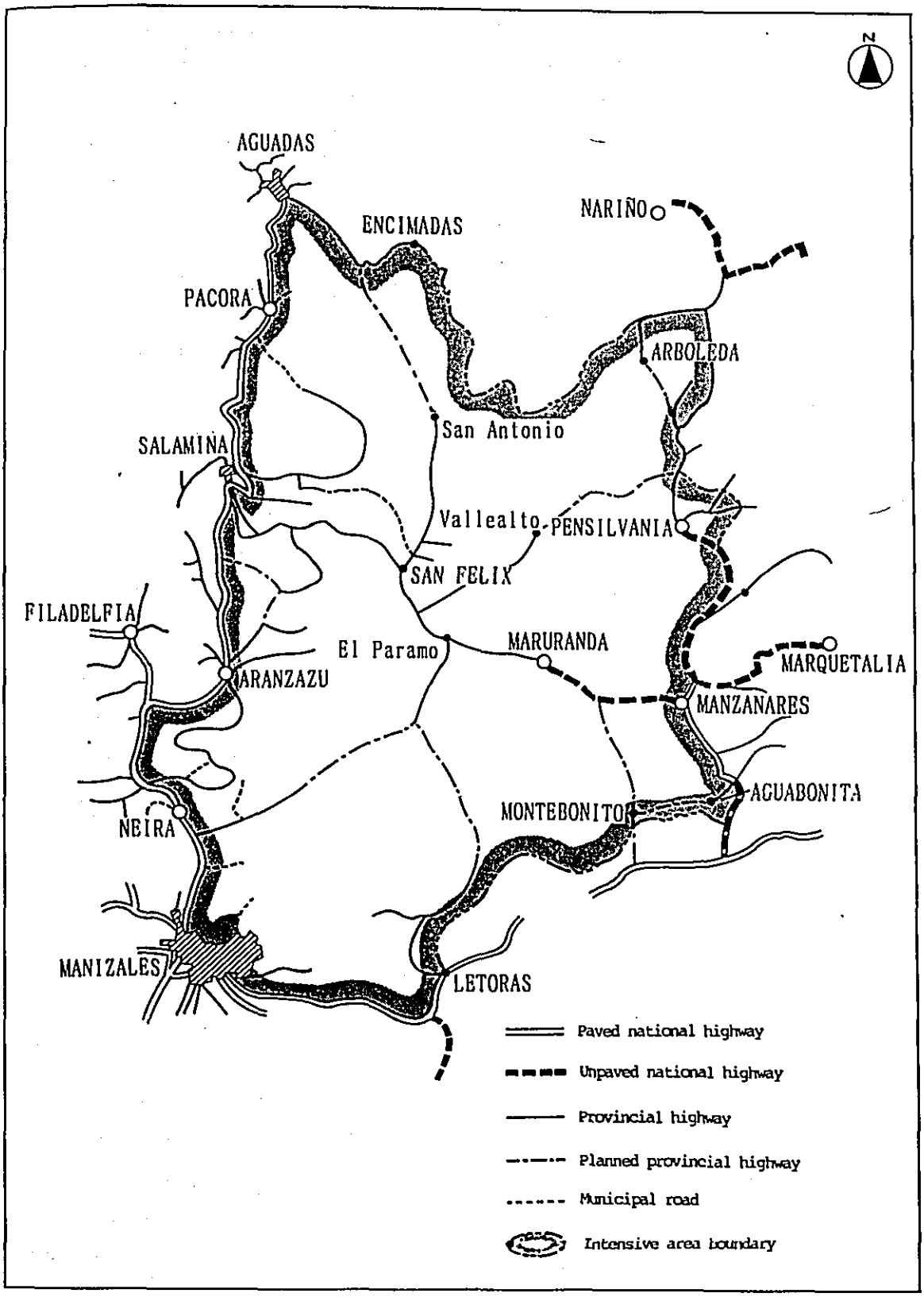


Fig. 12 Map of Traffic Network

Table 13 Population of Nine Cities Related to the Intensive Area

(source: Atlas de Caldas and Carta Estadística de Caldas, 1987)

Municipality		Population				Change (14 years)			Remarks
		1973 Year	1982 Year	1985 Year	1987 Year	%	Period	Yearly change	
MANIZALES	Urban area	207,574	226,014	275,104	295,363	+ 42.3	+ 87,789	+ 6,271	Increase
	Rural area	31,566	31,112	24,248	25,778	− 18.3	− 5,788	− 413	Gradual decrease
	Total	239,140	257,126	299,352	321,141	+ 34.3	+ 82,001	+ 5,857	
NEIRA	Urban area	8,425	9,095	9,684	40,193	+ 21.0	+ 1,768	+ 126	Increase
	Rural area	17,660	25,225	15,211	16,426	− 7.0	− 1,234	− 88	Gradual decrease
	Total	26,085	34,320	24,895	26,619	+ 2.0	+ 534	+ 38	
ARANZAZU	Urban area	7,211	7,539	6,180	6,260	− 13.2	− 951	− 68	Gradual decrease
	Rural area	8,921	6,094	7,283	7,803	− 12.5	− 1,118	− 80	Gradual decrease
	Total	16,132	13,633	13,463	14,063	− 12.8	− 2,069	− 148	
SALAMINA	Urban area	3,924	4,373	4,076	12,174	+310.2	+ 8,250	+ 589	Drastic increase
	Rural area	26,027	24,979	28,794	12,308	− 52.7	− 13,719	− 980	Decrease
	Total	29,951	29,352	32,870	24,482	− 18.3	− 5,469	− 391	
PACORA	Urban area	6,561	6,982	5,950	6,068	− 7.5	− 493	− 35	Gradual decrease
	Rural area	14,951	12,199	12,190	13,070	− 12.6	− 1,881	− 135	Gradual decrease
	Total	21,512	19,181	18,140	19,138	− 11.0	− 2,374	− 170	
AGUADAS	Urban area	10,831	18,915	9,868	10,055	− 7.2	− 776	− 55	Gradual decrease
	Rural area	23,445	12,822	16,587	17,432	− 25.7	− 6,013	− 430	Decrease
	Total	34,276	31,717	26,455	27,487	− 19.8	− 6,789	− 485	
MARULANDA	Urban area	1,721	1,949	1,779	1,838	+ 6.8	+ 117	+ 8	Drastic increase
	Rural area	4,215	3,510	2,427	2,467	− 41.5	− 1,748	− 125	Gradual decrease
	Total	5,936	5,459	4,206	4,305	− 27.5	− 1,631	− 117	
MANZANARES	Urban area	6,793	7,352	8,975	9,648	+ 42.0	+ 2,855	+ 204	Increase
	Rural area	10,361	7,901	16,165	18,926	+ 82.7	+ 8,561	+ 612	Increase
	Total	17,154	15,253	25,140	28,574	+ 66.6	+ 11,420	+ 816	
PENSILVANIA	Urban area	7,402	8,079	6,353	6,417	− 13.3	− 985	− 70	Gradual decrease
	Rural area	23,569	21,408	21,270	23,131	− 1.9	− 438	− 31	Gradual decrease
	Total	30,971	29,487	27,623	29,548	− 4.6	− 1,423	− 102	
Total	Urban area	260,442	288,298	327,969	358,016	+ 37.5	+ 97,574	+ 6,970	
	Rural area	160,715	145,250	144,175	137,341	− 14.5	− 23,374	− 1,670	
Grand Total		421,157	435,508	472,144	495,357	+ 17.6	+ 74,200	+ 5,300	
Percentage		100.0	103.4	112.1	176.2				

To conclude, the combined population of the related nine cities showed an increase of 17.6% from about 421,000 to about 495,000 over the past 15 years and there are clear signs of populational concentration in the urban districts of Manizales, Neira and Salamina and in Manzanares City.

(j) Head of Livestock

The population of livestock in the Intensive Area is as tabulated on Table 14. Cattle number about 100,000, forming the far largest group followed by pigs, horses, fowl and honey bees in that order.

b. General Situation of Land Use

The condition of land use in the Intensive Area is as illustrated by Fig. 13.

To look at the contents of land use, natural grasslands account for an overwhelming share of abou6 54% and the combined pastureland, including improved grasslands and man-made grasslands account for 57.2% of the entire territory. At present, such grasslands are distributed from the top of the mountains to their feet, but many are difficult to classify as natural or man-made by origin.

The next largest group is formed by forests, which occupy about 27% of the whole area. Of them, natural forests cover the far largest acreage, with secondary and man-made forests scattered here and there. However, no clear demarcation line is drawn between natural forests and secondary forests, with man-made forests distributed along a limited area.

Farmland accounts for 6.2% of the total area of the Intensive Area, mainly because the right area for crop growing is limited to low-altitude country. Yet, the actual acreage of farmland seems to be somewhat larger than this data, since pastureland is dotted with farms growing vegetables for private use.

There are also grasslands and bush lands, barren lands, abandoned farmlands and weedy fields, and residential districts, whose acreage is hard to determine.

Table 14 Population of Livestock in the Intensive Area (source: Carta Estadistica de Caldas, 1987)

Carta Estadística de caldas, 1987

Kind / Municipality	Occupancy Share	Milch cows		Beef cattle		Hide cattle		Total cattle		Pigs		Horses		Sheep		Fowl		Honey bees	
		Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area	Whole area	Intensive Area
	(%)		(head)		(head)		(head)		(head)		(head)		(head)		(head)		(head)		(boxes)
Manizales	45	1,656	762	5,650	2,599	19,369	8,910	26,675	12,271	3,500	1,575	6,813	3,066	380	171	110,000	49,500	–	–
Neira	63	1,500	945	15,000	9,450	6,800	4,284	23,300	14,679	4,800	3,024	5,395	3,399	–	–	15,000	9,450	60	38
Aranzazu	81	4,500	3,645	3,500	2,835	2,100	1,701	10,100	8,181	6,000	4,860	2,923	2,368	–	–	4,850	3,929	–	–
Salamina	86	1,500	1,290	4,850	4,171	23,500	20,210	29,850	25,671	4,820	4,145	5,020	4,317	4,000	3,440	10,200	8,772	20	17
Pacora	40	200	80	6,630	2,652	7,500	3,000	14,330	5,732	1,248	499	1,990	796	–	–	–	–	–	–
Aguadas	30	134	40	26,500	7,950	2,500	750	29,134	8,740	1,447	434	2,337	701	199	60	9,751	2,925	–	–
Marulanda	100	762	762	5,139	5,139	13,270	13,270	19,171	19,171	2,276	2,276	2,280	2,280	3,195	3,195	3,290	3,290	–	–
Manzanares	54	600	324	2,800	1,512	5,500	2,970	8,900	4,806	4,500	2,430	3,979	2,149	50	27	4,500	2,430	50	27
Pensilvania	78	140	109	1,260	983	12,600	9,828	14,000	10,920	13,000	10,140	6,856	5,348	1,300	1,017	22,000	17,160	450	351
total		10,992	7,957	71,329	37,291	93,139	64,923	175,460	110,171	41,591	29,383	37,593	24,424	9,124	7,910	179,591	97,456	580	433

Note: The number of livestocks in the Intensive Area has been estimated from occupancy share (%).

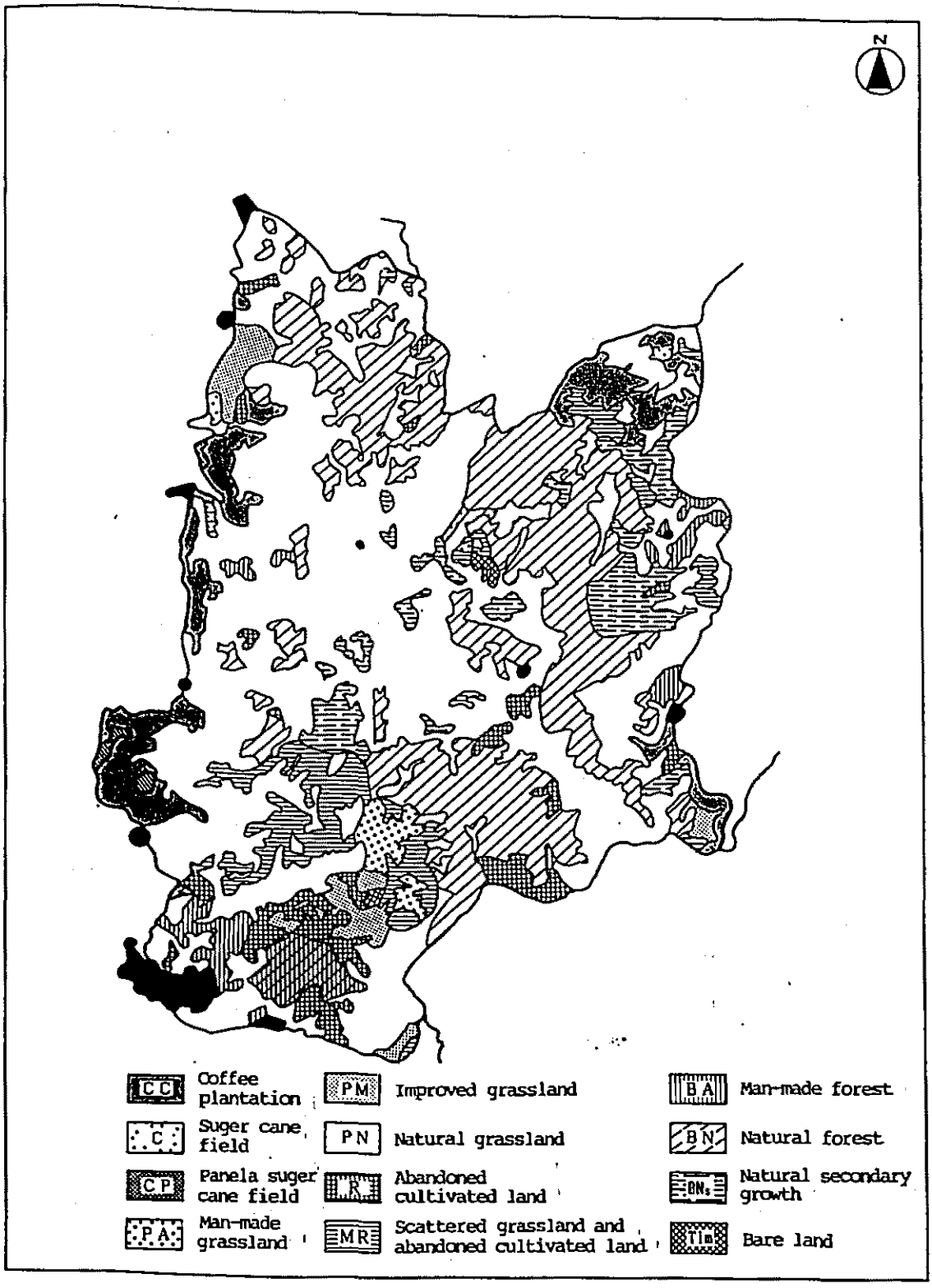


Fig. 13 Land Use Map

The present state of land use is checked with the agroecological zones (that shown on Fig. 14 indicative of land's potential) to estimte the right extent of land use. The results are listed on Table 15 and are likely to serve as one index in land use within the area.

The features of land use by altitude are set forth in a report on the results of the analysis of remote sensing data and resemble those of the whole of the Intensive Area.

And Map of Farmland by ownership Scale is shown on Fig. 15.

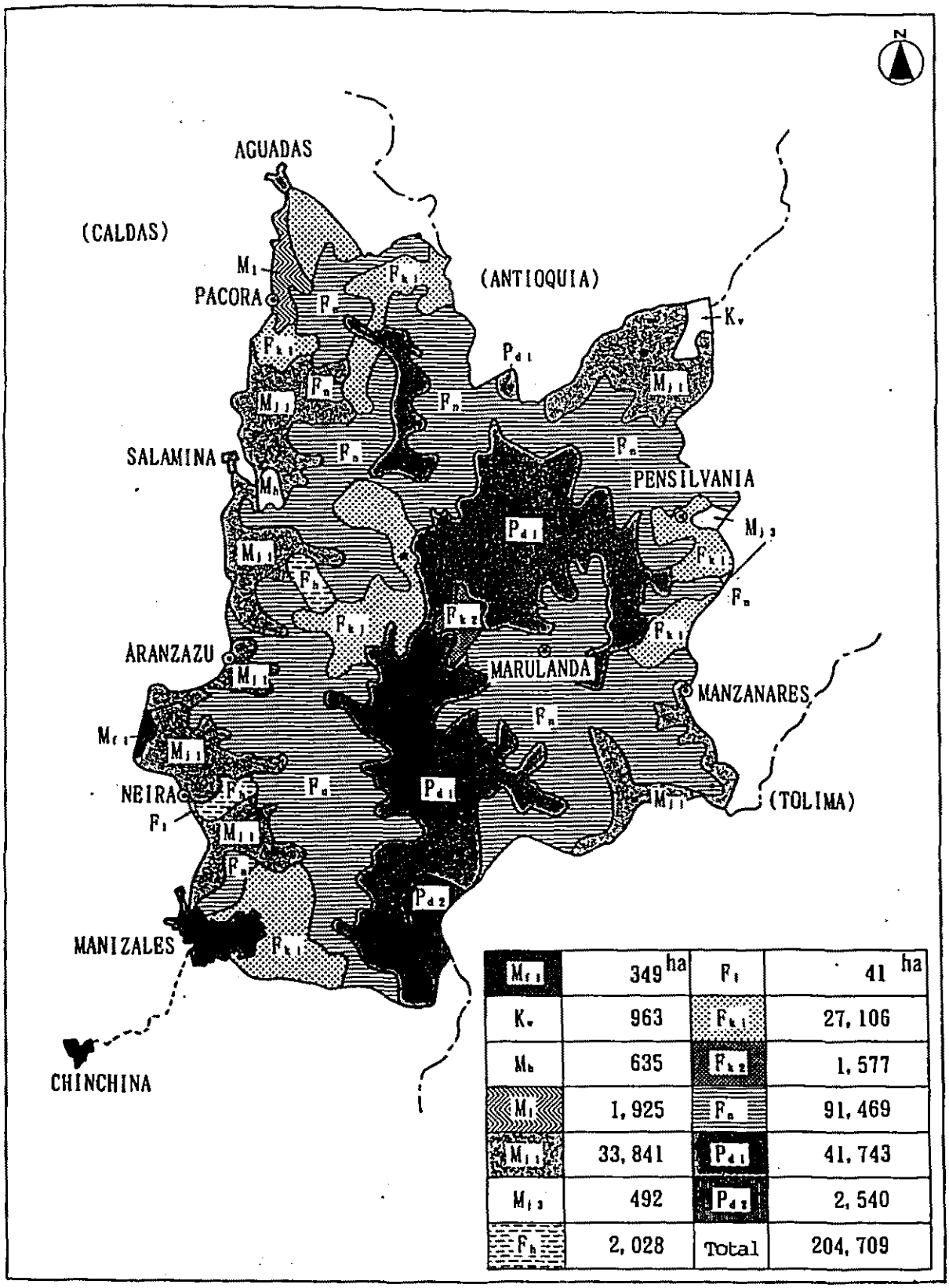
c. General Outline of Vegetation

The Intensive Area, because of its location near the Equator, has generally much rain and much humidity and finds itself in a right temperature, which are all favorable for the growth and luxuriance of plants.

The forests in this area are classified into four categories by altitude zone, as shown by Fig. 16. Of the forest types, low mountain rain forest accounts for a preponderant 62.26%, followed by moutain rain forests with 25.81%, hilly rain forests (also called fore mountain zone) with 11.39%, and tropical rain forests represent a mere 0.54%.

On the other hand, according to the forest map of Colombia (Fig., 17), the actual vegetation distribution is composed of the mountainside secondary forest zone of about 7,800 ha (3.8%), the poor vegetation zone of about 13,500 ha (6.6%), denuded pastureland of about 14,800 ha (7.2%) and farmland and pastureland of about 168,600 ha (82.4). In short, it is said that all the virgin forests have already disappeared from the area, leaving some selectively felled natural forests.

To look at vegetation distribution, pastureland accounts for the largest share in the 204,709 ha Intensive Area: man-made grasslands 1.3%, improved grasslands 1.9% and natural grasslands 54.0%. Man-made forests cover about 6,000 ha, or 3.1%, natural forest about 40,000 ha or 19.7%, natural secondary forests about 8,000 ha or 4.3%, with a combined share of forests totaling 27.1%. However, besides, abandoned farmland is 4.0% and those abandoned farm plots covered with weeds and shrubs 5.3%.



M_{f1}	349 ha	F_1	41 ha
K_v	963	F_{k1}	27,106
M_b	635	F_{k2}	1,577
M_1	1,925	F_n	91,469
M_{j1}	33,841	P_{d1}	41,743
M_{j3}	492	P_{d2}	2,540
F_h	2,028	Total	204,709

Fig. 14 Agroecological Map of the Intensive Area

(Modified from Atlas de Caldas)

Explanation of legend of fig.14

Symbol	Area (ha)	Description	Symbol	Area (ha)	Description
K_v	963	Suitable for a forest reserve. Perennial crops. Extensive livestock raising. Inclination is of more than 50%. Thin soil horizon. Susceptible to erosion.	F_h	2,028	Suitable for man-made production forest, orchards, vegetables, annual crops, intensive livestock farming. Inclination of under 25%, deep soil horizon, good drainage, low fertility.
M_h	635	Suitable for mixed sowing of perennial crops, rice and beans and for intensive livestock breeding. Inclination is within 25%. Deep soil horizon, good drainage, low-medium level of fertility and some landslides seen.	F_{k1}	27,106	Suitable for conservation forest, perennial crops and extensive livestock farming. Inclination of 25-50%, shallow-medium soil horizon, good drainage, low fertility, and susceptible to erosion.
M_1	1,925	Suitable for a forest reserve, perennial crops and extensive stock farming. Steep inclination of 25%-50%. Medium soil horizon, good drainage, low fertility. Suseeptible to erosion.	F_{k2}	1,577	Suitable for production forest, perennial crops and extensive stock breeding. Inclination of under 50%. Low-to-medium fertility.
M_{j1}	33,841	Suitable for a man-made forest and perennial crops. Extensive stock farming. Inclination of over 50%, medium in soil horizon depth, good drainage. Erosion features noted.	F_n	91,469	Suitable for forest (partially for commerical froest, perennial crops and extensive stock breeding).
M_{j3}	492	Eastern part of Caldus Province, suitable for the cultivation of production forest and perennial crops. Inclination of more than 50%, shallow soil horizon, good water retention, good drainage, low fertility and susceptible to erosion.	P_{d1}	41,743	———
M_{f1}	349	Production conservation forest, perennial crops, semi-intensive livestock raising, inclination of 25-50%, shallow-deep soil horizon, good drainage, low-to-medium fertility, susceptible to erosion.	P_{d2}	2,540	———
F_1	41	Suitable for man-made production forest, orchards, and semi-intensive livestock farming. Inclination of not more than 50%. Deep soil horizon, good drainage, low fertility, likely landslide.	Total	204,709	———

Table 15 Comparison of present land use and the suitable land use with in the Intensive Area (Reference: Atlas de Caldas)

Comparison / Use	Status of land use A				Agroecological classification of right land for right crops			Degree of suitability	Remarks
	Subdivision	Contents	Acreage	Percentage of total area	Contents	Acreage	Percentage	Ratio of excess or shortage	
			(ha)	%		(ha)	(%)	A/B (%)	
Farmland	CC	Coffee	11,873	5.8	Perennial crops				Rather expandable
	C	Sugar canes	205	0.1	rice, beans				
	CP	Panelera Sugar cane	614	0.3	fruit trees, vegetables, etc.				
	Sub total		12,962	6.2		18,751	9.2	67.7	
Pastureland	PA	Man-made grassland	2,661	1.3	Intensive pasturing and livestock raising				Excessive use
	PM	Improved grassland	3,889	1.9	Semi-intensive pasturing and livestock raising				
	PN	Natural grassland	110,543	54.0	Extensive livestock raising				
	Sub total		117,093	57.2		32,620	15.9	359.0	
Forest					Man-made production forest				Rather expandable
	BA	Man-made forest	6,346	3.1	Production forest and conservation forest				
	BN	Natural forest	40,328	19.7	Production forest conservation forest				
	BNS	Natural secondary forest	8,803	4.3	Man-made conservation forest,forest				
	Subtotal		55,477	27.1		71,251	34.8	77.9	
Abandoned land (unsuitable land)					Susceptible to erosion				Much land put to inappropriate uses (about 39,000 ha)
	R	Abandoned farmland	8,188	4.0	Thin soil horizon				
	MR	Weedy plot and abandoned farmland	10,850	5.3	Steep slope				
	Sub total		19,038	9.3	Low fertility	58,949	28.6	32.5	
Barren land					Exposed rocks				Much of barren land put to use (about 23,000 ha)
	Tim	Barren land	409	0.2	Occasional landslides				
	Sub total		409	0.2	Steep slope	23,594	11.5	1.7	
Total			204,709	100.0		204,709	100		

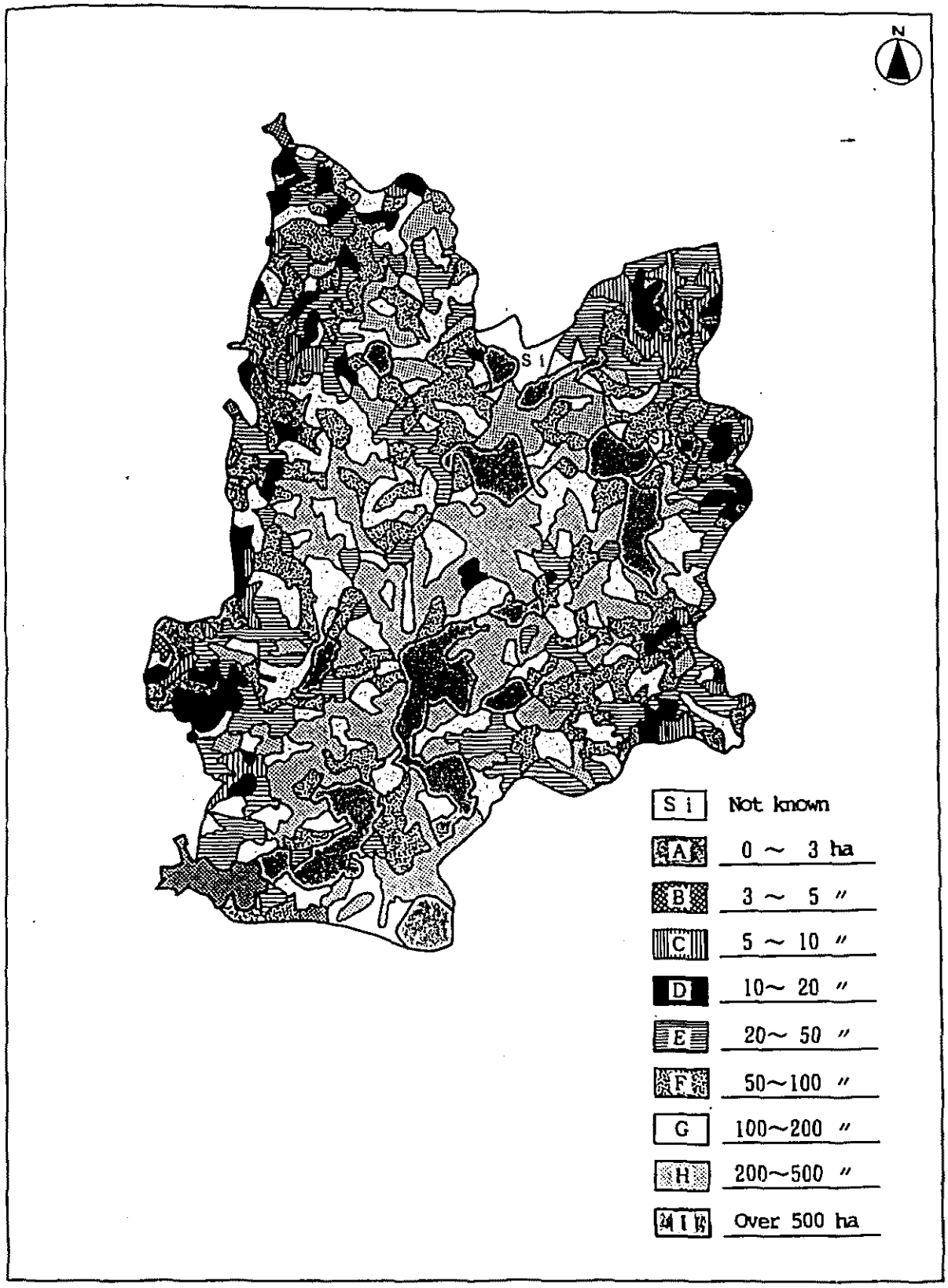
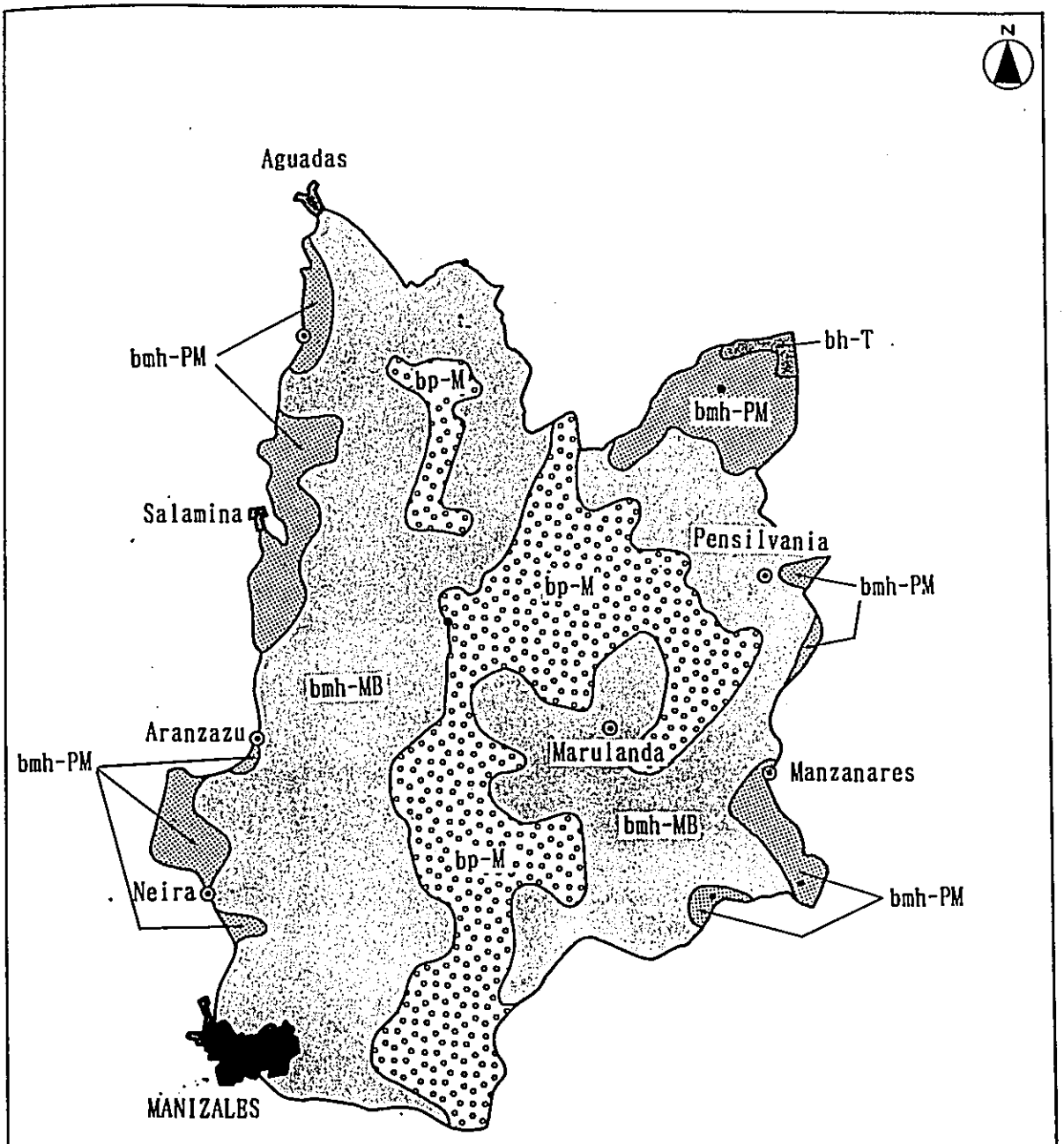


Fig. 15 Map Showing Farmland Ownership By Acreage

(Modified from Atlas de Caldas)



Legend			Acreage(ha)	%	Rainfall(mm)	Tempreture (c°)
bh-T	Bosque h medo tropical	Tropical rain forest	1,103	0.54	Over 2000	Over 24
bmh-PM	Bosque muy h medo premontano	Hilly rain forest (fore mountain zone)	23,316	11.39	2000~4000	18~24
bmh-MB	Bosque muy h medo montano bajo	Low mountain rain forest	127,448	62.26	"	12~18
bp-M	Bosque pluvial, montano	Mountain rain forest	52,842	25.81	Over 2000	6~12
Total			204,709	100%	——	——

Fig. 16 Map of Forest Ecology (Forest Types)

(Modified from Atlas de Caldas)

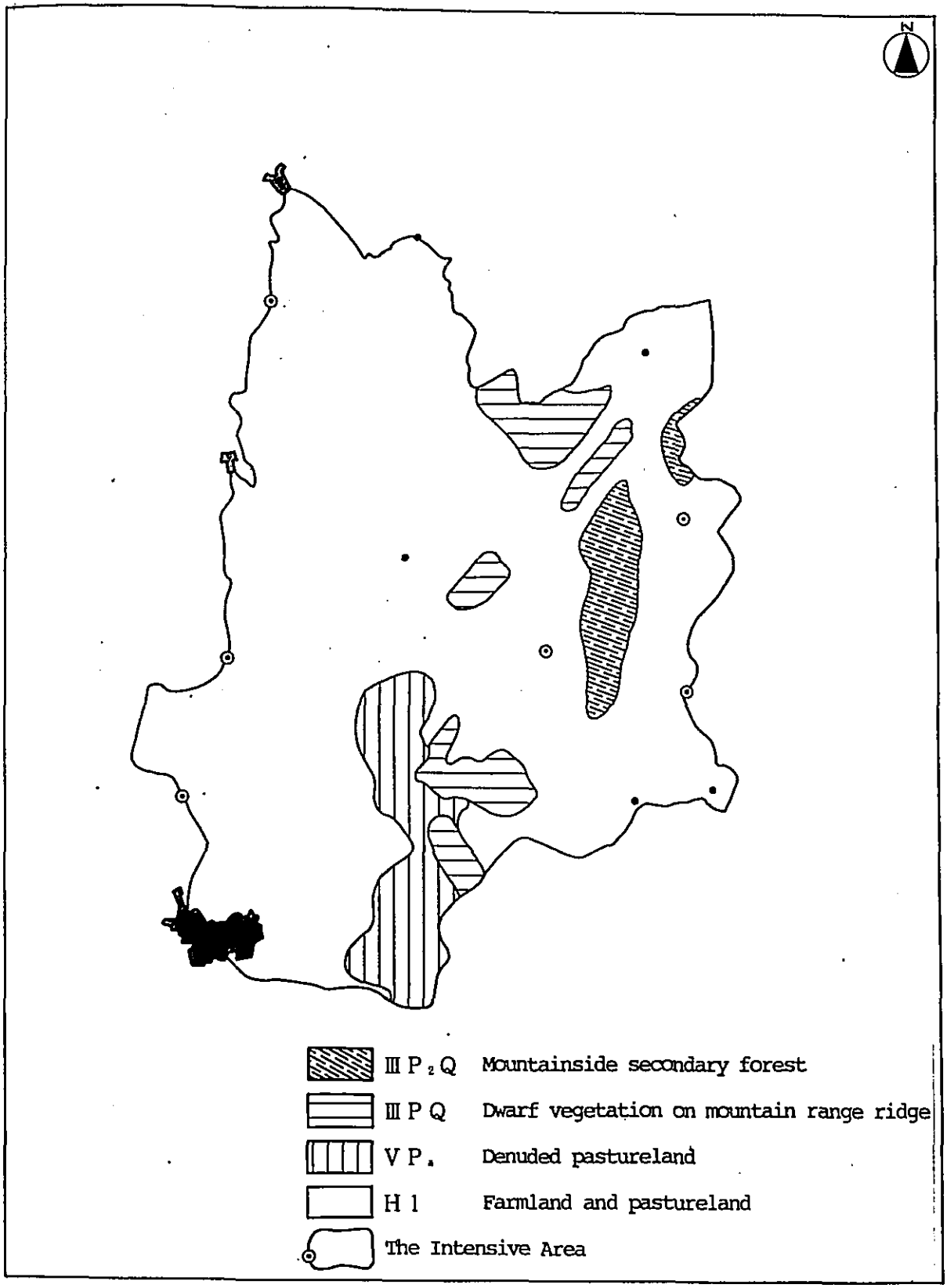


Fig. 17 Map of Forests (Current Vegetation)

(Modified from Mapa de Bosque, 1983, IGAS)

Types of Plants identified in this field exploration amount to about 159, including those confirmed in a forest survey and a soil investigation. Those plants are classified by form as shown on Table 16:

Table 16 List of Types Encountered

Form	Contents	Inside plot	Outside plot	Total
High tree	tree 10 m high or more	26	12	38
Sub-high tree	tree not less than 5 m and less than 10 m in height	17	15	32
Low tree	tree not less than 2 m and less than 5 m in height	12	12	24
Plant	plant not less than 30 cm and less than 2 m in height	—	—	31
Chamaephyte	plant less than 30 cm in height	(These Plants appeared both inside and outsid the plots)		18
Epiphyte and vine	Epiphyte and phanecrophyta scandentia			10
Artificially planted tree	6 kinds of coniferous trees and 3 kinds of broad-leaved trees			6
Total				159

Note 1: The planted broad-leaved trees are of the same kinds as those naturally grown.
2: Including some plants whose species and family are unknown.
3: Plots refered to in this table are those of forest inventory.

The forest distribution identified in the latest exploration is as follows:

- o The central part (northeast of El Paramo) has relatively much forests.
- o The western part (vicinity of Salamina) has little wooded land but much pastureland.
- o The southeastern part (vicinity of Manizales) does not have much forest except headwaters forests. It is very sparse, scattered with coffee fields and plantations.

- o The northern part and in particular the low-altitude tableland around Pacora and Aguadas cultivated fields are surrounded with patches of artificial pastureland. Some woods are found mainly on the slopes and high-altitude plateau.
- o The eastern part has man-made and natural forests in the vicinity of Pensilvania, while many plots of pastureland and coffee fields are found around Manzanares.

d. General Outlook of Soil

The soil within the Intensive Area is primarily of the type found in the temperate zone since a great part of this zone has an alpine environment with the right temperature, much rainfall and high moisture. Its general outline is as stated in the results of soil survey.

e. Outline of Topography

The topography of the Intensive Area can be defined as one formed as a result of erosion by the rivers flowing down east and west, separated by the Andes Central Range which runs through the central part.

As stated earlier, the altitude difference within the area is about 3,100 m between the 3,850 m point and the 750 m point. Considering that the east-west distance of the area is about 49 km, the terrain is very steep, climbing 3,100 m in the distance of 25 km. Big and small ridges are intricately intertwined with each other, presenting extremely complicated topographical features, except for the hilly districts and peneplains found on part of the northern part.

For this reason, each river forms a V-shaped valley, with many steep slopes, and without any plain at the bottom. Most of the residential areas spreading across the ridges and the upper part of the hilly land, with a great majority of roads being skyways built in the upper part of the mountains. Consequently the Intensive Area as a whole shows significant undulation and a high valley density except the peneplains fonnd in part of its northern district.

f. General Geological Features

The geological features of the Intensive Area are as described on Fig. 18. To apply the geological age division to them, the results are as illustrated on Table 17.

This geological distribution is characterized by these features: Andes moire rocks and lava are widely distributed on the southern side of the Central Andes Backbone which runs north-south through the central part of the area. Quartz diorite rocks are mainly distributed on the northeastern side, while the northwestern part is somewhat low hilly land, with mudstones and clay, mixed with conglomerate and sand, overlaid on the top of the Paelozoic rocks. Widely distributed throughout the district from the upper part of the mountains to their feet are layers with a mixture of gneiss rocks, quartz and mica. Metamorphic rock layers covered with volcanic ash run north-south along a huge fault in the piedmont lowland district in the west connecting Manizales and Aquadas. Another feature is the dotted distribution of layers with volcanic drifts, such as volcanic ash and pumice mostly in depressions, depending on terrain variations. upper part of the the mountains to their feet are layers with a mixture of gneiss rocks, quartz and mica. Metamorphic rock layers covered with volcanic ash run run north-south along a huge fault in the piedmont lowland district in the west connecting Manizales and Aquadas. Another feature is the dotted distribution of layers with volcanic drifts, such as volcanic ash and pumice mostly in depressions, depending on terrain variations.

Geologically the area is said to be divided into nine primary categories. To look at their contents, the largest group with a share of over 39% is an old geological age layer (Pe/Pc) comprising a mixture of gneiss, quartz and mica. The second largest groups are distributed on about 10% of the area: a layer (Tp) of Andes moire and lava which forms the Andes Range, a stratum (Qp) covered with volcanic products, a Mesozoic

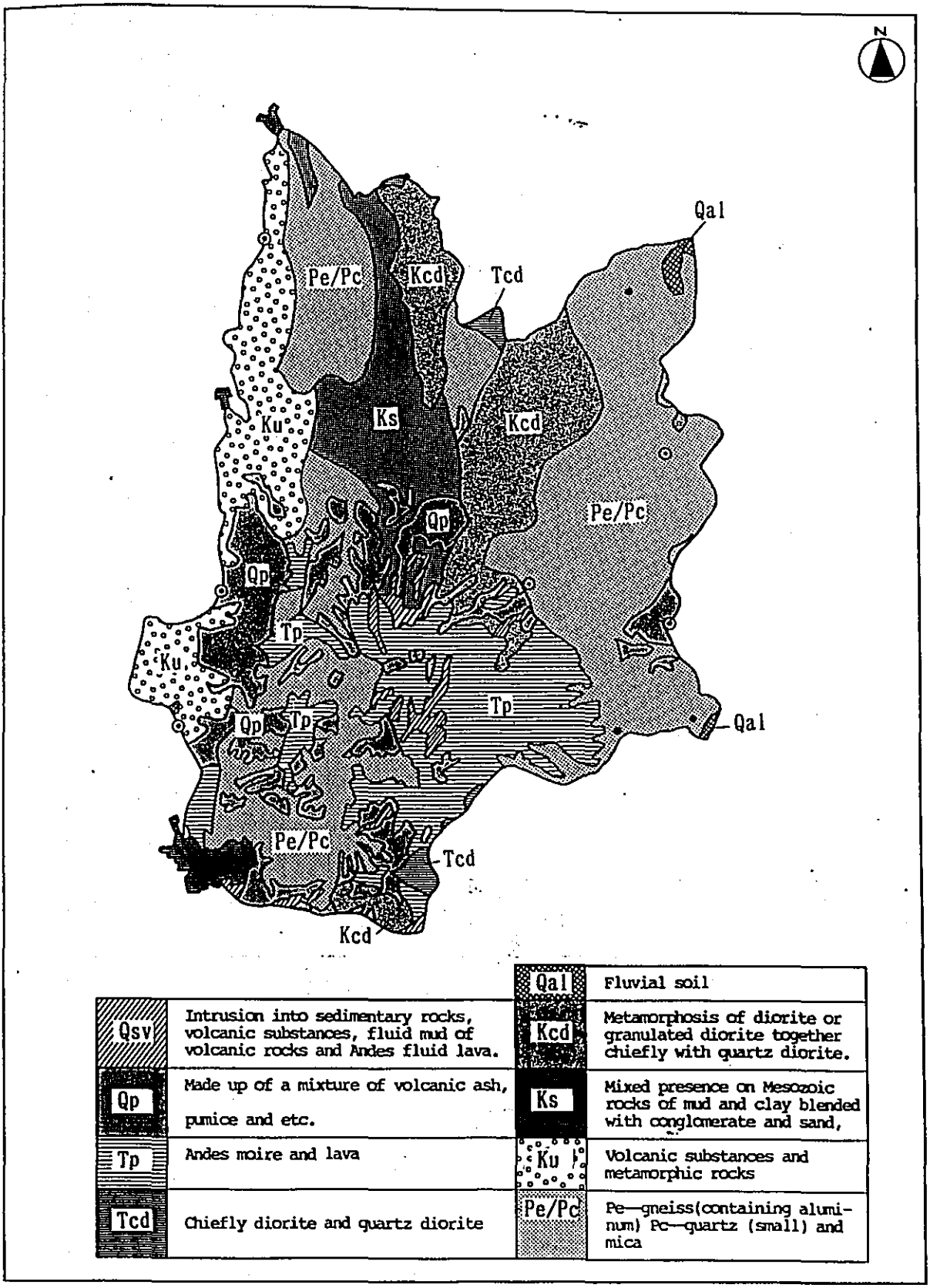


Fig. 18 Geological Map

(Modified from Atlas de Galdas)

Table 17 Geologic Time Chart of Geological Features Manifested in the Intensive Area

Time (10,000years)	Era	Period		Epochs	Contents of manifested geological features			
					Symbol	Explanation	Area	Ratio
				(Alluvial Epoch)			(ha)	(%)
		Quaternary		(Recent Epoch)	Q_{al}	Alluvial soil	905	0.4
				Holocene Epoch	Q_p	Mixture of volcanic ash, pumice and others	26,113	12.8
1.5				Diluvial Epoch				
	Cenozoic Era			Pleistocene Epoch	Q_{sv}	Formed with those sedimentary rocks, volcanic substances, and fluid mud by volcanic rocks and Andes fluid lava.	3,527	1.7
170								
		Tertiary	Neogene	Pliocene Epoch				
2,250				Miocene Epoch	T_p	Andes moire and lava	27,398	13.4
			Paleocene	Oligocene Epoch				
				Eocene Epoch	T_{cD}	Mainly diorite and quartz diorite	1,859	0.9
				Paleocene Epoch				
6,500								
	Mesozoic Era	Cretaceous Period		Late	K_s	Mixed presence on Paleozoic rocks of mud and clay mixed with conglomerate and sand	17,392	8.5
					K_{cD}	Metamorphosis of diorite or granualated diorite together with quartz diorite	25,732	12.6
				Early				
					K_u	Volcanic substances and metamorphic rocks	21,537	10.5
14,000		Jurassic Period		Late,Middle and Early				
		Triassic Period		Late,Middle and Early				
23,000								
	Paleozoic Era	Permian Period		Late and Early				
		Carboniferous Period		Late and Early				
34,500		Devonian Period		Late,Middle and Early				
		Silurian Period		Late and Early				
43,500		Ordovician photograph		Late and Early				
		Cambrian Period		Late,Middle and Early				
57,000								
	Precambrian	Proterozoic Period (Argon Era)			Pe/Pc	Mixture of gneiss (with aluminium content), tiny quartz, and mica	80,246	39.2
450,000		Archezoic Era						
						Total	204,709	100.0

formation (Kcd) mainly made up of quartz diorite, and another Mesozoic one (Ku) mainly formed with metamorphic rocks. A conglomerate-sand rock-clay mixed layer (Ks) is found in about 8% of the land. The remaining three, scattered across a very small area, account for an insignificant percentage.

g. General Condition of Denuded Land

It was initially estimated from the rugged terrain and the high rainfall climatic conditions of the Intensive Area that there would be a considerably high percentage of denudation. Contrary to the original predictions, however, the Preliminary field investigation this time suggested that there seemed to be comparatively fewer denuded sites. In other words, no large-scale denudation was found except in the vicinity of urban districts, as a high percentage of land, were covered with vegetation.

However, a closer look at the site shows that there are those places which are clearly to be identified as rehabilitated from devastation, or as sites of landslides or with exposure of a sedimentary layer of volcanic ash or a sand stratum. This means a great need to study the causes of occarrence of denudation in the environment which features an inclement combination of topographical and weather conditions.

A future survey will have to be conducted to get a more accurate picture of the status of denuded land distribution and the ratio of waste land within the area concerned. The following are identified as likely causes of denudation:

- o Natural erosion of steep topography (fall and land collapse)
- o Erosion attributed to much rainfall (gully, etc.)
- o Accelerated erosion by felling, road construction work, and undisposal of service water and sewage (damage by human action)

It seemed that a settlement on a steep slope owing to the concentration of population would readily and directly cause human casualities and was highly risky as it is.

In the area in question it is difficult to specify a particular season

for plant growth as shows so high a rate of vegetation rehabilitation because it is a high-altitude tableland near the Equator and characterized as the right temperature, much rainfall and high humidity. Accordingly, there is a very fast natural rehabilitation of the denuded land.

② Results of Forest Inventory

a. Method of the Inventory

A preliminary forest survey was conducted for the purposes of getting a precise picture of the forests in the model area. It was also intended to make preparations for a forest investigation to be conducted in fiscal 1989 for a basic study of a forest management plan: examination of the study items and surveying method in the forest investigation, the size, shape, number, position of each sample plot, the investigation process.

The investigation plots were marked off in representative forests of the model area divided into three parts (See Fig. 19 Map of Forest Inventory Plot Positions). In the case of a natural forest, each plot was set at 0.1 ha-0.5 ha and was square-shaped, in consideration of the ground conditions and forest situation in the field and accordingly each plot of a man-made forest measured 0.1 ha-0.2 ha and was square-shaped, too. The plots were marked out in order to obtain basic data needed for an optimum design of the next round of investigation.

The so-called every tree measurement method was used for the study, covering the trees with a diameter breast height of 10 cm or more. The items of the study were tree species, diameter breast height, exploitable height, full tree height, and quality.

In the case of natural forests, not only every tree measurement but also a natural regeneration Study was conducted. 20㎡ (1m x 20m) subplots were marked off in three places at the two ends and center of each every-tree measurement plot. The objects of the natural regeneration study were saplings under 10 cm in diameter breast height, which were excluded from the every tree measurement. Their species, number and height

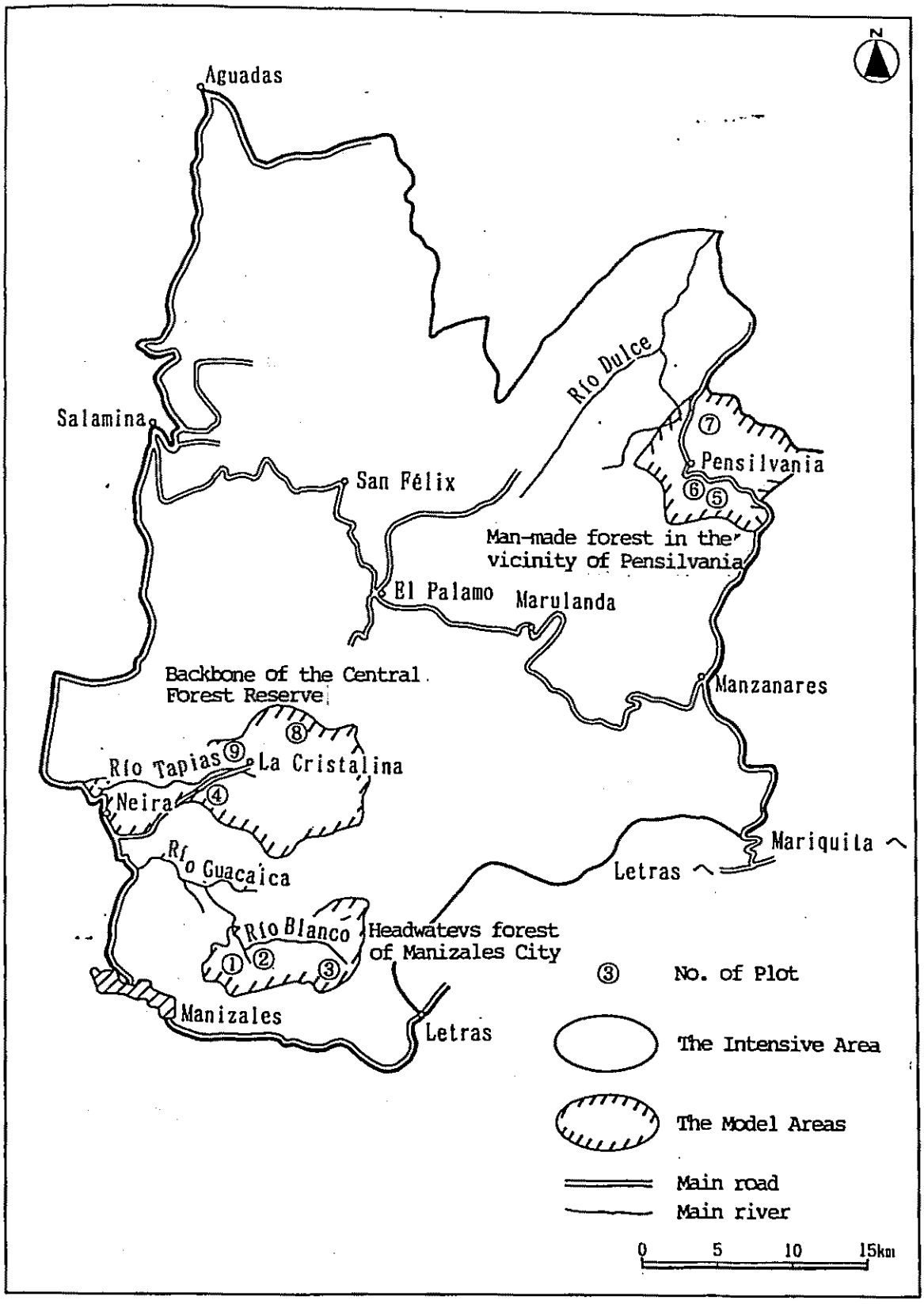


Fig. 19 Map Showing Location of Forest Inventory Plots

were investigated.

b. Results of the Survey

ⓐ Identified Tree Species

In this survey we obtained cooperation from technicians at the local National Forest Protection Institute (CONIF) in identifying the tree species. However, there were a lot of uncertain elements, little research in identification of the tree species in the survey area, shortage of data and the local use of one name to refer to two different species. Therefore here identification were limited to family or genus except those identified on the basis of reliable data.

Table 18 is a list of the tree species identified in the latest forest study and the natural regeneration survey, 59 species found in all.

ⓑ Every Tree Measurement

A total of nine every-tree measurement plots were marked off in the model area, three in each of its three sites. Table 19 shows the location of each plot and gives its sketch and area.

Tabulated on Table 20 are findings of the every-tree measurement.

The study of natural forests of broad-leaved trees shows that the per hectare number of standing trees is about 700-800, about a half of the figure of 1,350 in plot 3 with a higher altitude. Effective volume was found to be from 148.6 ㎥ to 195.0㎥ per hectae.

In the man-made forests of Aliso (Alnus jonullensis), Ciprés (Cupressus lusitanica) and Pinus Patula, however, the per hectare effective volume was estimated at 165.0㎥ to 194.0㎥, 245.0㎥ and 212.0㎥ to 248.0㎥, respectively.

ⓒ Natural Regeneration Study

As given on Table 21, the results of the natural regeneration study were tabulated with saplings classified into four groups by size. To look at the manifestation status of saplings in the four plots, the per ㎡ number of young growths ranges from 1.22 to 4.18 with different plots. The figure

Table 18 List of Tree Species Identified in the Natural Forest Survey and the Natural Regeneration Study (1)

No	Familiy name	Botanical name	Local name
1	*Annonaceae*	*Xylopia spp.*	–
2	*Annonaceae*	–	–
3	*Araliaceae*	*Oreopanax spp.*	–
4	*Araliaceae*	–	Patedanta(?)
5	*Araliaceae*	–	–
6	*Betuleceae*	*Alnus jorullensis*	Aliso
7	*Boraginaceae*	*Tournefortia spp.*	–
8	*Brunelliaceae*	*Brunellia sp.*	Cedrillo, Cedro riñon
9	*Caprifoliaceae*	*Virburnum spp.*	–
10	*Chloranthaceae*	*Hedyosmum sp.*	Granizo, Silva silva
11	*Chloranthaceae*	*Hedyosmum spp.*	–
12	*Compositae*	*Baccharis sp.*	Chilco
13	*Compositae*	*Montanoa sp. (?)*	Camargo
14	*Compositae*	*Polymnia pyramidalis*	Arbolocco
15	*Compositae*	*Polymnia spp.*	–
16	*Compositae*	–	Culo de fierro
17	*Compositae*	–	Guasimo
18	*Cunoniaceae*	*Weinmannia tomentosa*	Encenillo
19	*Cyatheaceae*	*Cyathea spp.*	–
20	*Dilleniaceae*	*Sauraunia ursina*	Dulumoco
21	*Dilleniaceae*	*Sauraunia spp.*	–
22	*Elaeocarpaceae*	*Vallea stipularis*	Campano, Raque
23	*Euphorbiaceae*	*Sapium spp.*	–
24	*Euphorbiaceae*	–	–
25	*Fagaceae*	*Quercus humboldtii*	Roble
26	*Flacourtiaceae*	–	–
27	*Guttiferae*	*Clisia sp.*	Cucharo
28	*Lauraceae*	*Nectandra spp.*	–
29	*Leguminosae*	*Inga spp.*	–
30	*Melastomataceae*	*Miconia sp.*	Mortiño
31	*Melastomataceae*	*Miconia sp.*	Niguito

List of Tree Species Identified in the Natural Forest Survey and the Natural Regeneration Study (2)

No	Familiy name	Botanical name	Local name
32	*Melastomataceae*	*Miconia spp.*	—
33	*Melastomataceae*	*Tibouchina spp.*	—
34	*Melastomataceae*	—	—
35	*Monimiaceae*	*Siparuna spp.*	—
36	*Myrsinaceae*	*Rapanea ferruginea*	Espadero
37	*Myrsinaceae*	*Rapanea spp.*	—
38	*Nyctaginaceae*	*Neea sp.*	Aguanoso
39	*Palmae*	—	—
40	*Rosaceae*	—	—
41	*Rubiaceae*	*Cinchona spp.*	Quina
42	*Rubiaceae*	*Palicourea spp.*	—
43	*Rubiaceae*	—	—
44	*Sapindaceae*	*Allophylus spp.*	—
45	*Solanaceae*	*Solanum spp.*	—
46	*Solanaceae*	—	—
47	*Staphyleaceae*	*Turpinia spp.*	—
48	*Theaceae*	*Freziera sp.*	Cerezo macho
49	*Verbenaceae*	*Aegiphila grandis*	Tabaquillo
50	*Verbenaceae*	*Lippia sp.*	Gallinazo
51	*Verbenaceae*	*Lippia sp.*	Gavilán —
52	*Verbenaceae*	*Lippia spp.*	—
53	*Verbenaceae*	—	
54	—	—	Bolinillo
55	—	—	Chilco colorado
56	—	—	Espino de oro
57	—	—	Huesito
58	—	—	Sangre Negro
59	—	—	—

※ The species of tree No.59 is not known.

※ The Japanese name of family No.8 is not known.

Table 19 An outlook of every-tree forest survey plot

Plot No.	Model Area	Site of Investigation	Forest physiognomy	Topography	Soil Unit	Slope Direction	Slope Inclination	Altitude	Plote size
1	Manizales head-waters forest	Eastern part of Rio river basin	Aliso *(Alnus jorullensis)* man-made forest (17yrs)	Complex slope	Ch (B_t	South and north	22~38°	2,400m	0.1 ha (50m× 20m)
2	〃	〃	Natural forest of broad-leaved trees	Straight slope	Ch (B_r	Soutywest-west	20~43°	2,700m	0.5 ha (200m× 25m)
3	〃	Vicinity of the western headwaters of the Rio Blanco river basin	Natural forest of broad-leaved trees	Convex slope	Ch (B_t	East-north	16~48°	3,550m	0.1 ha (50m× 20m)
4	Backbone of Central Forest Reserve	West of La Christiana on Lio Tapias river basin	Natural forest of broad-leaved trees	Straight slope	Ch ($B_{D\,(d)}$)	Northeast	25~38°	2,370m	0.1 ha (50m× 20m)
5	Man-made forest around Pensil-vania	Southern vicinity of Pensilvania	Cipres *(Cupressus lusistanica)*	Straight slope	Am ($B\ell_{D\,(m)}$)	Northeast	32~43°	2,280m	0.2 ha (50m× 40m)
6	〃	〃	*Pinus patula* Man-made forest (17 yrs)	Complex slope	Am ($B\ell_{D\,(m)}$) faded in color	East-south	14~32°	2,340m	0.2 ha (50m× 40m)
7	〃	Nothern vicinity of Pensilvania	*Pinus patula* Man-made forest (14 yrs)	Complex slope	Am ($B\ell_F$)	East-south	14~32°	2,450m	0.2 ha (50m× 40m)
8	Backbone of Central Forest Reserve Northeast of La Christiana	Natural forest of broad-leaved trees		Straight slope	Ch ($B_{D\,(d)}$)	East	24~47°	2,770m	0.1 ha (50m× 20m)
9	〃	West of La Christarian on the Rio Tapias river basis	Aliso *(Alnus jorullensis)* Man-made forest (18 yrs)	Complex slope with many folds	Ch (B_t)	Northeast-southwest	11~35°	2,260m	0.1 ha (50m× 20m)

Note: Ch refers to Humic Cambisol and Am to Moric Andosol.

Table 20 Results of Forest Survey

Plot No.	Forest physiognomy	Altitude (m)	Plot size	No. of Standing Trees	Average Breast Height Diameter (cm)	Mean exploitable Tree Height (m)	Mean Total Tree Height (m)	Total Effective Volume (m³)	No. of Standing Trees per ha.	Effective Volume m³/ha	Main Tree Species (Natural Forest)
1	Aliso (*Alnus jorullensis*) Man-made forest (17 yrs)	2,400	0.1 ha (50m×20m)	39	22.9	17.0	27.1	19.4	390	194.0	
2	Natural forest of broad-leaved trees	2,700	0.5 ha (200m ×25m)	417	18.0	8.3	15.6	74.3	834	148.6	*Tibouchina spp.*, *Hedyosmum sp.*, (Granizo), *Weinmannia tomentosa* (Encenillo), *Montanoa sp.(?)* (Camargo), *Miconia sp.* (Niguito), *Freziera sp.* (Cerezo macho)
3	Natural forest of broad-leaved trees	3,550	0.1 ha (50m×20m)	135	17.6	3.4	13.8	19.5	1,350	195.0	*Miconia sp.* (Niguito), *Lippia sp.* (Gallinazo), *Lippia sp.* (Gavilán), *Hedyosmum sp.* (Granizo), *Vallea stipularis* (Campano), Chilco colorado, Patedanta(?)
4	Natural forest of broad-leaved trees	2,370	0.1 ha (50m×20m)	77	17.8	7.1	14.8	18.4	770	184.0	*Hedyosmum sp.* (Granizo), *Miconia sp.* (Niguito), *Freziera sp.* (Cerezo macho), *Alnus jorullensis* (Aliso), *Saurauia ursina* (Dulumoco), *Rapanea jerruginea* (Espadero)
5	Cipres (*Cupressus lusitanica*) Man-made forest (17 yrs)	2,280	0.2 ha (50m×40m)	366	19.1	7.3	13.6	49.0	1,830	245.0	
6	*Pinus patula* Man-made forst (14 yrs)	2,340	0.2 ha (50m×40m)	285	19.9	7.3	15.0	49.6	1,425	248.0	
7	*Pnius patula* Man-made forest (14 yrs)	2,450	0.2 ha (50m×40m)	214	21.3	7.8	14.6	42.4	1,070	212.0	
8	Natural forest of broad-leaved trees	2,770	0.1 ha (50m×20m)	70	18.6	7.1	14.2	15.4	700	154.0	*Oreopanax spp.*, *Saurauia ursina*(Dulumoco), *Montanoa sp(?)* (Camargo), *Miconia sp.* (Niguito), *Miconia sp.* (Martiño), *Cinchona spp.* (Quina), *Freziera sp.* (Cerezo macho)
9	Aliso (*Alnus jorullensis*) Man-made forest (18 yrs)	2,260	0.1 ha (50m×20m)	34	25.7	14.0	22.1	16.5	340	165.0	

Note: Effective volume formula used
Plots 1, 2, 3, 4, 8, 9 · · · 0.035 + 0.46 (D2 × A). Source: Tablas de volumen para árboles en pie (INDERENA)
Plot 5 · · · 0.011704 + 0.394465 × (D2 × A). Source: Pro Oriente data
Plots 6 and 7 · · · 0.007799 + 0.474277 × (D2 × A). Source: Maderas de Oriente data

D = Breast height diameter (m)
A = Exploitable tree height (m)

Table 21 List of Natural Regeneration Survey by Plot

Table of Natural Regeneration Study (Plot 2)

No.	Family Name	Botanical Name	Local Name	No. of Trees by Class					Appearance Rate
				A	B	C	D	Total	
3	Araliaceae	Oreopinex spp.	—	0	1	0	0	1	
10	Chloranthaceae	Hedyosmum sp.	Granizo, Silva silva	6	12	9	0	27	10.8%
13	Compositae	Montanoa sp.(?)	Camargo	0	0	0	1	1	
21	Dilleniaceae	Saurauia spp.	—	0	0	1	0	1	
23	Euphorbeaceae	Sapium spp.	—	0	0	1	0	1	
31	Melastomataceae	Miconia sp.	Niguito	0	3	2	1	6	
32	Melastomataceae	Miconia spp.	—	4	11	10	1	26	10.4%
34	Melastomataceae	—	—	33	94	16	0	143	57.0%
37	Myrsinaceae	Rapanea spp.	—	0	4	2	0	6	
42	Rubiaceae	Palicourea spp.	—	0	2	3	0	5	
43	Rubiaceae	—	—	0	4	2	0	6	
44	Sapindaceae	Allophylus spp.	—	4	7	2	0	13	5.2%
45	Solanaceae	Solanum spp.	—	0	0	3	0	3	
47	Staphyleaceae	Turpinia spp.	—	0	0	1	0	1	
52	Verbenaceae	Lippia spp.	—	0	0	0	1	1	
53	Verbenaceae	—	—	0	1	3	0	4	
59	——	—	—	1	3	2	0	6	
Total				48	142	57	4	251	100%

(4.18 tree/㎡)

Table of Natural Regeneration Study (Plot 3)

No.	Family Name	Botanical Name	Local Name	No. of Trees by Class					Appearance rate
				A	B	C	D	Total	
4	Araliaceae	—	Patedanta(?)	0	2	0	0	2	
10	Chloranthaceae	Hedyosmum sp.	Granizo, Silva silva	10	11	17	0	38	32.2%
22	Elaeocarpaceae	Vallea stipularis	Campano, Raque	0	2	0	0	2	
31	Melastomataceae	Miconia sp.	Niguito	1	4	2	0	7	5.9%
46	Solanaceae	—	—	46	13	8	0	67	56.8%
51	Verbenaceae	Lippia sp.	Gavilon	0	0	1	0	1	
56	——	—	Espino de oro	0	0	0	1	1	
Total				57	32	28	1	118	100%

(1.97 tree/㎡)

Table of Natural Regeneration Study (Plot 4)

No.	Family Name	Botanical Name	Local Name	No. of Trees by Class					Appearance Rate
				A	B	C	D	Total	
1	Annonaceae	Xylopia spp.	—	0	1	0	0	1	
2	Annonaceae	—	—	3	5	0	0	8	11.0%
9	Capriloliacae	Viburnum spp.	—	1	0	2	0	3	
10	Chloranihaceae	Hedyosmum sp.	Granizo, Silva silva	0	2	4	0	6	8.2%
11	Chloranihaceae	Hedyosmum spp.	—	1	0	0	0	1	
15	Compositae	Polymnia spp.	—	1	0	1	2	4	5.4%
20	Delleniaceae	Saurauia ursina	Dulumoco	1	1	6	0	8	11.0%
24	Euphorhiaceae	—	—	0	1	0	0	1	
25	Fagaceae	Quercus humboltii	Roble	1	1	0	0	2	
26	Flacourtiaceae	—	—	1	0	0	0	1	
31	Melastomataceae	Miconia sp.	Niguito	0	1	0	1	2	
39	Palmde	—	—	15	2	0	0	17	23.3%
42	Rubiaceae	Palicomea spp.	—	0	0	2	0	2	
45	Solanaceae	Solanum spp.	—	0	4	2	0	6	8.2%
46	Solanaceae	—	—	1	3	1	0	5	6.8%
48	Theaceae	Freziera sp.	Gerezo macho	1	0	0	0	1	
49	Verbenaceae	Aegiphila grandis	Tabaquillo	0	2	1	1	4	5.4%
59	——	—	—	1	0	0	0	1	
Total				27	23	19	4	73	100%

(1.22 tree/㎡)

Table of Natural Regeneration Study (Plot 8)

No.	Family Name	Botanical Name	Local Name	No. of Trees by Class					Appearance Rate
				A	B	C	D	Total	
1	Annonaceae	Xylopia spp.	—	0	2	0	1	3	
2	Annonaceae	—	—	2	1	0	0	3	
9	Capriloliacae	Viburnum spp.	—	0	1	0	0	1	
10	Chloranihaceae	Hedyosmum sp.	Granizo, Silva silva	1	1	3	3	8	6.7%
13	Compositae	Montanoa sp.	Camargo	0	0	1	0	1	
20	Dilleniaceae	Saurauia ursina	Dulumoco	0	0	1	0	1	
21	Dilleniaceae	Saurauia spp.	—	0	0	11	1	12	10.0%
27	Guttiferae	Clusia sp.	Cucharo	0	1	0	0	1	
30	Melastomataceae	Miconia sp.	Mortino	0	3	1	1	5	
31	Melastomataceae	Miconia sp.	Niguito	24	15	2	0	41	34.2%
32	Melastomataceae	Miconia spp.	—	0	0	3	1	4	
35	Monimiaceae	Siparuna spp.	Aguanoso	0	1	0	1	2	
38	Nyctaginaceae	Neea sp.	—	0	1	0	0	1	
39	Palmae	—	—	7	4	0	2	13	10.8%
43	Rubiaceae	—	—	0	2	0	0	4	
46	Selanaceae	—	—	2	4	0	0	6	5.0%
49	Verbenaceae	Aegiphila grandis	Tabaquillo	3	1	0	1	5	
57	——	—	Huesito	0	3	0	0	3	
59	——	—	—	1	4	1	0	6	
Total				40	44	24	12	120	100%

(2 tree/㎡)

Class A: Tree height <= 0.3m

Class B: 0.3m<tree height<1.3m

Class C: Tree height >= 1.3m, breast height diameter <5 cm

Class D: " 5cm <= breast height diameter <10 cm

for plot 2 is especially big for unknown reasons. As for the number of trees by species, Melastomataceae accounts for preponderant 70% and 42% respectively in plots 2 and 8. In plot 3 Solanaceae accounts for 57%, followed by Chloranthaceae with 32%. The largest family in plot 4 of the Central Forest Reserve is Palmae with 23%, followed by Solanaceae with 15%, Annonaceae with 12%, Dilleniacea with 11% and so on, with no particular species standing out.

The number of tree species is about 18, but the figure is halved to 7 in plot 3 with a higher altitude.

c. Forest Inventory Process

The forest inventory process depends on the location of plots. This preliminary investigation was carried out in a trial-error way, banking on the experience gained thus far. Its findings suggest the following team lineup is right for an investigation of the Intensive Area:

Two Japanese technicians; one technician from the counterpart; two tree species identifying technician; four laborers.

An inventory with this lineup is most efficient, with work loads properly assigned. The investigation process is divided into the following five components:

ⓐ A wheeled two-way travel between the investigation base (Manizales, Pensilvania or any other city) and the nearest road point. (The nearest point refers to the place with the shortest distance between the road and the sample plot.)

ⓑ A roundabout walking trip between the nearest point and the sample plot

ⓒ Time to establish plots

ⓓ Every-tree measurement time

ⓔ Time for investigation of natural regeneretion.

The survey area has the steepest inclination in the Andes Range, with every process largely depending on the topography and inclination of the area. Given below are the results obtained after considering every item:

ⓐ Two-way drive time

The two-way drive time varies with distances from the investigation base. Since most of the length of the national highway surrounding the the Intensive Area is unpaved but some part, the highway more often than not becomes impossible in a heavy rain. On many sections of the road a car has to drive at an hourly speed of up to five km because of many curves and a steep inclination. The preliminary investigation showed that an average hourly cruising speed on the paved section is about 25km and unpaved section is about 10 km.

ⓑ Two-way walking trip

The time of a two-way walking trip is approximately proportional to the distance from the road to the sample plot. The findings of the investigation showed that it took about one hour in the case of a man-made forest and about two hours in the case of a natural forest.

ⓒ Time for Marking Off Plot

The time for marking off a plot varies with the state of vegetation but is most dependent on the topographical features of the area concerned. This time it was decided to make oblong-shaped sample plots, with the longer side 50-250m. Few plots with the longer side 100m or more in a direct line do not exceed one slope, and most spreads far, comprising a small dell, with the steepest slope showing a grade of 48°

The per-ha average time it took to mark out a plot was one hour in a man-made forest and two hours in a natural forest.

ⓓ Every-Tree Measurement Time

The time of every-tree measurement was determined by the degree of the inclination, the volume of undergrowth and the number of trees to be covered in the investigation. In the man-made pine forest with a 0.1 ha plot, it took about one hour and a half, and in an alder forest, man-made and natural, it took about two hours and a half.

⑥ Time of Natural Regeneration Investigation

The time of a natural regeneretion survey is determined by the same factors as in an every-tree measurement. In this preliminary investigation it took about two hours to survey one plot with 60㎡.

To sum up the above items, it takes the following hours on average to survey a sample plot with 0.1 ha:

		Man-made forest	Natural forest
①	Two-way drive time	2.5	2.5
②	Two-way walking trip	1.0	2.0
③	Plot-making time	1.0	2.0
④	Every-tree measurement time	1.5	2.5
⑤	Natural regeneration survey	-	1.5
⑥	Others (rest, lunch, etc.)	1.5	1.5
	Total	7.5	11.5

Therefore, it became obvious that it takes one day to survey 0.1 ha of a man-made forest and 1.5 days a natural forest.

③ Survey for Establishment of Criteria for Land Use Interpretation

a. Survey Method

The status of land use within the Intensive Area was surveyed in order to decide on items of land use clarification needed for the interpretation of aerial photographs. The survey involved the field verification of the results obtained in the tentative interpretation of the existing aerial photographs.

b. Results of the Survey

Given below are highlights of the findings of the survey, including those which can be classified as future interpretation items as a result of tentative on-the-spot intrepretation.

- Forests can be classified into man-made, natural forests and bamboo thicket, with details to be given in a section on vegetation interpretation.
- Farm Forests (Providing overstory on coffee plantation and others)
- Coffee plantations without overstory.
- Farmland other than coffee plantations.
- High Altitude Grasslands (Natural Grasslands of over 3,000m)
- Pastures and Grasslands: Some are difficult to distinguish from pastureland or grass-cutting field or those considered part of farmland, depending on the crops cultivated.
- Cut-over area: There are extremely few forestry business-type cut-over areas in this district. They are felling blanks mainly to pave the ground for shifting cultivation and pastureland. The cut-over area seems to be identifiable.
- Denuded area: Collapsed sites and outcrop of rocks and so on are relatively easy to identify.

  However, it is difficult to distinguish thin and sparse pastureland on the alpine zone from ordinary denuded land.
- Draingge systems are easy to identify.
- Settlements are relatively easy to identify because in the Intensive Area urban districts are found mainly from the mountainside to the mountain ridge.
- Roads: Being skyways laid on the upper part of the mountains, many motorways can be identified.

c. Determination of Interpretation Criteria

Considering the results of investigations in section b,forests,farm

forests, coffee plantations, cultivated lands, pastures and grasslands, felled areas, denuded lands, drainege pattern and roads were determined as items of interpretation. However, the necessary revisions and modifications will be introduced in the above mentioned items using the aerial photographs to be taken later.

④ Survey for Establishment of Criteria for Vegetation Interpretation

a. Survey Method

The status of vegetation distribution within the Intensive Area was surveyed in order to finalize vegetation identification items needed for aerial photograph interpretation. The study method used is the same as in the land use classifiction criteria survey.

b. Results of the Survey

A tentative photo interpretation in the field produced the following interpretation items on aerial photographs:

- Natural forest: Distinguishing a natural forest from a second growth Proved to be difficult. However there were sites where this was possible. A second growth mainly composed of shrubs has many resemblances to a farm forest.
- Man-made forest: Tree species grown within the area are pines, cypresses, alders, eucalyptus. Coniferous trees are relatively easy to identify. The more aged broad-leaved trees, the more difficult their forest is to distinguish from a natural forest of broad-leaved trees.
- Farm Forests (These have to be distinguished from secondary growths, which are mainly composed of bushes)
- Bamboo thicket: There is a scattered distribution of bamboos, each thicket covering a small area, but it is possible to identify a bamboo thicket.
- Grasslands and Pastures : There are three kinds of pastureland, man-made, improved and natural. The older pasturing is, the more difficult their field identification is. However, it seems possible to identify a

natural pastureland found at a altitude of 3,000 m and more.

- High Altitude Grasslands (Photo interpretation of natural grasslands located at altituder of over 3000 m is possible)
- Cultivated land: It is easy to distinguish perennial crops, such as coffee, banana, and panera from annual crops like vegetables. It seems possible to identify as a farm a farm plot where those crops are grown mixed or non-shade trees are found. However, there seems to be no rice paddy within the area.

Something like a forest type identification criterion is yet to be produced by INDERENA, the agency concerned in Colombia.

c. Determination of Interpretation Criteria

Considering the results of investigations in section b, natural forests (natural forests, secondary growth), man-made forests (needle leaved by species,broad leaved), farm forests, bambo thickets, pastures and grasslands, high altitude grasslands and cultivated lands were determined as items of interpretation of vegetation.

Furthermore, the forest form of natural forests will be classified into 4 classes of crown density and 2 classes of crown diameter and that of man-made forests into 4 classes of crown density and 3 classes of total tree height.However, the necessary revisions and moditications will be introduced in the above mentioned items using the aerial photographs to be taken later.

⑤ Survey for Establishment of Criteria for Denuded Land Interpretation

a. Survey Method

The status of denuded land within the Intensive Area was investigated in order to finalize identification items for classification of forms of devastation.

The method used is the same as in the land-use clarification criteria investigation.

b. Results of the Survey

The tentative photo interpretation in the field stood short of setting

for clear interpretation items by form of denudation. The field situation can be summed up as follows:

- V-shaped channel erosion: This refers to the so-called gully erosion. Many are difficult to identify because large V-shaped channels often overlap riverheads.
- Surface erosion: This refers to the so-called sheet erosion. Sheet erosion is to be recognized on a very small part of pastureland, but it seems impossible to add this to the list of photographic identification items because the erosion effect is not generally active.
- Rain erosion: This refers to the so-called rill erosion. Rill erosion was judged difficult to pinpoint as an erosion because of quick vegetation rehabilitation in the area. Therefore its identification is impossible.
- Valley erosion: This refers to the so-called channel erosion, inclusive of bank erosion. No valley erosion of significant scale was found in the field. Since generally valleys are deep enough to become shades on photographs, those except particular ones seem to be difficult to identify.
- Deris flow and landslide: Though none of debris flows and landslides were identified in the field, it seems possible to locate any one of some scale.
- Collapse of percolating water type: This includes a natural erosion on the so-called steep slope. Some of small scale were found on the spot. Considering the way it occurs, it was confirmed possible to clarify a collapse of the type of a certain scale for photographic identifications.
- Man-caused erosion: This refers to the so-called accelerated erosion, which can be distinguished from a natural erosion because of its rate and causes. Since all the houses in this area, including to a dwelling

on the out-of-the-way mountain or field, has a water-supply facility but lacking a sewerage system to carry water safely, the outgoing water, therefore, run on the surface of land: often causing erosion especially when the slope is steep. Such erosion can be indentified on aerial photographs. However, it is difficult to distinguish them from the infiltrating water-type collapse described in the preceding paragraph.

C. Survey for establishment of the criteria for Photo interpretation of denuded lands

Debris flows and landslides, land collapses and man-caused erosion were determined as items of photo interpretation of denuded areas. Necessary modifications in these items will be made using aerial photographs to be taken later.

⑥ Soil Survey

a. Kinds of Soil

ⓐ Survey Method

In order to know the types and quality of soil distributed within the Intensive Area, a soil profile was dug in every forest survey plot for examination. Given below are survey items:

Position of soil profile, topography, direction, inclination, altitude, parent material, shape of soil profile, soil type, way of deposit, and vegetation.

The Yamanaka hardness tester was used to measure soil consistency and a handy pH meter to monitor pH. Fig. 20 gives the location of each plot, combined with its altitude and topography.

Simple trial pits were dug in every place, taking into account topography, forest type and vegetation, in order to help get an accurate picture of soil distribution which is necessary for the future preparation of a soil map.

Soil is to be ultimately classified using either FAO/unesco soil

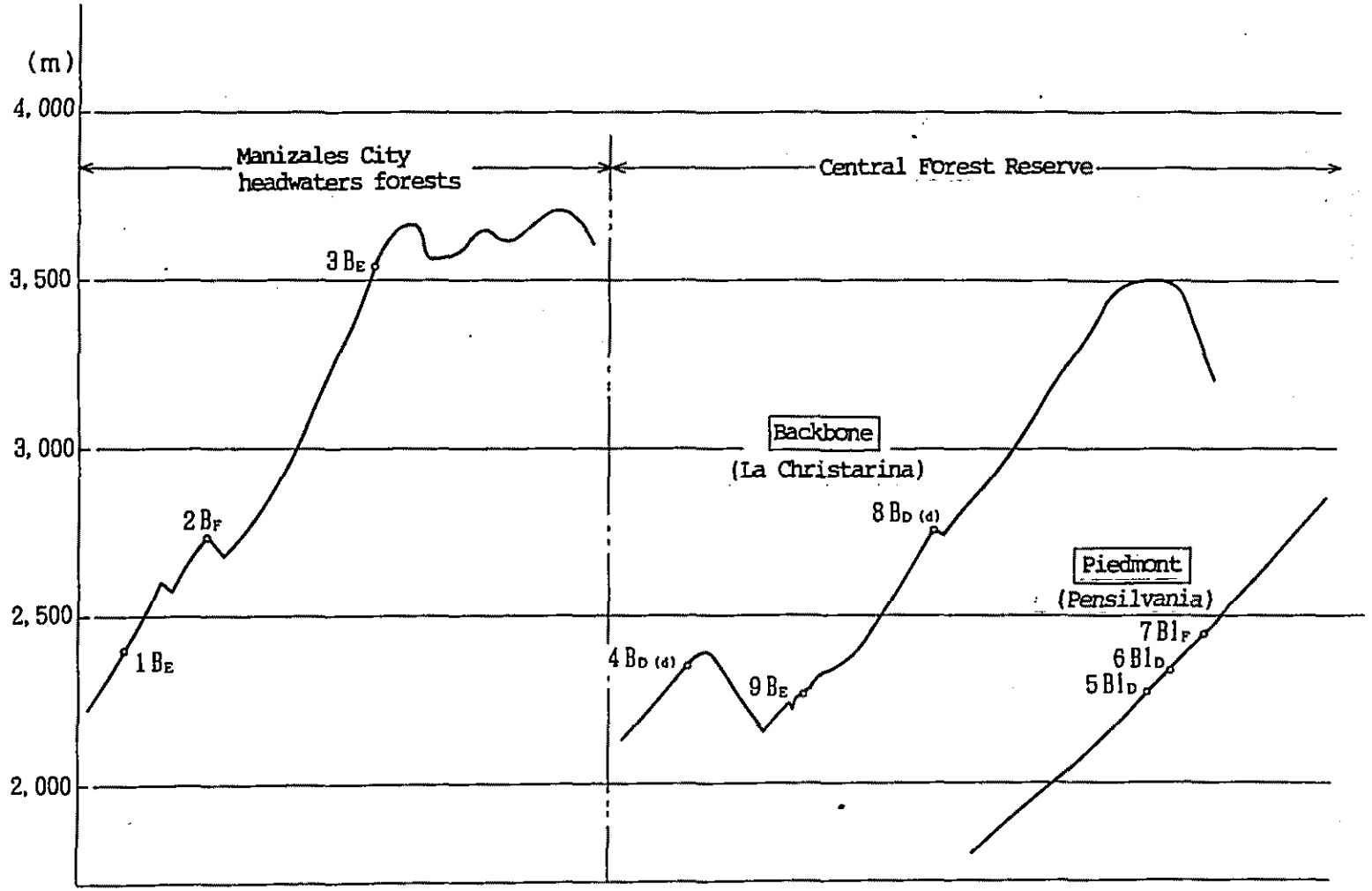


Fig. 20 Altitude, Topography and Soil Distribution

classification system or the USDA soil classification system in local use. Deciding to consider the matter while proceeding with the investigation, we continued with our study, relying on the Japanese forest soil classification method for the time being.

⑮ Results of the Survey

Table 22 lists types of soil observed in this field survey. There are two types according to the FAO/unesco classification system and six types according to the Japanese method.

Table 22 Types of Soil

FAO/Unesco	Soil types by the Japanese method
Humic Cambisol	B_D (d), B_E , and B_F ype soils
Moric Andosol	Bl_D (m), Bl_D (m)(faded in color), Bl_F types

Normally none of these types are distributed in the area in the tropical or subtropical climate, but they are to be widely found in the temperate pluvial region. This is thought to be due to the fact that the area covered in the survey is country in the north of the Andes Central Range, between 2,000 and 3,700 m in altitude, and is located in the warm and pluvial temperate zone, except the vicinity of the main edges.

The peculiarity of soil distribution in the surveyed land is attributable to the volcanic activities frequently repeated in the area centering on the headwaters forests of Manizales in the southwestern part of the model area. Its characteristic feature lies in the sandwich of a pumice layer scores of meters underground in particular as there is a widespread distribution of soil whose parent material is layers of a great lots of volcanic ejecta with different sedimentation periods.

The second peculiarity is to be found in the general presence of consistent massive-structure soil as a majority type except some outer strata. However, its cause is not necessarily clear. The soil profile

investigated is profile 9.

The results of the survey are summarized on Table 23. Profile number corresponds to plot number in forest inventory.

Table 23 Description of Sites with soil profile Examined

Profile Number	Soil Unit	Altitude (m)	Topography	Vegetation
1	Ch (B_E)	2,400	Mountainside with complex slope	Alnus jorullensis Man-made forest
2	Ch (B_r)	2,700	Mountainside with straight slope	Tibouchina sp.
3	Ch (B_E)	3,550	Mountainside with convex slope	Miconia sp.
4	Ch ($B_{D(d)}$)	2,370	Mountainside with straight slope	Polymnia sp.
5	Am ($B\ell_{D(m)}$)	2,280	〃	Cupressus lusitanica Man-made forest
6	Am ($B\ell_{D(m)}$)	2,340	Mountainside with complex slope	Pinus Patula Man-made forest
7	Am ($B\ell_F$)	2,450	〃	Pinus Patula Man-made forest
8	Ch ($B_{D(d)}$)	2,770	Minor ridge with straight slope	Miconia sp.
9	Ch (B_E)	2,260	On Convex part of a complex slope with many folds	Alnus jorullensis Man-made forest

Ch: Humic Cambisol
Am:Moric Andosol
The sign in a parenthesis refers to soil type by Japanese classification.

b. Shape of Soil Profile

Described below is the representative shape of soil profile of each type, classified by the Japanese method:

1. Representative Profile of Humic Cambisol

(1) B_D (d) Type Soil (Profile Number 8)

Location: Backbone of the Central Forest Reserve (La Christarina)

Altitude: 2,770 m

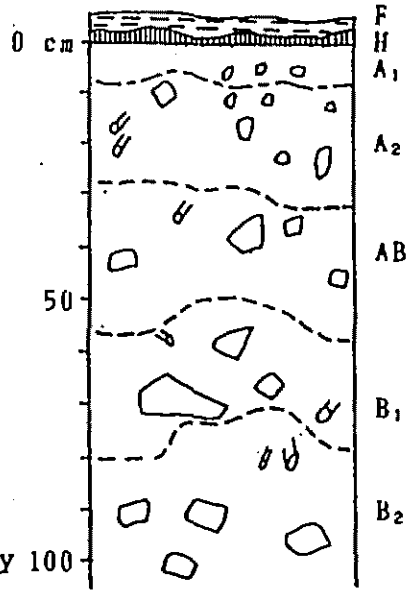
Topography: Minor ridge with straight slope

Direction: N50° E

Inclination: 40°

Parent material: Quartz andesite

Sedimentation form: creeping soil



Soil Profile Descriphion

F 2-3 cm Dark brown, fermentation horizon

H 1-3 cm Blackish brown, humus honizon

A1 5-8 cm Blackish brown-dark brown (7.5yr 3/2.5), clay soil rich in humus, mixture of some clod or angular structure with crumbed structure, consistency 4, wet, andesite gravel, fine and weathered, subroots, many rootlets, clear boundary.

A2 18-24cm Brown (7.5yr 4/3), fine sandy soil with humus content, massive-structure, weak angular and blocky structure only in the upper part, consistencey 11, wet, small and medium-sized gravel 10%, subroots, rare rootlets, gradual boundary

AB 20-30cm Grayish and yelloish brown (10 yr 4/2), clay soil with humus content, massive-structure, consistency 21, wet, gravel 15%, subroots, rare rootlets, gradual boundary.

B1 15-24cm Grayish and yelloish brown (10 yr 5/6), clay soil with humus content, massive-structure, consistency 19, wet, gravel 20%, subroots, rare rootlets, gradual boundary.

B2 30cm + Orange (7.5 yr 6/8), sandy soil with little humus, massive structure, consistency 10, moist, gravel 20%, subroots, rare rootlets

(2) B_E Type Soil (Profile No.1)

Location: Manizaleus City headwaters forests

Altitude: 2,400 m

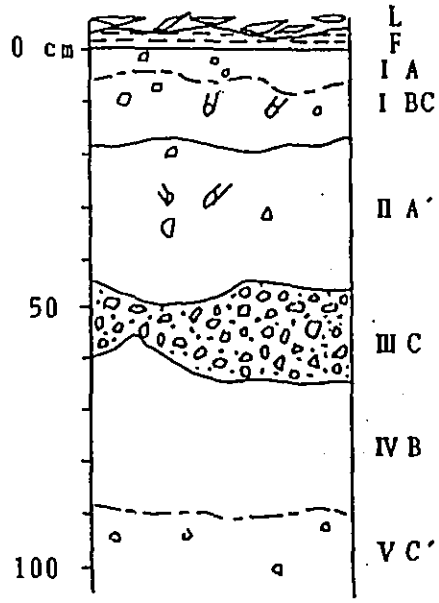
Topography: Mountainside with complex slope

Direction: S30° W

Inclination: 22°

Parent material: Volcanic ejecta

Sedimentation form: Residual soil



Soil Profile Description

L 2-3cm Litter

F 3-4cm Fermentation horizon

IA 4-7cm Blackish brown (7.5 yr 2/2), sandy soil rich in humus, crumb structure, mixture of 2 cm clod structure, hardness 4, wet, pumice-like gravel 2%, rootlets, clear boundary

1BC 10-15cm Darkish brown (10 yr 3/3), sandy soil deficient in humus, massive structure, hardness 16, wet-humid, pumice-like fine gravel 20%, subroots, clear boundany

IIA' 30-40cm Blackish brown (7.5 yr 3/2), soil rich in humus, massive structure, hardness 17, humid, pumice-like fine gravel, subroots, rare rootlets, clear boundary

IIIC 8-16cm Dull yellowish brown (10 yr 5/5), sand with little humus, single grain , hardness 17, wet, fine pumice gravel 90%, no root, clear boundary

IVB 25cm Darkish brown (10 yr 3/3), soil with humus content, massive structure, hardness 18.5, wet, no gravel, no root, clear boundary

VC' 15 cm+ Brown (10yr 4/4), sand with little humus, massive structure, hardness 19, wet, fine gravel 2%, no root

The above is soil whose parent material is several layers of volcanic ejecta with different sedimentation periods.

(3) B_F -Type Soil (Profile No. 2)

Location: Manizales City headwaters forest

Altitude: 2,700 m

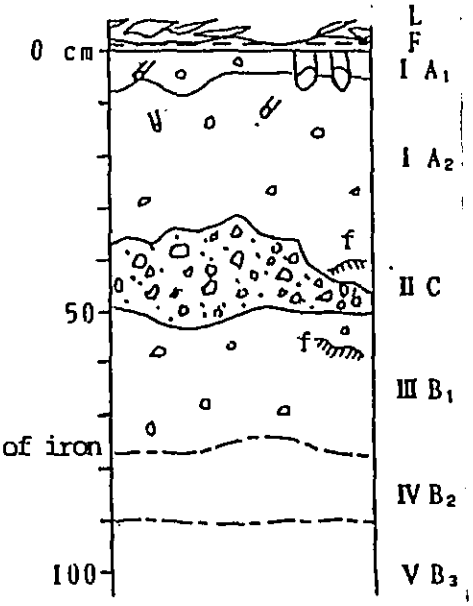
Topography: Mountainside with straight slope

Direction: N

Inclination: 26°

Parent material: Volcanic ejecta

Sedimentation form: Residual soil



f : specks of iron

Soil Profile Description

L 0-4m Litter

F 2-3cm Fermentation horizon

IA1 4-7cm Blackish brown (5yr 2/2), clay soil rich in humus, crumb structure, hardness 4.5-7.0, quite humid, fine gravel 2%, main and subsidiary roots, roolets, clear boundary

IA2 30-40cm Blackish brown (7.5 yur 2/2), crumb structure, hardness 16-19, quite humid, specks of iron, clear boundary

IIC 15-25cm Brown (10yr 4/4), sand with little humus, single grain structure, hardness 10.5, wet, fine gravel 95% mixing some scoria with pumice, no root, clear boundary

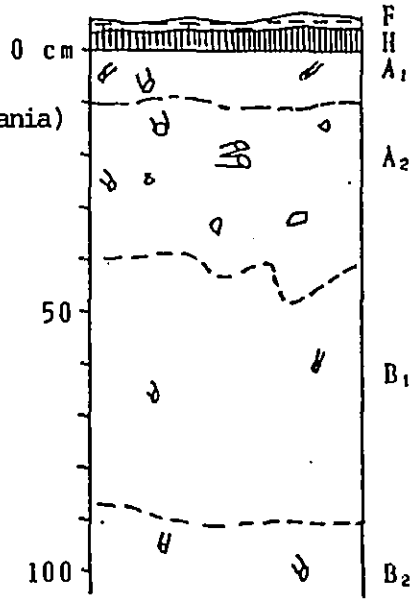
IIIB1 20-24cm Blackish brown (10yr 2.5/3), sandy soil with humus, massive structure, hardness 18.5, fine gravel 5%, no root, partially clayed with specks of iron, clear boundary

IVB2 10-14cm Blackish red brown (5yr 3/3), sand with little humus, massive structure, hardness 15, wet, no gravel, no root, clear boundary

VB3 15cm + Darkish brown (10yr 3/3), soil with little humus, massive structure, hardness 13.5, wet, no gravel, no root.

2. Representative profile of Moric Andsol

(1) $B\ell_D$(m) Type soil (Profile No. 5)



Location: Piedmont of Central Forest Reserve (Pensilvania)

Altitude: 2,280 m

Topography: Mountainside with straight slope

Direction: N40° E

Inclination: 30°

Parent material: Volcanic ejecta and quartz andesite

Sedimentation form: Sedimentary soil

Soil Profile Description

F 2-3cm Dark brown, fermentation horizon

H 3-4cm Blackish brown, powdered humus layer, pretty many rootlets

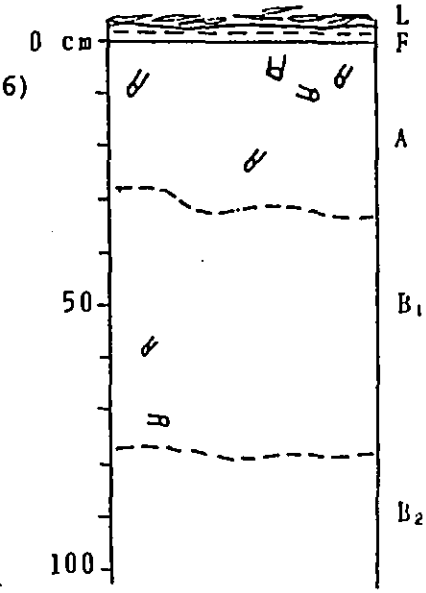
A1 10-12cm Blackish brown (7.5 yr 2/2), fine sandy loam very rich in humus, massive structure, partly fragile crumb structure, hardness 17.5-21.0, dry, no gravel, subroots, many rootlets, clear boundary

A2 32-36 Black (7.5 yr 2/1), fine sandy loam very rich in humus, massive structure, hardness 27.6, wet, fine gravel 2%, subroots, many rootlets, gradual boundary

B1 30-40cm Darkish brown (7.5 yr 3/3), soil with humus content, massive structure, hardness 23, wet, fine gravel 2%, subroots, rare rootlets, gradual boundary

B2 20cm+ Yellowish brown (10 yr 5/6), soil with little humus, hardness 19.5, wet, fine gravel 2%, rare rootlets.

(2) $B\ell_D$ (m) (Faded in Color) Type Soil (Profile No. 6)



Location: Piedmont of Central Forest Reserve (Pensilvania)

Altitude: 2,340m

Topography: Mountainside with complex slope

Direction: N70° E

Inclination: 15°

Parent material: Volcanic ejecta and metamorphic rock

Sedimentation form: Sedimentary soil

Soil Profile Description

L 2-3cm Litter

F 2-3cm Darkish brown, fermentation horizon

A 28-32cm Blackish brown (7.5 yr 2/2), fine sandy loam very rich in humus, massive structure, hardness 9.0-20.5, humid, no gravel, subroots, rootlets, gradual boundary

B1 38-40cm Darkish brown (10yr 3/4), fine sandy soil with humus, massive structure, hardness 23.5, no gravel, subroots, rare rootlet, gradual boundary

B2 250cm+ Brown(10 yr 4/4), fine sandy soil contain little humus, massive structure, hardness 22.5, no gravel, no roots.

The soil is faded black soil, what we call light-coloured Andosol, and the soil profile is highly consistent.

(3) $B\ell_F$ Type Soil (Profile No. 7)

Location: Piedmont of Central Forest Reserve (Pensilvania)

Altitude: 2,450 m

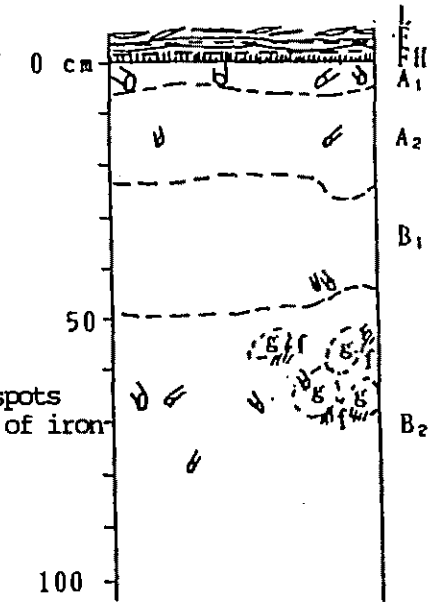
Topography: Mountainside with complex slope

Direction: S50° E

Inclination: 24°

Parent material: Volcanic ejecta

Sedimentation form: Residual soil



Soil Profile Description

L 1-2cm Litter

F 1-2cm Darkish brown, fermentation horizon

FH 2-3cm Darkish brown, mixture of damp decayed leaf and powered humus

A1 4-6cm Blackish brown(5yr 2/2), loam very rich in humus, massve structure, partially fragile crumbled structure, hardness 14, pretty humid, no gravel, subroots, rootlets, clear boundary

A2 16-18cm Blackish (7.5yr 2/2), loam very rich in humus, massive structure, hardness 24.5, humid, no gravel, rootlets, rare subroots, gradual boundary

B1 25-33cm Darkish brown (10yr 3/3), massive structure, hardness 25.5, wet, no gravel, subroots, rare rootlets, gradual boundary.

B2 40cm+ Dull yellowish brown (10yr 3/3), massive structure, hardness 25.5, wet, no gravel, subroots, rare rootlets, roots clustered at a depth between

60-70cm, tiny gray spots and specks of iron.

The profile is consistent throughout and significantly in B1 layer.

c. Future Direction of the Survey

This field investigation did not include a full-scale survey whose job it is to get a full picture of soil distribution. Generally topography influences the soil distribution in an area if climatic conditions remain the same all over that area.

This has been the case with the area investigated. Most of the topography of the model area covered in this survey is highly undulating, has many slopes, and is large in valley density: in short, complicated terrain with many folds.

Therefore, in order to prepare a fairly accurate soilmap for the model area it is essential to put stress on making a more informed knowledge of the relationships between topography and soil distribution in proceeding with a future survey.

Because the investigation was limited to the model area for its own convenience, we stop short of deriving necessary information for the position of the model area in the Intensive Area.

It is also of great importance to acquire and store information and to continue investigations by considering candidate sites for future reforestation and furthering the studies of the relationships of vegetation, the growth of tree species to be planted and land use with the kinds and quality of soil.

⑦ Local Socio-Economic Survey

a. Outline of the Survey

An interview survey was conducted of representative households within the Intensive Area to gather appropriate data on the lifestyle, customs and manners of residents around a candidate model area, the local industrial structure, the forms of agriculture and livestock raising, and the actual conditions of land ownership. The number of households covered in the investigation was 8 in the Central Forest Reserve area, 10 in the Manizales headwaters forest area, and 3 in the man-made forest of Pensilvania, 21 in all. Fig. 21 shows the sites of such investigation.

b. Survey Method

The method employed was to make a random sampling of inhabitants in the survey area, make direct interviews with them, and fill out the prescribed questionnaire by asking them questions.

The question items were given below:

o Years of settlement

o Form of employment

o Household composition(number of people, sex and age)

o Family budget (living cost and fuel consumption)

o Status of management(acreage of farmland, kinds and head of livestock, species of farm crops, income, etc.)

o Resident's consciousness (sufficiency of farmland acreage, future wishes)

c. Summary of Survey Findings by Item

The findings of survey findings by item are as tabulated on Tables 24 and 25. Their summaries are given below:

ⓐ Years of Settlement

The years of settlement differ with different households. The average years of the 21 households are 8.5 years.

ⓑ Forms of Employment

The forms of employment are classified into four categories, full-time self-employed farmer, part-time selfemployed farmer, employed farmer

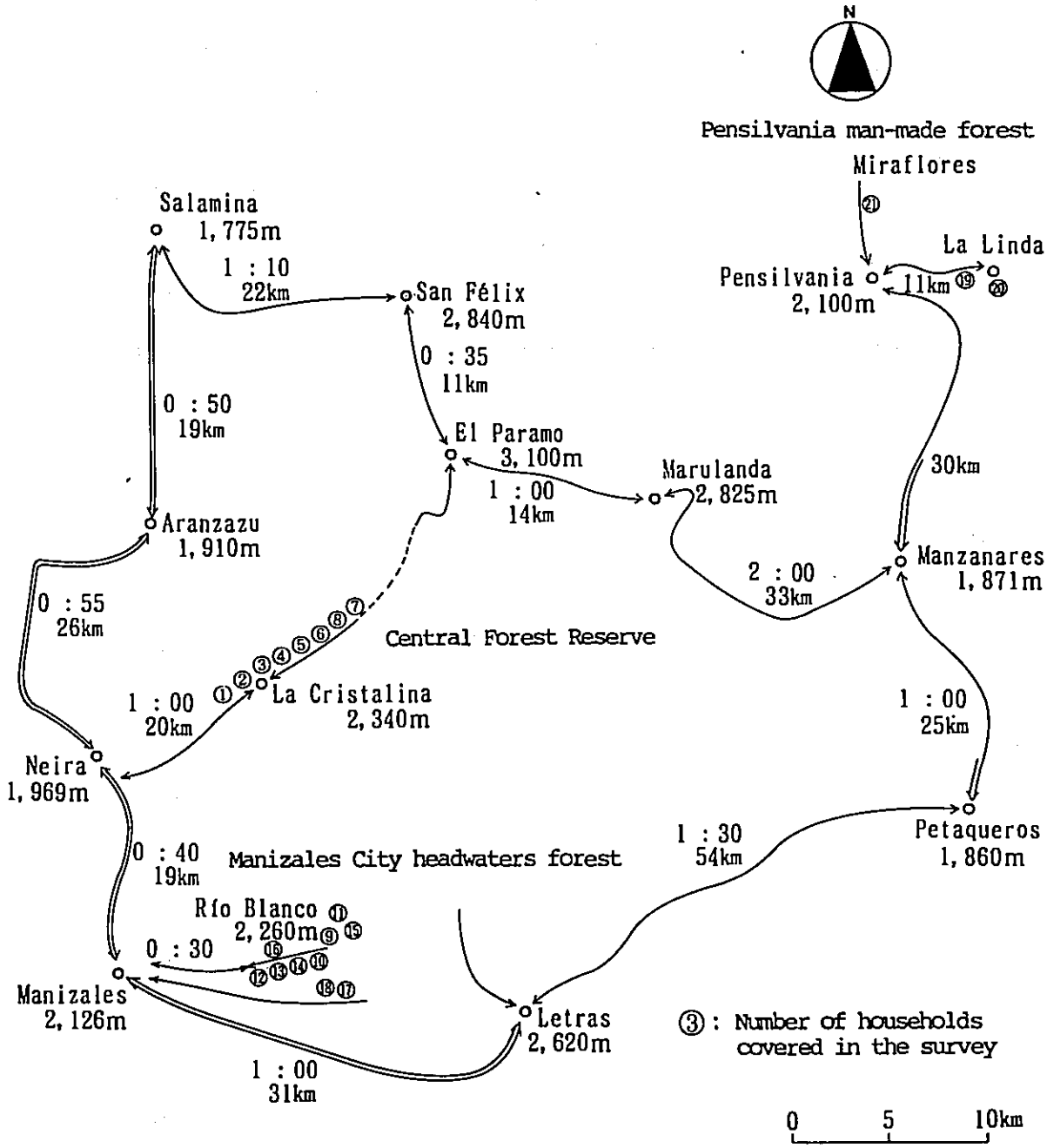


Fig. 21 Map of Sites of Local Socio-Economic Survey

(employed by a pastureland owner) and others. There were three full-time self-employed farming houses, two part-time self-employed farming houses, and three employed farming houses, and the rest 13 households. The last group includes 10 households of caretakers of the Manizales headwaters forests.

ⓒ Household Composition

The number of people who form the 21 households totals 113, 5.4 per household. To look at the number of households by the number of persons, the households with four to seven persons are the largest group, and in particular those with six persons account for 38.1% of the total. To classify the household members by age group, one five years older than another, people aged 5-9 years account for 18.5%, those aged 15-19 years 16.6%, those aged 10-14 years 12.4%. In short, the young people five to 19 years in age represent 47.5%, nearly a half of the total.

ⓓ Acreage of Farmland

The land (56.1 ha) owned by five self-employed farming houses breaks down: pastureland is 37.3 ha, or 66.%, fields 8.8 ha, or 15.7%, and others 10.0 ha, or 17.8%. To give a breakdown of the land (95.12 ha) tended by by three employed farming households and 10 households of caretakers of the Manizales headwaters forests, pastureland accounts for 94.5 ha and fields 0.62 ha.

ⓔ Yearly Cash Income

The per-household average cash income of those covered in the survey stood at 747,028 pesos (62,252 pesos a month) (1 US$ approximates 350 pesos). It breaks down: farming income 235,990 pesos (19.666 pesos a month) and non-farming income 511,038 pesos (42,586 pesos a month). In the case of caretaker households, proceeds from farming stood at 41,030 pesos (340 pesos a month) and non-farming earnings 726,060 pesos (60,505 pesos a month), a very low dependence on farming. The present minimum monthly wages are 32,560 pesos.

ⓕ Household Economy

i . Living Expenses

The households which gave answers to the survey questions spent the monthly average 37,192 pesos as living expenses. Its breakdown is: 20,391 pesos on grain(54.8%), 2,567 pesos on meat (15.0%), 4,929 pesos on vegetables (13,3%), 971 pesos on seasonings (2.6%), 4,167 pesos on clothing (11.2%), and 1,167 pesos on education (3.1%). Obviously food expenses account for a large share.

ii . Fuel Consumption

A variety of fuels are used, such as firewood, gas, electricity, and oil. Of all the households surveyed, 95.2% use firewood, extremely few use other fuels. Most of firewood is gathered by the households for themselves.

On the other hand, average monthly firewood consumption per household is 0.0379 m^3 in terms of timber. For reference, per-capita consumption is 0.166 m^3 (1.99m^3 per year).

ⓖ Status of Farming and Stock Breeding

i . Production of Livestock Products Main livestock in the Intensive Area are cattle, pigs, horses, sheep, fowls, geese, and turkeys. Cattle and pigs are being bred mainly for sale, and fowls and geese are for home consumption, and horses as draft animals.

Of cash returns from livestock products 93.9% are from cattle, most of which are from the sale of milk.

Species of cattle are of the native breed, Normandish (raised both for milk and beef), Holsteins (for milk) and of their crossbreeds. Generally grass used for their feed is Kikuyo (Pennisefum clandestinum) on the pastureland and Imperial (Axonopus scoparius) on the fields to gather grass for hay.

ii. Production of Crops

The crop growing seasons are not fixed in the Intensive Area, because the weather which changes little throughout the year is suitable

for the growth of crops. Except for coffee, vegetables and fruit trees are cultivated on a small scale for domestic consumption. Of all the crops only coffee (Caturra and Arábigo) yields cash. Among the self-supplied crops there are corn, potatoes, kidney beans, bananas, Peruvian turnips, onions, cabbages, pumpkins, tomatos, passionflowers, raspberries, and corianders (used as spice).

⑥ Resident's Consciousness

i . Degree of Satisfaction with Farmland Size

Of the households surveyed 28.6% replied that the present farmland was sufficient for farming and livestock breeding, while 71.4% complained about the shortage of farmland. However, as it is, in the Intensive Area there is little land left for the development of farmland, because most of the available land has been converted into farmland.

ii . Future Hopes

Some of the inhabitants hope to have a better life, but most of them can be described as content with the present life.

d. Outlook of the Socio-Economic Conditions in the Model Area

ⓐ Plantations are to be found along roads in the La Christalina district which belongs to the Central Forest Reserve in the model area, but most of the land in the area is pastureland under private ownership by owners of large stock farms. Many of about 69 households scattered over the area are those of workers employed at large stock farms.

Generally one head of milking or beef cattle is put to grass in one ha of natural pastureland. Pasture fences are to be seen along roads as boundaries of pastureland, but no clear demarcation line is drawn between pastureland and a natural forest. Naturally-grown trees are left standing in places of small valleys as fences against a landslide, which are tended in a very negligent manner. Domestic-consumption crops are grown mainly on fields made by the slash-and-burn method, which are gradually converted to pastureland as they lose fertility.

Fields along roads around Neira City — inclusive of the Rio Tapias

Table 24 Results of the Interview Survey

Area	Survey No.	Years of Settlement	Employment Form			No. of Household Members			Kinds of Fuels Used		
			Full-time Farmer	Part-Time Farmer	Worker	Male	Female	Total	Firewood	Charcoal	Gas, Electricity, Oil
National Forests at the Backbone of the Central Forest Reserve	1	54	O			1	0	1	O		O
	2	12	O			1	5	6	O		
	3	4			O	2	3	5	O		O
	4	0.2			O	3	3	6	O		
	5	0.8		O		4	2	6	O		
	6	4			O	2	3	5	O		
	7	1		O		4	1	5	O		
	8	2	O			3	7	10	O		
Manizales Headwaters Forests	9	8			O	3	3	6	O		
	10	4			O	3	5	8	O		
	11	0.2			O	2	5	7	O		
	12	0.2			O	4	2	6	O		O
	13	6			O	4	3	7	O		O
	14	5			O	3	3	6	O		
	15	2			O	2	2	4	O		
	16	0.6			O	4	2	6	O		
	17	9			O	3	2	5	O		
	18	9			O	4	2	6	O		
Man-Made Forest at the Piedmont of the Central Forest Reserve (Pensilvania)	19	6		O		3	1	4			O
	20	50			O	0	2	2	O		
	21	0.3			O	1	1	2	O		
Total		178.3	3	3	15	57	57	113	20		5
Average		8.5				2.7	2.7	5.4			
Share (%)			14.3	14.3	71.4	50.0	50.0	100.0	95.2		23.8

Table 25 Summary of Results of the Local Socio-Economic Survey (1)

February-March, 1989

Items				Grand Total	Per-Household Average Value	Remarks
No. of Households Surveyed				21		
Years of Settlement					8.5	
Form (No. of Households)	Self-Employed Farmer	Full-Time		3		
		Part-Time		2		
	Employed Farmer			3		
	Others			13		
No. of Household Members	Total			113	5.4	
	Sex	Male		56	2.7	
		Female		57	2.7	
Farmland Acreage	Land Owned	Pastureland		37.3		5 households
		Fields		8.8		5 households
		Others		10.0		2 households
	Land Tended	Pastureland		94.5		12 households
		Fields		0.62		11 households.
		Others		0.0		
Yearly Cash Income	Farming			4,955,800	235,990 } 747,028	US1$ approximates 350 pesos.
	Non-Farming			10,731,800	511,038 }	
Household Finances	Living Expenses	Total		781,028	37,192 (100.0%)	
		Food Expenses	Grain	428,216	20,391 (54.8%)	
			Meat	116,900	5,567 (15.0%)	
			Vegetables	103,500	4,929 (13.3%)	
			Seasonings	20,394	971 (2.6%)	
		Clothing		87,501	4,167 (11.2%)	
		Education		24,517	1,167 (3.1%)	
	Fuel Consumption		Firewood	18.759	0.9379	In terms of timber volume
	Use and Procurement of Fuels (No. of Households) Replies received from two households or more)	Firewood	Total	20 (95.2%)		
			Gathering	19 (90.5%)		
			Purchase	1 (4.7%)		
		Gas		2 (9.5%)		
		Electricity		4 (19.0%)		
		Oil		1 (4.7%)		

Table 25 Continued (2)

Item			Grand Total	Per-Household Average Value	Remarks
Status of Farming and Stock Breeding	Annual Farming Cash Income (pesos)	Livestock Products	2,155,800	235,990	
		Farm Produce	2,880,000		
	Production of Livestock Products (Head of Livestock Raised)	Cattle	120		17 households
		Pigs	12		10 households
		Horses	9		8 households
		sheep	18		1 household
		Fowls	176		19 households
		Geese	2		1 household
		Turkeys	1		1 household
		Coffee	1		Caffea arabica L. (Variedad : Caturra, Arabigo)
		Corn	4		Zea mays L.
		Potatos	2		Solanum tuberosum L.
		Kidney Beans	2		Phaseolus vulgaris
		Bananas	1		Musa sapientum L.
		Peruvian Turnips	1		Arracacia xanthorhiza
		Onions	2		Allium spp.
		Cabbages	3		Brassica oleracea
		Pumpkins	1		Cucurbita pepo
		Tree tomotos	5		Cyphomandra betacea
		Passionflowewrs	4		Passiflora mollisima
		Raspberries	1		Rubus glauca
		Corianders	1		Coriandrum sativum
Resident's Consciousness	Degree of Satisfaction with Farmland Acreage	Sufficient	28.6		
		Insufficent	71.4		

River basin flowing from the Central Mountain Region — are under coffee cultivation mixed with sugar canes and bananas using the traditional farming method.

ⓑ The Manizales headwaters forests are divided into the northern part and the southern part by the three rivers streaming at its center, Rio Blanco, Q. Dantas and Q. La Carlota. The northern part is privately owned and the southern part belongs to the Manizales City Public Works Bureau. About 1,000 ha of the private land on the northern side are made up of grazing grounds and fields, dotted with about 15 farming households engaged in potato growing as well as stock breeding. Houses of 24 caretakers tending the headwaters forests straggle across the southern land of about 3,000 ha owned by the Manizales City Public Works Bureau.

This time, of those residents in the land owned by the City Public Works Bureau ten households were selected at random for interviews. They are employed as caretaker staff of the City Public Works Bureau and mainly engaged in the maintenance and administration of man-made forests and waterways. Each caretaker staff member is provided by the City Public Works Bureau with wages, three milking cows, one horse and a house including some grazing ground. A home garden of 0.06 ha (20m x 30m) is developed around the house, and most of the pastureland is a man-made forest of aliso trees.

ⓒ Seen along the roads extending from Pensilvania City to La Lind to the east are many plantations owned by Maderas de Oriente and coffee fields partly grown with bananas.Fertilizer is applied to the cultivation of coffee, but no special measures are taken to preserve the soil on the steep slopes. La Linda is a hamlet of about 16 households about 11 km away from Pensilvania City, each supplied with service water and electricity.

The road leading from Pensilvania City toward Miraflores to the north is dotted with six or seven houses of sugar cane-growing farmers and

pastureland workers. The road conditions in that area are extremely bad.

On both sides of the provincial road leading to Manzanares City south of Pensilvania are sprawling plantations and pastureland owned by Pro-Oriente, and intermixed on the lower reaches of the river under 2,000 m in altitude are coffee, sugar cane and banana fields. The road conditions are not so good.

e. Next Survey

The next round of surveying will concentrate on the segement of the model area which was not covered in this survey. The survey will focus on the following aspects: the status of livestock breeding conducted by owners of stock farms which occupy the great majority of pastureland located in the Central Forest Reserve area; farmers growing sugar canes and coffee along the roads around Neira City; private land found on the northern side of the Manizales headwaters forests and the southern side of the Pensilvania man-made forests. The next survey will use the same method used in this survey, but since a status investigation will be conducted to clarify the relationships between the local inhabitants and the forests, new survey items will be added to meet the purposes.

(3) Decision on Model Areas

The model area in this survey is considered to be the field for an important model project which embodies the forest management plan guideline and presents an example to be emulated in handling a forest in any other similar area. Therefore, in order to pick up the most ideal site, we examined any likely variable factors in the conservation of the forest within the Intensive Area and a future large-scale development plan (e.g., a power generation dam project as shown on Fig. 6). With its findings in mind, we held careful consultations with the Colombian side and reached agreement on the proposed model area demarcation. (Fig.22)

① Model Area in the National Forest Area on the Backbone of the the Central Forest Reserve

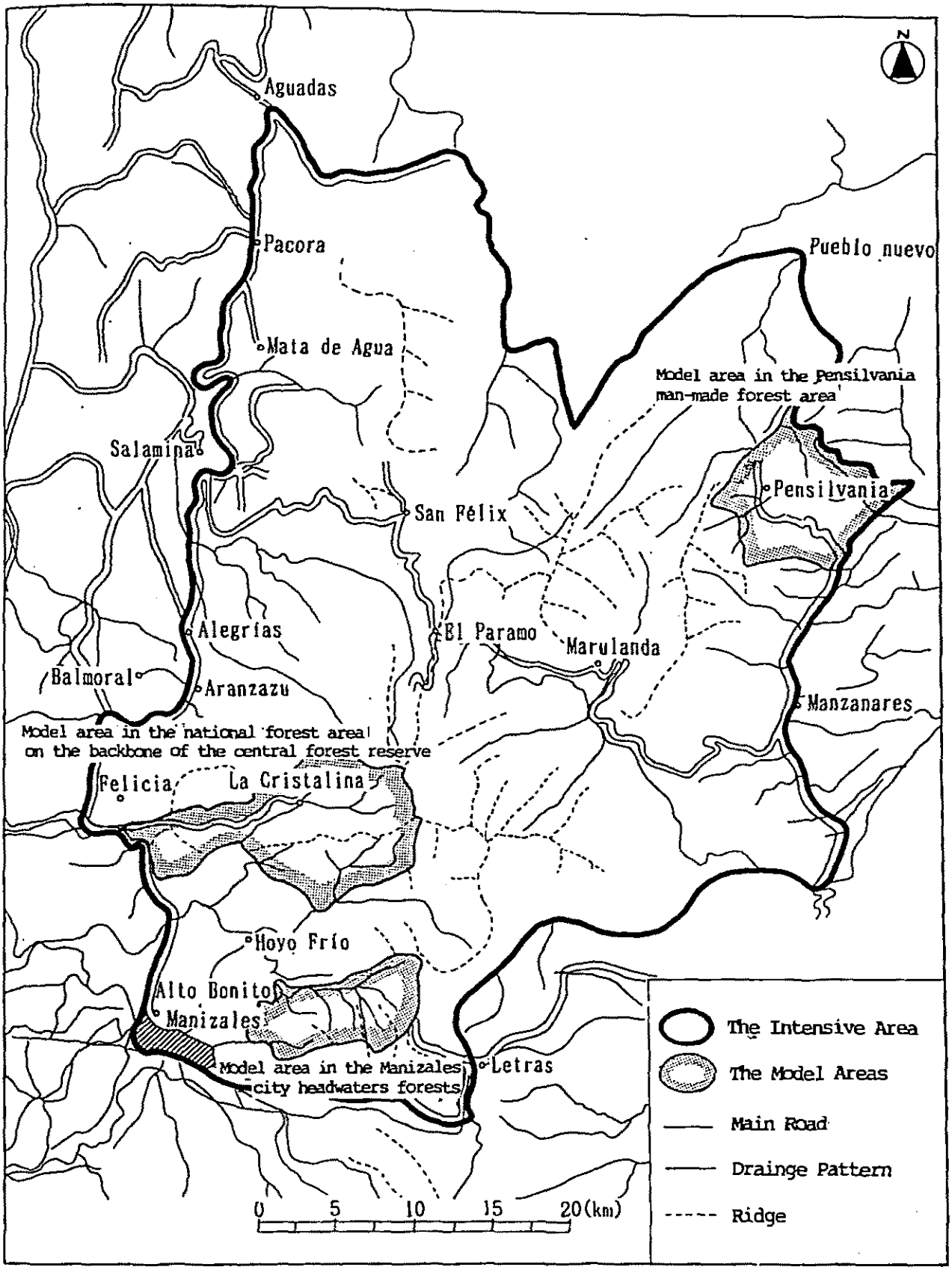


Fig. 22 Map of Model Area Location

This area comprises a portion 30 km wide on either side of the Backbone of the Andes Central Mountain Area, which is designated as the Central Forest Reserve by law No. ... of the Republic of Colombia. It covers specifically an area of about 9,650 ha of the Rio Tapias River basin, with La Christalina as its center, so that it can correctly mirror the actual conditions in the Intensive Area marked by an ongoing extensive forest development and various land uses.

② Model Area in the Manizales City Headwaters Forests

This area is marked off for the purpose of mapping out an appropriate management plan for the Headwaters forests of the provincial capital of Manizales with a population of some 300,000. The district administered by the Water Management Office of the city is used as the demarcation line of the model area, which specifically covers 4,343 ha of the Rio Blanco River basin.

③ Model Area in the Pensilvania Man-Made Forest Area

This area is marked out for the purpose of helping draft a business plan whose main objective it is to promote timber production in the area afforested for forest management. This is drawing considerable interest as the first of the type launched in Colombia. Consequently, the model area covers about 6,370 ha in the outskirts of Pensilvania city where plantations are relatively concentrated and where successes are expected to be obtained efficiently.

Ⅱ-5 Technology Transfer

The following are the main aims of technology transfer relating to the production of an overall plan for this survey.

① Understanding of the kind of a basic survey necessary for the preparatio of the plan and of the surveying method

② Understanding of how to process data obtained in the survey and the preparation of the plan.

The above are to be briefed when each report is presented, and since this is the first round field investigation, we gave a briefing on them at the time of explaining the inception report.

In the briefing session we gave a detailed explanation of where the ultimate goal of the survey lies, what survey method to use in reaching that goal, how to analyze the results of the survey and how to prepare the plan. At first the INDERENA side had an insufficient understanding of the aims explained, partly because they had no clear idea of what a forest management plan is about and partly because the survey is the first round of the series. However, as the consultations were repeatedly held, they showed a better understanding.

The above is about technology transfer pertaining the overall plan. In the field survey, each investigation team was assisted by the counterpart and gave what was termed on-the-job training through the operations. Described below are the contents of technology transfer provided by each group:

a. Remote Sensing Analysis

As for remote sensing analysis, we tranferred the technology of setting a training area and of the survey method to be used there. In particular the technology transfer mainly concerned how to check the status of land use, vegetation and forests with false colour images and pictures of primary ground cover classifications.

We also explained to them the technique of data processing and image interpretation in an analysis undertaken in Japan.

b. Aerial Photography and Mapping

As regards aerial photography, the technical transfer involved how to prepare a photography plan and draw up a map for the plan. In control point surveying, we transferred the technology relating to how to plan a control point survey, how to make a control point observation, and to the method of sticking needles into the existing photographs and the method of leveling.

c. Forest Management Plan

Throughout the forest management plan, we undertook the technology transfer of how to identify the objects on the surface by checking the existing aerial photographs against the actual area, and how to clarify land use, vegetation and waste land.

In the forest survey, the technology transfer concerned how to select a sample plot, how to mark off a sample plot, and how to measure a tree. In the soil survey, the technology transfer involved the method of soil profile description and soil classification.

This survey comprised the techinically undeveloped fields in the Republic of Colombia and contained a lot of aspects which interested the counterpart. It is likely that a sufficient technology transfer has been carried out as a preliminary survey.

Ⅱ-6 Study of Environmental Impact

This survey is designed to draft a project guideline and a model plan for proper forest management in a response to the decline of soil fertility, landslides and water shortage which are results of an excessive shrinkage of forests in the Central Forest Reserve in the Andes region of Colombia owing to the expansion of settlements. It is intended to prepare what can be termed an environment amelioration project through the establishment in place of a right management system for forest resources.

However, since the aim is to formulate a forest management plan covering a wide expanse of area, it will likely involve the change of the trend hitherto.

In short, as the project concerns the alteration of the quality of the land and the plan for different operations in the forest including felling, it is assumed that it will produce some effects on the physical and social environments. It is also necessary to conduct a careful environmental impact assessment because the Colombian Government is thought likely to proceed with the preparation of a forest management plan for the Andes region on the basis of the guideline emerging from the findings of this survey.

This time a preliminary survey was carried out, the data collected and the findings of the field investigation will be made the most of in a future environmental impact research.

A flow chart on Fig. 23 gives an outline of the method to be used in a future environmental impact assessment and each item is explained below:

(1) Method of Environmental impact Assessment

① Classification of Contents of the Plan

To infer from the contents of the plan and clarify the factors with an impact on the environment.

② Classification of Environment Elements

To identify the elements in the environemnt of the area subject to an impact.

③ Preparation of Matrix

To prepare the matrix for the factors in the plan and the environmental elements in regard to the generation and reception of an impact, predict the items likely to be affected by the plan and name the elements in the environment which requires on-the-spot investigation.

④ Establishment of Objectives of Environment Preservation

To establsih objectives of environment preservation as regards the environment elements to be investigated. To use the environment standards, if any in Colombia. If not, to set up the standards in consultation with INDEREN.

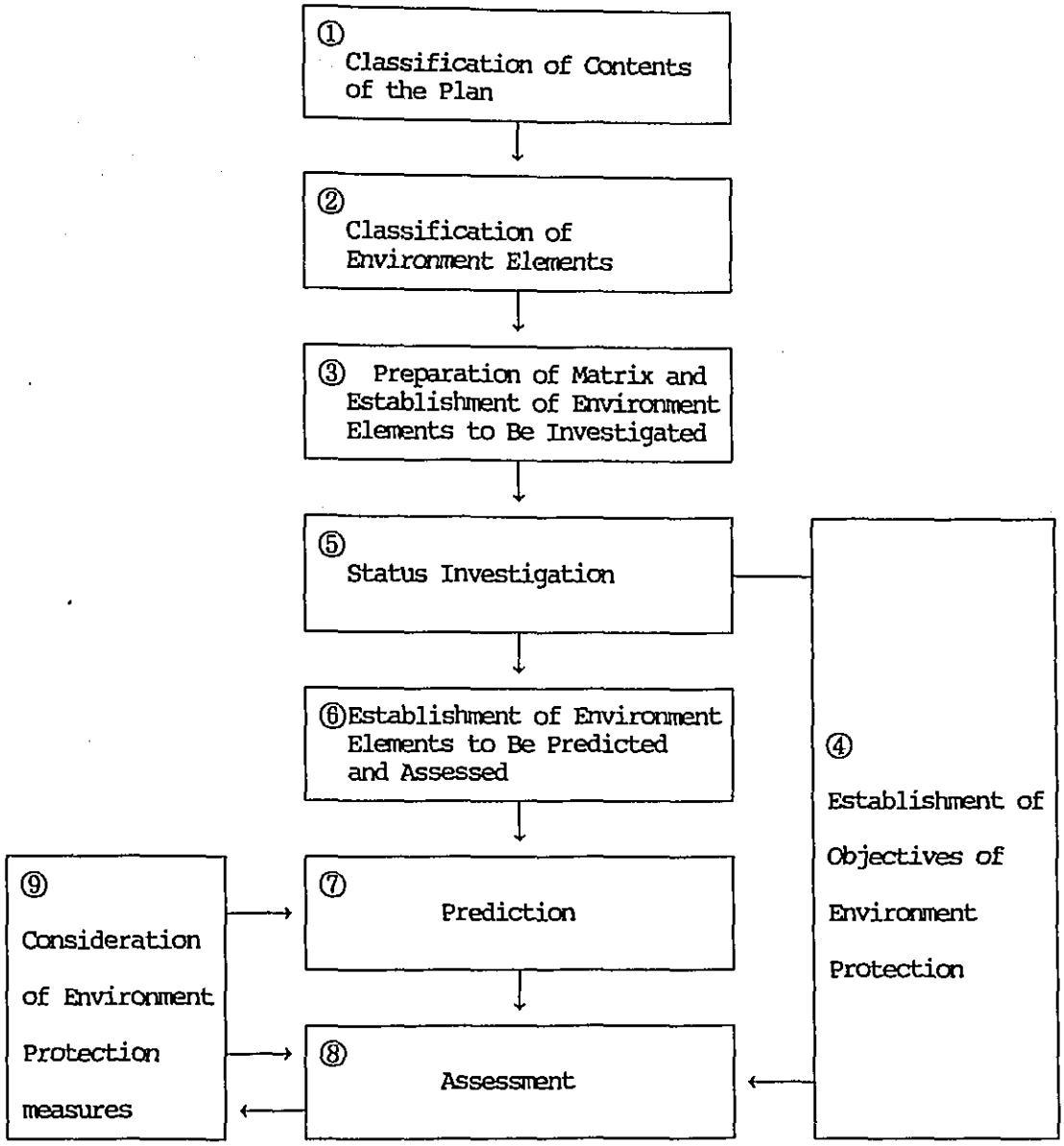


Fig. 23 Flow Chart of Environmental impact Assessment

⑤ Status Investigation

To carry out an status investigation of those environment elements of those items specified in the previously mentioned (3) which needs status investigation. A status investigation will be made up of collection of data, interviews and field investigation.

⑥ Establishment of Environment Elements

To remove from the findings of a status investigation the non-affected

elements which have cleared the environment protection goals and establish the environment elements which need prediction and assessment.

⑦ Prediction to clarify the changes in the environment elements when the pla is carried out, as regards to those specified in the preceding (6).

⑧ Assessment

To take into account the results of the predictions and assess the likely effects of the execution of the plans on the environment.

⑨ Consideration of Environment Protection Measures

To consider environment protection measures , such as the removal of harmful effects with the installation of proper facilities or review of the plan, in regard to those elements which environment effect assements suggest will likely produce baleful consequences. To repeat a prediction-assessment process depending onthe results of consideration of the possible measures and make a thoroughgoing scrutiny of measures which will clear the environment protection goals set in (4).

(2) Factors Likely to Produce Impact on Environment and Environment Elements

① Factors with Impact on Environment

The aim of this survey is to draw up a guideline for forest management plan and a modele plan to cover the forested area of Caldas Province in the the Central Forest Reserve of Colombia and assist in the establishment of a right management system for the forest resources of the country.

Therefore, the items of each model plan as illustrated in Table 26 are estimated to produce an impact on the environment.

② Environment Elements

The following items are environment elements likely to be adversely affected by the plan:

a. Natural Environment Elements

Water, weather, soil, rivers, swamps and lakes, plants, animals, scenic beauty, outdoor recreation, etc.

b. Socio-Economic Elements

Table 26 Factors with impact on environment

Plan \ Model area	Model plan for the national forest in the the Central Forest Reserve	Model plan for the Manizales headwaters forests	Model plan for the man-made ferests of Pensilvania
In relation to forest protection	Establishment of the area Suspension of loggin in the area marked off	Establishment of the area	
In relation to forest improvement		Suspension of logging, cutting down of thick grwoth within forest	
In relation to rehabilitation of denuded land	Works to prevent sediment discharge Works to rehabilitate collapsed land	Works to prevent sediment discharge Works to rehabilitate collapsed land	Works to prevent sediment discharge Works to rehabilitate collapsed land
In relation to forest management	Designation of area, Planting, Felling Forest protection measures	Designation of area Planting Felling Forest protection measure	Designation of area Planting Felling Forest protection measure
In relation to forest road construction	Opening of forest road, Use of road	Opening of forest road Use of road	Opening of forest road Use of road
Others	Creation of common-use forest,Creation of pastureland and farmland	Installation of facilities, Fire-fighting measures	Earnings and expenses, Labor

Land use, land ownership, agriculture, forestry and fisheries, employment, water exploitation, traditional customs and manners, religion, etc.

We plan to examine the factors likely to affect the environment and its elements prior to the next round of investigation, produce the matrix and classify the items to be objects of status investigation.

Ⅲ Outline of Future Study

As regards the taking of aerial photographs in this survey, all the planned photographing operations were not completed by the original target date, namely, March 31, 1989, and the operations are still under way. The operations completed till today are 40% of the plan.

The future surveys for forest management plans are dependent on when the taking of photographs will be wound up. Suppose the operations will be over sometime in July at the present rate,July 15, 1989,(in case it was not possible to conduct aerial photography a re-examination of the plan might be necessary) the following are an outline of the survey to be conducted:

This year's forest management plan survey can be defined as a basic survey. In short, field survey will be undertaken on the basis of the contents summed up in this progress report I, and its results will be summed up in progress report II, which will serve as the basis of next year's survey for forest management plans.

① Preparations in Japan for Basic Survey for Forest Management Plan

a. Collection of Data

To analzye data and information collected in the preliminary investigation for forest management plans and its findings and process them as basic material for the prepration of a survey plan.

b. Interpretation of Aerial Photographs

To make interpretations of land use, vegetation and waste land, using aerial photographs to be newly taken in accordance with the land use interpretation standards and the vegetation identification criteria which will be decided this year.

c. Advance Preparations for Field Investigation

To consider and classify survey items which need basic investigation on the basis of the analysis of the collected data and this progress report.

To prepare materials data necessary for field survey, sort out instruments, draft a schedule for field survey, and make out documents and

materials to ask the INDERENA side for facilities.

② Basic Investigation for Forest Management Plans (Field Investigation)

a. Consultation with INDERENA

To submit two reports to INDERENA, one being this progress report summing up the findings of the preliminary survey for forest management plans and the other being a report containing the findings of the analysis of remote sensing data, and then to explain their contents and hold consultations. To brief them on the objectives and contents of the basic investigation for forest management plans and ask them to provide facility to help conduct the survey without any hitch.

b. Field Investigation

ⓐ Matters Pertaining to Socio-Economic Survey in the Intensive Area

i . To collect data relating to the general socio-economic affairs from various organizations in the Intensive Area.

ii . Investigation of Relationships between Local Residents and Forests

To interview mainly peasants in the Intensive Area using the same method as in the preliminary investigation and get a prcise picture by asking questions about their way of life, living conditions, the past land uses, their relationships with forests and forestry, the method of cultivation, cropping system, varieties of crops, their yield, problems and their views on the administration.

iii . Market Distribution Investigation

To make an interview investigation of the status and issues of raw materials, line of products, output, equipment, manpower, problems, marketing system and so on, by polling businesses or individuals involved in forestry.

iv. Status Investigation of Farming and Livestock Breeding

This investigation is a parallel inquiry with the previously cited study of the relationships between local inhabitants and forests. To target local peasants engaged in grazing as regards pastureland and

investigate the management method, scale, and business condition of the pastureland, the kinds of domestic animals, the varieties of feed and grass, their relationships with forests and the chances of their co-existence with forests.

v . Probe of Demand-Supply Situation of Forestry Products

To make a probe of the status of the demand-supply situation of forestry productds related to the Intensive Area simultaneously with a market distribution research.

ⓑ Matters Pertaining to the Preparation of Soil Map, Map for Land Use Plan and Forest Type Map

i . Soil Investigation

To carry out a soil investigation of the modeal area to clarify the soil types and distribution and produce a soil map(scale: 1:20,000).

To make a soil profile investigation of a sample plot, pastureland, coffee fields and observe the relations of soil with land use, vegetation, and topography.

ii . Investigation of the Status of Land Use

To find out whether the interpretations of aerial photographs as regards land use in the model area are correct or not.

iii . Investigation of Forest Type and Vegetation

To find out whether the interpretations of aerial photographs as regards forest types and vegetation in the model area are correct or not.

ⓒ Matters Pertaining to the Preparation of Guideline and Model Plan for Forest Management

i . Soil Classification Investigation

To carry out simple pit tests for soil classifiction in the Intensive Area at the same time with a soil investigation.

ii . Forest Resource Survey

To choose the representatives from forest types and classifications and make an every-tree measurement as part of a forest survey.

iii. Investigation of Candidate Sites for Reforestation

To investigate candidate sites for reforestation in terms of the relationships of soil with the existing natural forests and man-made forest at the time of a soil survey.

iv. Survey for Establishment of Standards for Forest Improvement

A field investigation will be made of the forestry operations under way within and around the Intensive Area. A similar investigation will be carried out by the agencies concerned. The two investigations will help establish the standards for forest amelioration. Listed below are items to be explored:

- Aims, system and scale of operations (species and numbers of trees)
- Forest classification and tree species to be covered
- Renewal method, seedling production, procurement and preservation of seeds
- Selective felling, nursery method(vine cutting, pruning, shrub removal, weeding, etc.)
- Felling method, cut volume, bugging, yarding, hauling
- Volume table, increment, predicted yield
- Method of building logging road

v. Investigation for Preparation of Volume Table

The table of volume in use in Colombia was confirmed in the preliminary investigation. Standing trees to be measured in a forest survey will be covered in the investigation.

vi. Survey of Waste land

To conduct this survey, using findings of this progress report I and making the best of the technique of field exploration and field surveying in addition to interpretations of aerial photographs and topographical maps, interview investigations, field studies and

surveying.

vii. Study of Environmental Impact

This study will be conducted according to procedures mentioned in Study of Enviromental Impact in section II-6.

Progress report II will be drafted, summing up the above findings of the field investigations for the basic survey for forest management plans. The field investigations are scheduled to last for two months from late October to late December, this year.