JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF AGRICULTURE (MoA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

THE FOREST RESOURCES MANAGEMENT STUDY IN THE SOUTHWESTERN PART OF ETHIOPIA

VOLUME 1

MAIN REPORT

MARCH, 1998

JAPAN FOREST CIVIL ENGINEERING CONSULTANTS FOUNDATION
KOKUSAI KOGYO CO., LTD.

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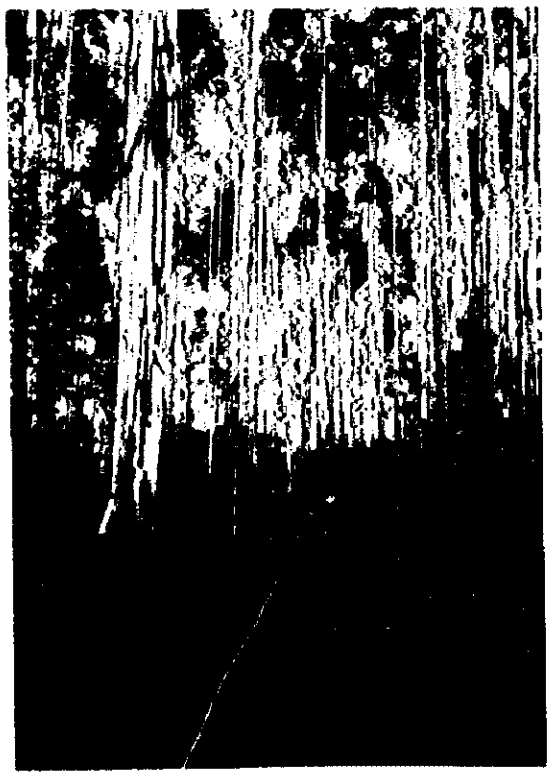
Distant view of natural forests
(Gera Forest)

Distant view of farmland and
forest plantation in the direction
of Komo Hari (Belete Forest)

A feeder turning into
a footpath in a natural forest
(Gera Forest)

Encroachment due to agricultural development at Elke Togobe

Transfer of aerial photograph interpretation techniques



Survey at a 12 year old planting site of *Eucalyptus grandis* (measurement of tree height by the counterparts)

Soil profile survey jointly conducted with the counterparts: soil type Ntu (Belete Forest)

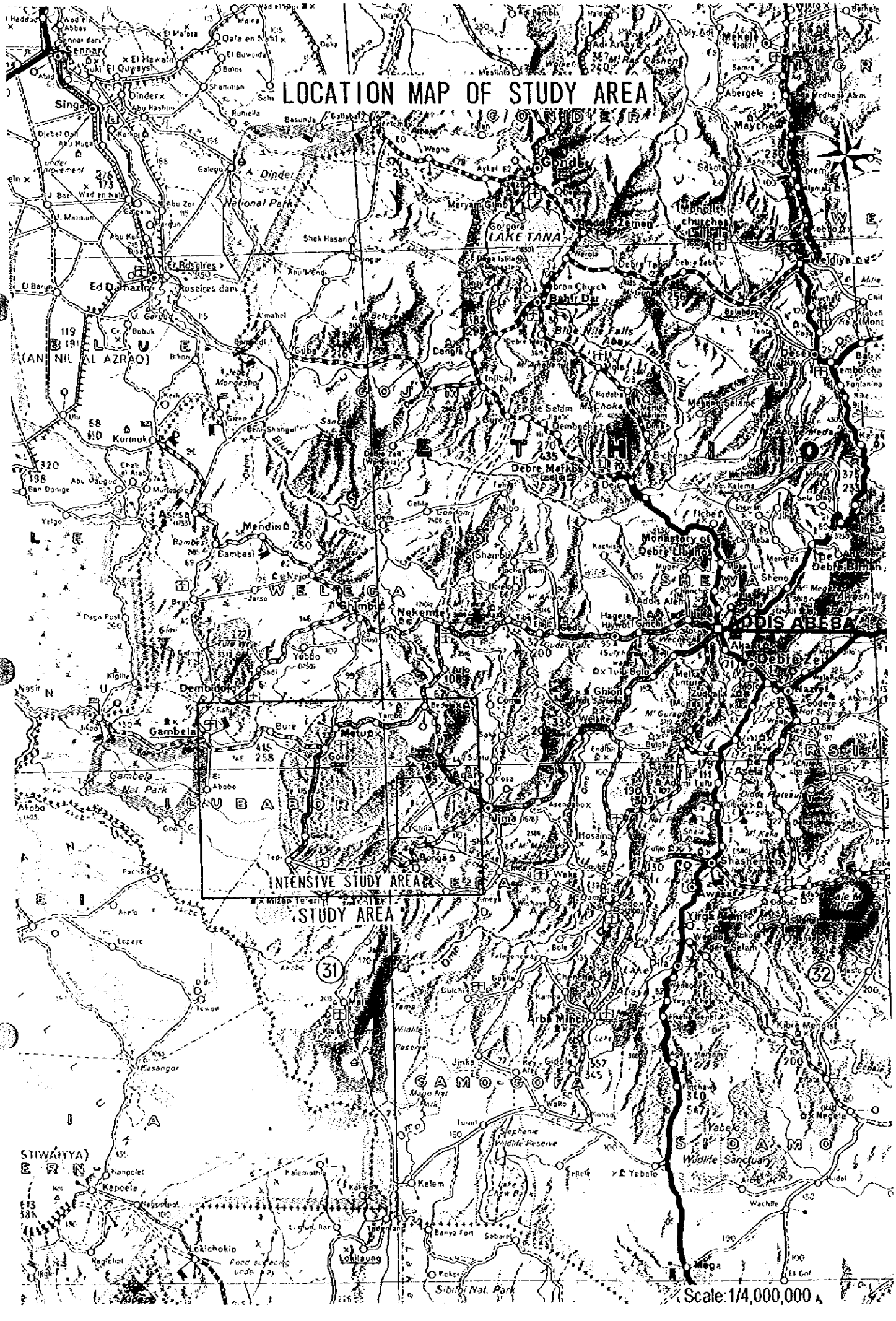
Social forestry survey (Kishe, Belete area)

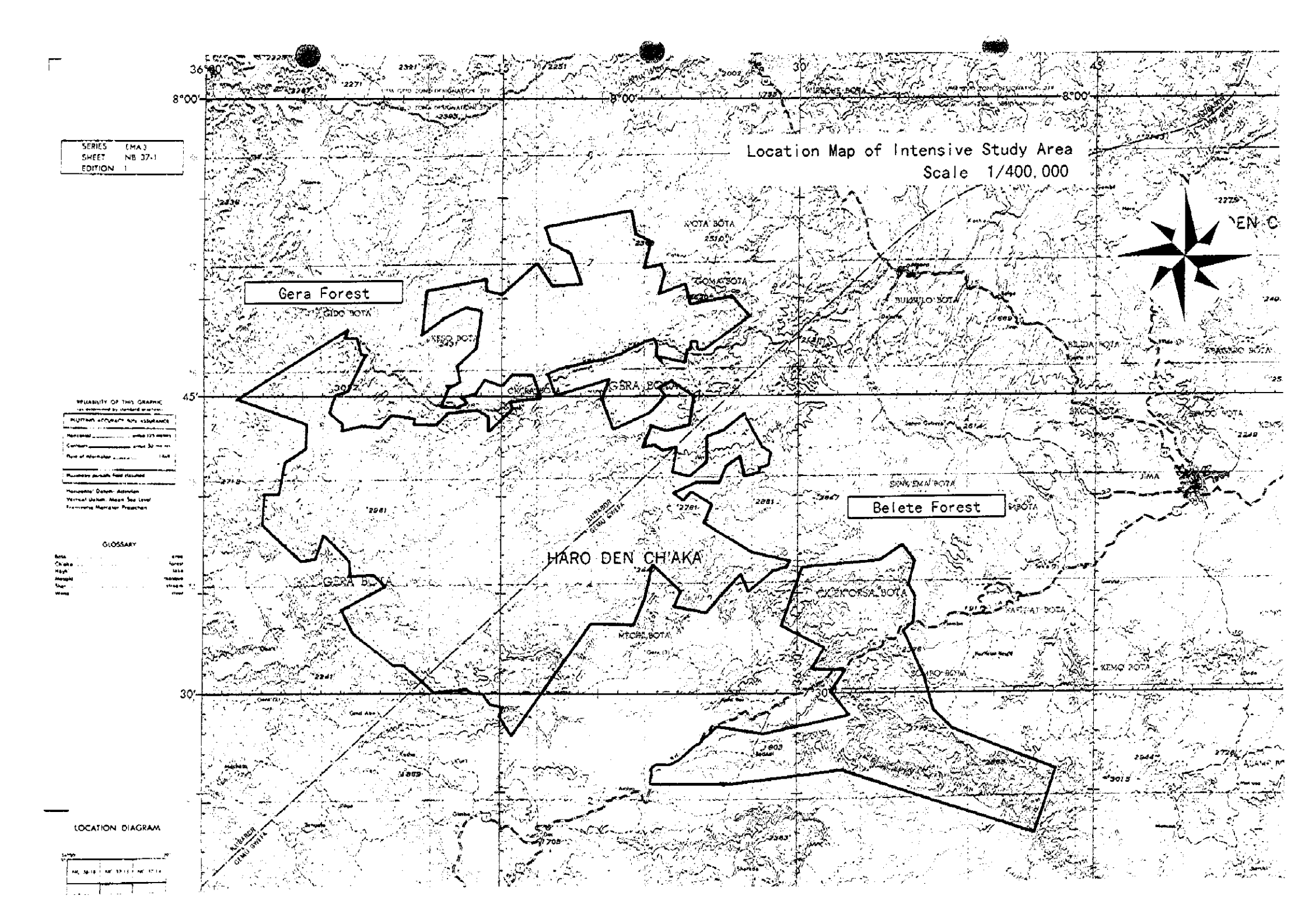
Scene of technology transfer to the counterparts during the forest survey (forest plantation)

Soil erosion seen at
a forest plantation of
Cupressus luseitanica

Harvesting of coffee beans in
a natural forest
(Gure Kesso, Gera Forest)

Technology transfer seminar


LOCATION MAP OF STUDY AREA
GONDER
Gondar
LAKE TANA
Bahir Dar
Blue Nile Falls
Debre Markos
Debre Zeit
ADDIS ABEBA
Nekemte
Shimbi
Dembidolo
Gambela
Metu
Jimma
Bonga
Mizan Teferi
INTENSIVE STUDY AREA
STUDY AREA
Arba Minch
Sodo
Yabelo
Mega
Scale:1/4,000,000


Location Map of Intensive Study Area
Scale 1/400,000
Gera Forest
Belete Forest
HARO DEN CH'AKA
SERIES E MA 3
SHEET NB 37-1
EDITION 1
8°00'
45'
30'
36°30'
GLOSSARY
LOCATION DIAGRAM

PREFACE

In response to the request from the Government of the Ethiopia, the Government of Japan decided to conduct the Forest Resources Management Study in the Southwestern part of Ethiopia and entrusted the study to Japan International Cooperation Agency (JICA).

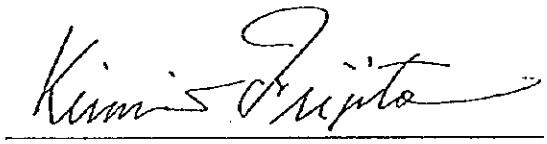
JICA sent to Ethiopia a study team headed by Mr. Tatsuka NUMATA, Japan Forest Civil Engineering Consultants Foundation six times during the period from February 1996 to January 1998.

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

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

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

March, 1998



Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF SUBMITTAL

Mr. Kimio FUJITA
President
Japan International Cooperation Agency

It is my great pleasure to inform you that the Forest Resources Management Study in the Southwestern Part of Ethiopia has been successfully completed and that the Final Report has also been compiled for submittal to your agency.

The present Report compiles the results of the surveys and analyses conducted and the plans, etc. formulated by the joint venture over the period from February, 1996 to March, 1998 in accordance with the contract made with the Japan International Cooperation Agency. The Study Team visited Ethiopia six times during the period to conduct field surveys in the Study Area.

The Forest Management Plan including countermeasures against encroachment of forest and aspects of social forestry was prepared by the Study Team through discussions conducted with the officials concerned of the Government of Ethiopia and by using the results of surveys conducted on natural conditions, socioeconomic conditions, forest resources and land use and vegetation, etc. in the Study Area.

I sincerely hope that the present Plan would be appropriately implemented with the efforts of concerned officials of the Government of Ethiopia and the Government of Regional State of Oromia and contribute to the development of Ethiopia through enhancing forest resources and raising the living conditions of local people.

I would like to take this opportunity to express my utmost gratitude for the considerable understanding and assistance afforded to the Study Team by JICA, as well as the Ministry of Foreign Affairs and the Ministry of Agriculture, Forestry and Fisheries. I would also like to draw your attention to the fact that the Study Team was provided with useful advice and assistance in Ethiopia by the JICA Ethiopia Office, the Japanese Embassy in Ethiopia, the Ministry of Agriculture of Ethiopia, the Government of Regional State of Oromia and many other organizations involved with the Study.

I sincerely hope that the Report in hand will be put to full use in the Study Area and that it proves useful for drawing up plans of similar projects in other areas.

March, 1998

Tatsuka Numata
Team Leader
Study Team for Forest Resources Management
Study in the Southwestern Part of Ethiopia

SUMMARY AND RECOMMENDATION

I. Summary

1. Introduction

The Government of Ethiopia, in an attempt to cope with the rapid deforestation in recent years, requested the Government of Japan in March 1994 to provide assistance in the compilation of Forest Management Plan, and as a result, the Forest Resources Management Study in the Southwestern Part of Ethiopia was carried out.

The objectives of the Study are as follows:

- Aerial photography and preparation of a forest location map for the Study Area covering approximately 2,700,000 ha;
- Preparation of a topographical map, land-use/vegetation map, soil map and a forest inventory book and compilation of a forest management plan for the Intensive Study Area covering approximately 150,000 ha; and
- Transfer of concerned technology to staff of the counterpart agencies on the Ethiopia side.

The Study Area is located in the southwestern part of Ethiopia and spans the Oromia, Gambela and Southern Ethiopia Administrative Region. The Intensive Study Area is the Belete-Gera National Forest Priority Area (NFPA) located to the west of Jimma.

In carrying out the Study, effort was made to ensure that the study findings were adequately utilized and the necessary technical transfer was conducted properly. In compiling the forest management plan, a balance between forest conservation and rehabilitation and the needs of local people was to be achived.

2. Basic Surveys

(1) Socio-economic Conditions

Concerning the survey of the socio-economic environment relating to the Intensive Study Area, data were collected, interviews with local people were carried out and local communities were studied through a local consultant. The local community survey covered 32 villages selected for their close relationship with Belete-Gera NFPA and its environs.

(2) Initial Environmental Survey

The Intensive Study Area does not include any wildlife sanctuaries, historic monuments nor reserves for indigenous people, and so on, that have been established by national or international agreements.

(3) National Forestry Policy

Currently in Ethiopia, the Forestry Conservation, Development and Utilization Proclamation promulgated in 1994 acts as the basic policy covering all areas of forests and forestry.

Moreover, as a country-based programme of the Tropical Forestry Action Plan (TFAP), which is a global agreement reached in 1985, the Ethiopian Forestry Action Program (EFAP) was formulated in December 1994. This urges preparation of forest management plans on the basis of a comprehensive forest resources survey.

(4) Aerial Photographs and Topographical Map

Monochromatic aerial photography on a scale of 1/25,000 covering the Study Area of 2,700,000 ha was consigned to Swedesurvey Co. Photography was carried out over two stages (January and February 1996, and October 1996 through February 1997) and photographs covering 2,530,910 ha, equivalent to roughly 94% of the target area, were produced.

Concerning the topographical map (1/25,000) of the Intensive Study Area, existing topographical maps (1/50,000) were enlarged where available and, for areas where no topographical maps currently exist, a map was prepared by using images by the French SPOT satellite.

(5) Soil Survey

A soil profile survey necessary for classifying soil in the Intensive Study Area was conducted and, based on this soil classification, a soil map (1/25,000) was prepared. A comprehensive survey results and description of soils were prepared.

(6) Land Use/Vegetation Survey

(i) Forest Location Map

A forest location map of the Study Area of 2,700,000 ha was prepared upon carrying out interpretation of the aerial photographs, field verification of the interpretation findings and transcribing onto existing topographical maps (1/250,000). This work was subcontracted to a local consultant.

(ii) Land Use/Vegetation Map

A land use and vegetation map (1/50,000) of the Intensive Study Area was prepared through interpretation of the aerial photographs and field verification. Classifications of the land use/vegetation map are as indicated in Tab. 1.

Forests in the Intensive Study Area has been largely affected by human disturbance. The total area of F1 forest and F2 forest where disturbance has been minimal comes to only 82,572.0 ha or 55.4% of the total area. The combined area of forest being encroached (OT) and F4 forest where encroachment is in progress amounts to 52.1% of the forest area.

Tab. 1 Classification of land-use/vegetation types and areas

Classification	Sub-classification	Symbol	Crown Density	Area (ha)
Forest land	Closed high forest	F1	75%	64,314.0
	Disturbed forest	F2	51% to 74%	18,258.0
	Heavily disturbed forest	F3	20% to 50%	23,810.0
	Under-stocked forest	F4	<20%	3,096.0
	Forest plantation	PL		1,103.5
	Bamboo thicket	BT		2,232.0
Non-forest land	Farmland, grazing field and village	OT		35,574.0
	Marsh	M		560.0
Total				**148,947.0**

(iii) Current Conditions and Issues of Land-Use

Two major issues, the encroachment of natural forests and coffee production in natural forests, had been identified. Followings can be raised as causes of the issues:

a. population increase resulting from high birth rate in the past 20 years and national resettlement programs;

b. lack of, or insufficient, environmental awareness and motivation to plant trees among local people; and

c. unclear NFPA boundaries, no understanding of the concept of NFPA within local society, and inadequate execution of administrative policies, as can be seen in weak, or non-existant, coordination among policies in agriculture, coffee production and forestry.

The number of areas where encroachment has occurred in the past four years is 291, and the combined area of these amounts to 8,615 ha or 5.8% of the total Intensive Study Area. Encroachment has largely been occurring on areas with gentle slope around settlements or along roads.

Coffee cultivation by farmers within natural forests has a serious impact on the forest and leads to decrease in tree density and the variety of tree species in natural forests. It is estimated that between 26-50% of accessible natural forests are affected by coffee production activities. In order to ensure the effectiveness of the Forest Management Pan, it is vitally

important that overall policies on forestry, agriculture and coffee production are well coordinated.

(7) Forest Survey

Stand volume in both natural forests and forest plantations was inventoried by the standard plot method. The total stand volume of natural forests is approximately 36,000,000 m^3, of which 26,000,000 m^3 is commercially usable, though infrastructure development would be required in order to achieve this. The stand volume of forest plantations is approximately 199,000 m^3.

(8) Forest Operation Survey

(i) Timber Production

The amount of timber harvest in the Intensive Study Area dropped by half from 2,670 m^3 in 1995/1996 to 1,340 m^3 in 1996/1997. It was thought initially that this trend would continue into the future, however, further examination would be carried out based on the results of the allowable cut in the natural forest. Now, an estimated annual timber harvest on a sustainable basis would be about 7,000 m^3 (See also 3-4-1).

In the Intensive Study Area, there are no forest plantations that have reached the main harvest age, but thinning was carried out in *Cupressus lusitanica* and *Pinus patula* plantations. The thinning quantity in recent years has been 1,200-2,700 m^3 over 70 ha per year. Judging from the conditions of stand, thinning should be scheduled for many stands.

(ii) Reforestation and Protection

Weeding should be carried out for two or three years after planting, however, the current practice is only for the first year. This situation should be rectified.

Nursery techniques for main exotic species, e.g. eucalypts, cypress and pine, are already developed. In case of indigenous species, seedlings production at operational scale of *Hagenia abyssinica* is possible, but the techniques for other indigenous species are yet to be developed. This must be tackled as a matter of urgency.

Concerning measures for the prevention of forest fires, look-out towers have been constructed and forest guards are to monitor the outbreak of fires. However, equipment and staff are inadequate, and need to be improved immediately.

Currently no records of disease and pest damage in the forest plantations exist, however, signs of damage on *Cupressus lusitanica* and *Pinus Patula* in the surrounding NFPAs have been reported. Therefore, it is necessary to build a system for early detection and quick remedial action in the near future.

(iii) Timber Utilization

The amount of timber produced by Belete-Gera NFPA is 1,340 m^3/year from natural forest and approximately 1,400 m^3/year from forest plantations. Logs are mainly supplied to plants in the Jimma Zone (See also (i)).

(iv) Current Road Conditions

As a result of poor maintenance after the construction of roads, most existing roads suffer badly from erosion caused by rain. Motorable roads must be repaired and maintained well for the implementation of the Forest Management Plan.

(9) Social Forestry Survey

(i) Forest Utilization by Local People

The main benefits from the forest, as felt by the local people, are firewood and construction timber for domestic use. In 12 villages around the Intensive Study Area, deforestation, or degradation, of surrounding natural forests has led to smaller amount of collected firewood from more remote areas.

(ii) Education and Extension

The followings are some of the education and extension activities currently conducted in and around the Intensive Study Area:

a. forest conservation education at primary schools as extracurricular activity in line with agricultural production and tree seedlings production,

b. supply of tree seedlings from District Nurseries to local people; and

c. assignment of agricultural extension agents and home agents.

In addition, traditional mutual-aid organizations (Shene) that are active at ceremonial occasions and temporary communal working group (Debo) for farming exist in the Study Area, and it is expected that these organizations could play an important role in the promotion of social forestry.

(iii) Homestead Tree Plantations

Eucalypts are planted in homestead. Sites planted are commonly around farms and on farmland. These trees serve the domestic use of construction timber and firewood. Excess is sold as construction timber.

(iv) Expectations of Forest and Needs of Local People

The most immediate need of the local people is firewood for domestic use. In particular, in villages where there is a firewood shortage, they strongly desire to collect firewood from nearby. Species commonly preferred as firewood are eucalypts and cypress.

3. Forest Management Plan

3-1. Basic Concept

The Forest Management Plan consists of the following plans compiled on the basis of the various basic surveys, and would be implemented over a period of ten years.

- Forest classification
- Resource management plan
- Operation Plan:
  - Forest utilization
  - Reforestation and protection
  - Social forestry measure
  - Infrastructure improvement
- Project cost
- Initial environmental impact assessment and erosion control
- Management system
- Monitoring

3-2 Forest Classification and Function Classification

The forest has been zoned according to named forest, forested or non-forested, main river basins, forest functions and forest types, and is composed of compartments and sub-compartments.

In function classification, the forests are grouped into preservation forest, area closure, production forest, restoration forest, reserved forest and consigned forest. Criteria for management methods aimed at maintaining and improving each function have been established.

The forest inventory book contains details of land conditions (compartment and sub-compartment numbers, area, altitude, slope, soil type, etc.) and forest conditions (forest, type, tree height, stand volume, etc.) for each sub-compartment.

3-3. Resource Management Plan

The resource management plan contains measures intended to protect the forest from other

land-use. As mentioned earlier, the main problems in land-use within the Intensive Study Area are encroachment (competition between forestry and agriculture) and coffee production in natural forests. This plan proposes specific measures designed to raise awareness towards forest conservation. However, whether or not these measures are effective would depend on how well national and regional level policies are coordinated to achieve a balance between the competitive laud-use policies.

To prevent encroachment of natural forests, two strategies, one to contain further expansion of encroachment and another to restore encroached land would be adopted.

Measures proposed for preventing the expansion of encroachment are (a) maintaining a close cooperative relationship with PA, (b) bolstering patrols and improving legislation on encroachment, (c) setting up boundary posts, and (d) setting priority for patrol areas.

Measures proposed for restoring encroached land are (a) to set priority among encroached areas, (b) to relate restoration plan to other plans for reforestation and social forestry, etc., (c) to maintain close dialogue with other government agencies and private organizations, (d) to analyze the risk of possible encroachment and to assess the possibility of encroachment prevention, and (e) to encourage participation of PA in planning and implementation of relocation plans for encroachers.

In order to control coffee cultivation within natural forests, a permission or registration system would be established and unlawful activities within forests would be regulated.

3-4 Operation Plan

The operation plan is composed of the plans for forest utilization, reforestation and protection, social forestry measures and infrastructure improvement.

(1) Forest Utilization

The forest ulitization plan pertains to proper utilization of timber and other forest products.
Gera Forest with a relatively dense distribution of closed high forests, would be the area for harvest of natural forest. Based on the area, stumpage volume, growth, selective felling rate, and also taking into account damages from encroachment, an allowable cut would be about 7,000 m^3 a year on sustainable basis.

Operation in forest plantations would be mostly thinning, as only a few stands will reach the main harvest within the project period. The harvest volume, arrived at by adding the thinnings and main harvest would be 17,400 m^3 a year over the project period.

Forest utilization by local people are (a) collection of dead branches and leaves, (b) cutting of construction timber for domestic use (with permit), (c) apiculture, (d) collection of natural

coffee beans, and (e) collection of medicinal herbs.

(2) Reforestation and Protection

(i) Planting

The land for planting in the Intensive Study Area are F3 forest, F4 forest and encroached land (OT). The areas are gentle slopes within 2 km from the existing roads.

The following table shows the planned annual reforestation area during the ten year project period.

Tab. 2 Reforestation area by year

Year	1	2	3	4	5	6	7	8	9	10	Total
Area (ha)	268	320	341	393	425	449	424	420	437	410	3,887

(ii) Tending

Tending would consist of weeding, climber cutting, improvement felling and pruning.

(iii) Nurseries

The target of seedlings production is determined by species for the planned area of reforestation. The following table shows the number of seedlings to be produced during the project period.

Tab. 3 Number of seedlings required by year

Year	1	2	3	4	5	6	7	8	9	10	Total
Number of seedlings (1,000)	686	820	874	1,008	1,089	1,151	1,087	1,077	1,121	1,051	9,964

(iv) Protection

Protection consists of the prevention of (a) forest fires, (b) forest disease and pest, (c) damage by animals, and (d) weather damage. Among them the most important of these subjects is the prevention of forest fires.

(3) Social Forestry Measures

(i) Measures to meet the needs of local people would be: (a) a stable supply of firewood for domestic use, (b) the same for construction timber, (c) production of seedlings for private planting, and (d) promotion of homestead planting of firewood species and fruit trees.

(ii) Social forestry models consist of (a) school nursery development, (b) family planting extension, and (c) the buffer zone planting. Each would be carried out in a number of areas selected as the most suitable.

(iii) Gender (WID) and alleviation of poverty

Gender (WID) measures are intended to mitigate heavy labor of women, in particular, the collection of firewood. The active participation of women would be encouraged in private tree planting, the result of which would directly benefit them by reducting the amount of time and effort spent on collection of firewood.

As measures to alleviate poverty, traditional techniques for apiculture, a promising means for cash income, would be disseminated and educated, methods for collecting and refining honey would be improved and cultivation of medicinal herbs would be carried out.

(iv) Conservation education and extension would be carried out by making a full use of life improvement agents (agricultural extension agents, etc.) and forest guards. They would receive training and education on extension and guidance methods and techniques in nursery operation, planting, tending, etc.

(4) Infrastructure Improvement

Measures include repair and maintenance of existing roads, construction of additional nurseries and project offices with related facilities.

3-5. Revenue and Expenditure

(1) Project Cost

The following table shows the estimated project cost over the project implementation period. To sum up each project, the first year's total expenditure is 3 million Birr, due to initial investments such as for building constructions and vehicle preparations. Total expenditures for the second and third years are in the 2 million Birr range, and the fourth and fifth are in the 1.5 million Birr range, but the total expenditures of the sixth, seventh and eighth years are in the 2 million Birr range due to vehicle renewals.

Tab. 4 Project cost chart

(Birr)

Project Component	Year 1	Year 2	Year 3	Year 4	Year 5
Encroachment prevention	30,000	30,000	30,000	30,000	10,000
Logging and sales	38,561	35,140	32,396	31,772	52,709
Reforestation and protection	503,634	453,495	485,014	602,809	637,670
Social forestry	103,000	117,697	61,075	112,267	61,075
Infrastructure improvement	465,140	347,380	337,300	171,180	16,100
Roads	126,840	132,080	137,000	81,280	-
Nurseries	32,400	-	-	-	-
Buildings	305,900	215,300	200,300	89,900	16,100
Others	1,430,183	828,585	674,785	420,985	287,185
Subtotal	2,570,518	1,812,297	1,620,570	1,369,013	1,064,739
Staff salaries	459,660	503,700	503,700	503,700	503,700
Total	**3,030,178**	**2,315,997**	**2,124,270**	**1,872,713**	**1,568,439**

Project Component	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Encroachment prevention	10,000	10,000	10,000	10,000	10,000	180,000
Logging and sales	45,262	70,665	61,161	88,285	125,223	581,174
Reforestation and protection	680,527	665,919	671,499	726,347	709,428	6,136,342
Social forestry	53,198	61,875	52,304	37,075	24,775	684,341
Infrastructure improvement		3,600			3,300	1,344,000
Roads	-	-	-	-	-	477,200
Nurseries	-	3,600	-	-	3,300	39,300
Buildings	-	-	-	-	-	827,500
Others	1,347,185	1,077,185	757,185	237,185	437,185	7,497,648
Subtotal	2,136,172	1,889,244	1,552,149	1,098,892	1,310,211	16,423,805
Staff salaries	503,700	503,700	503,700	503,700	503,700	4,992,960
Total	**2,639,872**	**2,392,944**	**2,055,849**	**1,602,592**	**1,813,911**	**21,416,765**

Notes; others are vehicles, forest guard costs, etc.

(2) Revenue and Expenditure (An estimate)

The following table shows the revenue and expenditure in each year of the project.

Tab. 5 Revenue and expenditure

(Unit: thousand Birr)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Revenue (a)	1,750	2,236	2,747	3,183	3,410	3,799	4,369	4,553	4,517	5,707	36,271
Project cost	2,571	1,812	1,621	1,369	1,065	2,136	1,889	1,552	1,099	1,310	16,424
Staff salaries	460	504	504	504	504	504	504	504	504	504	4996
Total expenditure (b)	3,031	2,316	2,125	1,873	1,569	2,640	2,393	2,056	1,603	1,814	21,420
a - b	-1,281	-80	622	1,310	1,841	1,159	1,976	2,497	2,914	3,893	14,851

Since figures of less than 1,000 Birr have been rounded, values may differ from those given in Table 4.

The values of revenue and expenditure have been estimated on many assumptions, therefore, should not be taken as firm guarantees of profits in later years.

3-6. Initial Environmental Impact Assessment and Erosion Control Measures

(1) Initial Environmental Impact Assessment

The Forest Management Plan aims at the prevention of forest encroachment and to achieve sustained forest utilization and conservation by reforesting the disturbed areas. The project does not entail changing the form of the land nor constructing large-scale structures. Therefore, the impact of project implementation on the environment would be minimal.

One of the major goals of the Social Forestry Measures is to carry out tree planting to supply firewood and construction timber for domestic use, and this would contribute to reducing hardships of local people, particularly women. In this way, the project could improve the social environment.

(2) Erosion Control Measures

No major erosion is seen in the Intensive Study Area, however, since partial erosion is observed along mountain roads, in dense forest plantations and on pasture land, erosion control measures would be implemented.

3-7 Management System

In order to implement the Forest Management Plan, a Belete-Gera Forest Management Office would be established and an organization consisting of three departments, nine sections and one committee under a project manager would be set up. Branch offices would also be established in Belete and Chira.

The proposed management organization would consist of 51 staff, excluding forest guards who are assigned in addition.

3-8. Monitoring Plan

Monitoring would be carried out for the Resource Management Plan, Operation Plan, Reforestation and Protection, and Social Forestry Measures. Monitoring on implementation, effectiveness and validation would be carried out at set intervals during the project period. Monitoring on effectiveness would only be carried out when the result of monitoring on implementation is satisfactory.

Apart from this, evaluation of the project could be organized by the Oromia Regional State Government including outside and independent expertise as members of the evaluation team.

II. Recommendation

1. Sustainable Forest Management

The objective of the Forest Management Plan is to properly maintain and manage Belete-Gera Forest. However, the highland rain forests widely found throughout the southwestern part of Ethiopia including Belete-Gera Forest are invaluable not only for the Oromia Regional State, but also for Ethiopia and the world as a whole. It is, therefore, essential that this Forest Management Plan be implemented on the ground.

2. Establishment of Organization and Provision of Budget

Establishment of a new organization is proposed in order to implement the Forest Management Plan, and funds are required for the implementation of the project components. This organization would be established and the necessary budget be provided.

3. Participation of Local People

Effort must be made to ensure active participation of the local people in all facets of the operation, in particular the Social Forestry Measures throughout the whole project period is encouraged.

4. Return of Profit to the Forest

Profits earned by the forest management project should be returned to the forests in the Regional State of Oromia as a whole. A fund may be established to conserve and rehabilitate the existing forests and to promote people's tree planting.

5. Staff Training

The number of staff would be increased to fill the posts of the new organization. These staff would be trained in the respective fields in order to perform their duties properly.

6. Project Review

Monitoring would be carried out during implementation of the Forest Management Plan. However, in the event where circumstances change during implementation, the project would be reviewed and the plans revised accordingly.

7. Actual Situation of Coffee Plantation in Natural Forests

In addition to encroachment caused by conversion of natural forests into farmland and grazing land, forest degradation by coffee plantation within natural forests could not be discounted. In order to mitigate this conflicting relationship between forest conservation and

income generation, concerted efforts of all concerned authorities are required. It is essential to obtain information on the actual conditions of coffee plantation that is a prerequisite for an inter-sectoral meeting.

8. Establishment of Growth Trial Sites

It is necessary for sustainable forest management to clarify process of forest recovery after harvesting. For this purpose, a number of fixed trial plots would be established within the selective felling sites and periodic survey would be carried out, possibly in cooperation with MoA and FRC.

9. Review of NFPA Boundaries

The Forest Management Plan covers Belete-Gera NFPA, of which 35,600 ha or 24% is encroached. Some of this encroached land consists of already legally recognized areas (i.e. land use charges are paid). On the other hand, forests still remain in some other adjacent areas.

It would be essential to thoroughly review the boundaries of NFPA and, based on this up-to-date information, to confirm new and actual boundaries, excluding areas already under other types land-use and possibly incorporating adjacent forests.

10. Request for Technical Cooperation

Although the Plan envisages a considerable profit in the implementing period, initial investment in both physical facilities (including equipment) and staff training may cause problems. If this is the case, a request for technical cooperation should be submitted to a relevant organization as early as possible.

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Abbreviations

CSA ..... Central Statistical Authority
DA ..... Development Agent
DADO ..... District Agriculture Development Office
D.B.H..... Diameter at Breast Height
EFAP ..... Ethiopian Forestry Action Program
EMA..... Ethiopia Mapping Authority
FAO ..... Food and Agricultural Organization of the United Nations
FRC ..... Forestry Research Centre
FWCD ..... Forestry & Wildlife Conservation Department (Oromia)
FWCDD..... Forestry & Wildlife Conservation & Development Department
FWPT ..... Forestry & Wildlife Protection Team (Jimma)
FWSLTRD ..... Forest & Wildlife, Soil & Landuse Technology Regulatory Department
GTZ ..... Gesellschaft Fur Technische Zusammenarbeit
JICA..... Japan International Cooperation Agency
JZADO ..... Jimma Zonal Agriculture Development Office
MNRD&EP ..... Ministry of Natural Resources Development & Environmental Protection
MoA..... Ministry of Agriculture
NFPA..... National Forest Priority Area
NGO ..... Non-Governmental Organization
OADB..... Oromia Agriculture Development Bureau
ODA ..... Overseas Development Administration
PA..... Peasant Association
SFCDD..... State Forest Conservation & Development Department
SIDA..... Swedish International Development Agency
S/W..... Scope of Work
TFAP ..... Tropical Forestry Action Plan
UNDP..... United Nations Development Program

Unit

Birr..... Unit of currency of Ethiopia
m^3..... cubic meter
° ..... degree
' ..... minute
" ..... second
km..... kilometer
ha ..... hectare
%..... percent

Currency Rate

US$ 1 = Birr 6.6 (as of May, 1997)

Chapter 1: INTRODUCTION

1-1. Background of the Study

Of Ethiopia's total land area of 112.8 million ha, 35%, or 42 million ha, was covered with forests in the not-too-distant past. In particular, highland areas over 1,500 m elevation, which account for 45% of the total land, used to be densely covered with closed high forests. As a result of population explosion, however, these forests have drastically diminished in both area coverage and stand volume. By the early 1980s, the proportion of forest lands to the total land area was estimated at only 3.6%. By 1989, it has gone down to 2.7%, or 3.2 million ha, as EFAP estimates.

The decline of forest in both area and quality is most evident in the central highland region, and is gradually spreading to the south western part where relatively dense forests are still remaining. In Oromia region closed high forests are diminishing at an estimated rate of 60,000 to 100,000 ha a year. Unless effective measures are applied, the forest resources in Ethiopia's south western region might disappear in 20 years to come.

In an effort to reverse this trend, the Transitional Government of Ethiopia issued the "Forestry Conservation, Development and Utilization Proclamation" on March 28, 1994. This Proclamation covers all the state, regional and private forests.

In parallel, the Government proceeded to formulate EFAP within the framework of TFAP, the global consensus on the conservation of the tropical forest, with the support of international organizations. The challenge of EFAP is, therefore, to develop a management plan that will minimize further destruction of natural forests, and achieve a balance between forest protection and forest production interests of both state and local communities. At the same time preservation of ecosystems and genetic resources of forests would be pursued.

On the other hand, MNRD&EP started the improvement of state forests in 1989 and identified 58 estates (totaling to 4.8 million ha, including 1.9 million ha of non-forested areas) as NFPAs. The identification of forest areas, inventory of forest resources, and formulation of forest management plans are underway for these NFPAs. Management plans for state forests in Tiro Boter-Becho and three other sites have already been completed.

In the face of an urgent need to deal with forest issues, the Government of Ethiopia in March 1994 requested Japan to cooperate in the formulation of forest management plans. Consequently, the Scope of Work (hereafter "S/W") concerning the "The Forest Resources Management Study in the Southwestern Part of Ethiopia" was signed between the two governments in November 1995. JICA was asked to implement the study while MoA's FWCDD was appointed as the counterpart.

1-2. Objectives of the Study

The "Forest Resources Management Study in the Southwestern Part of Ethiopia" is to carry out the following tasks in order to conserve forest resources and to improve the well-being of local residents in the area:

- Take aerial photographs of the Study Area, approximately 2.7 million ha. NFPAs account for approximately 1.7 million ha in this area. JICA was directly involved in the aerial photograph of 1,364,000 ha.

- Produce a 1/25,000 topographical maps of the Intensive Study Area, 150,000 ha, established in the Belete-Gera NFPA.

- Conduct a forest survey in the Intensive Study Area to assess forest resources, and carry out a local community survey in the area and its environs to study socio-economic conditions of local communities.

- Formulate a Forest Management Plan, including sub-plans, resource management plan, forest utilization plan, reforestation and forest protection plan, social forestry measures, infrastructure improvement, initial environmental assessment and erosion control measures, monitoring, etc. The plan is based on the results of the forest survey and local community survey and other surveys.

- Produce a forest location map for the Study Area.

- Produce land-use/vegetation map, soil map, and forest inventory book for the Intensive Study Area.

- Transfer technologies conserned to the staff of the counterpart organization throughout the study.

1-3. Study Areas

The Study Area, where aerial photographs were taken and forest location maps were prepared, spans the Oromia, Gambela and Southern Ethiopia Administrative Regions in the southwestern part of the country.

A Forest Management Plan was formulated for the Intensive Study Area consisting of the Belete-Gera Forest, which is located west of Jimma and spreads in Seka Chekorsa and Gera districts of Jimma Zone in Oromia Region. Details of the Intensive Study Area is described in Chapter 2.

1-4. Basic Principle of the Study

This study was carried out in accordance with the S/W, which was signed between JICA and the Government of Ethiopia on November 20, 1995, and the contract between JICA and the Forest Civil Engineering Consultants Foundation and Kokusai Kogyo Co., LTD.

In implementing the study, the background and objectives of the study and the requests of the Ethiopian Government were fully accomodated. Surveys were carried out through carefully designed survey plans and methods on the basis of preliminary information collected. The surveys aimed at a full utilization of the survey results and technologies at a later stage.

To obtain the maximum benefits from forests, appropriate forest management measures must be applied in light of the specific benefits expected from forests. Accordingly, the Forest Management Plan was formulated with a view to balancing the improvement of forest productivity with the needs of local residents.

1-5. Outlines of the Study

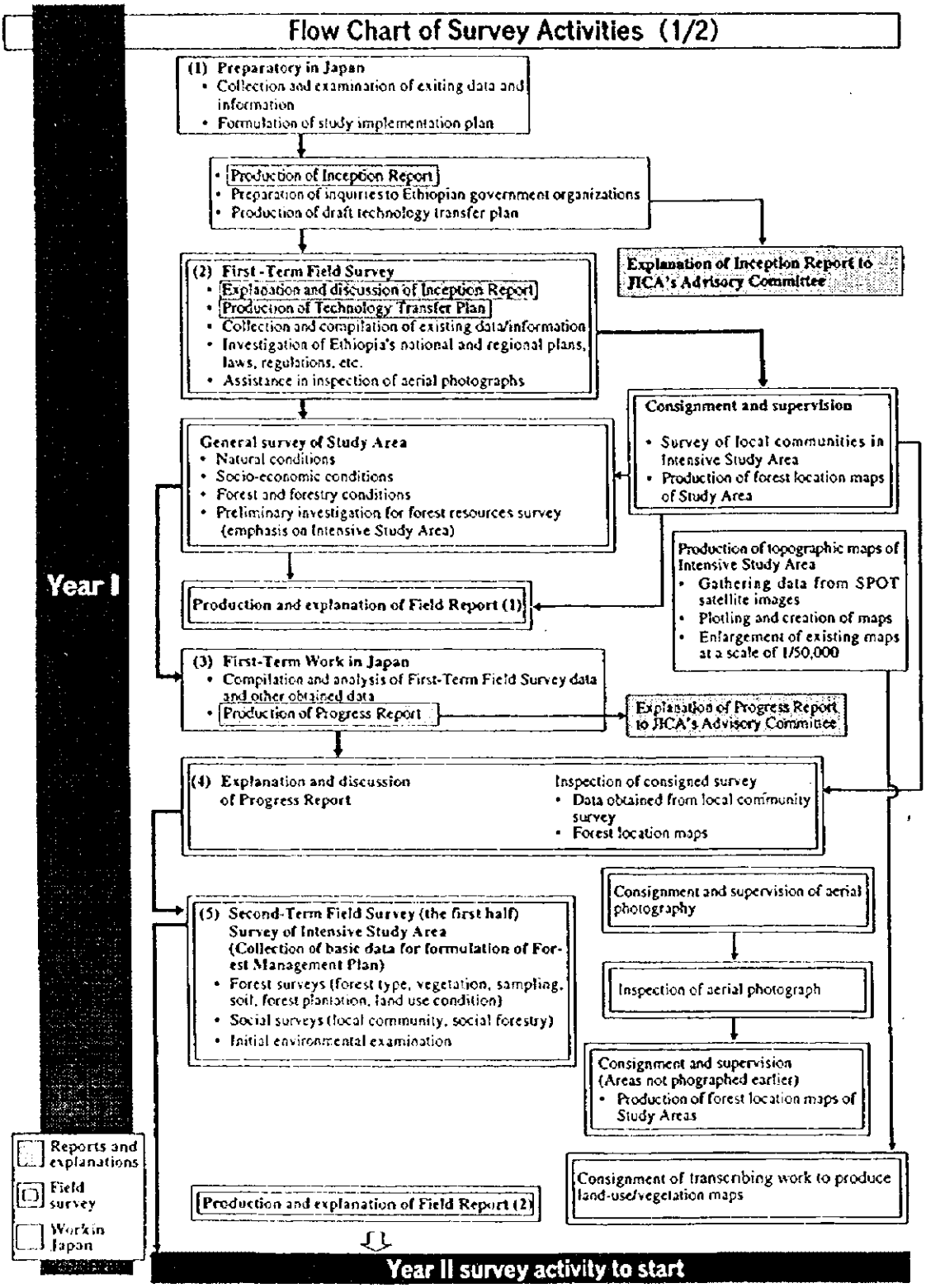
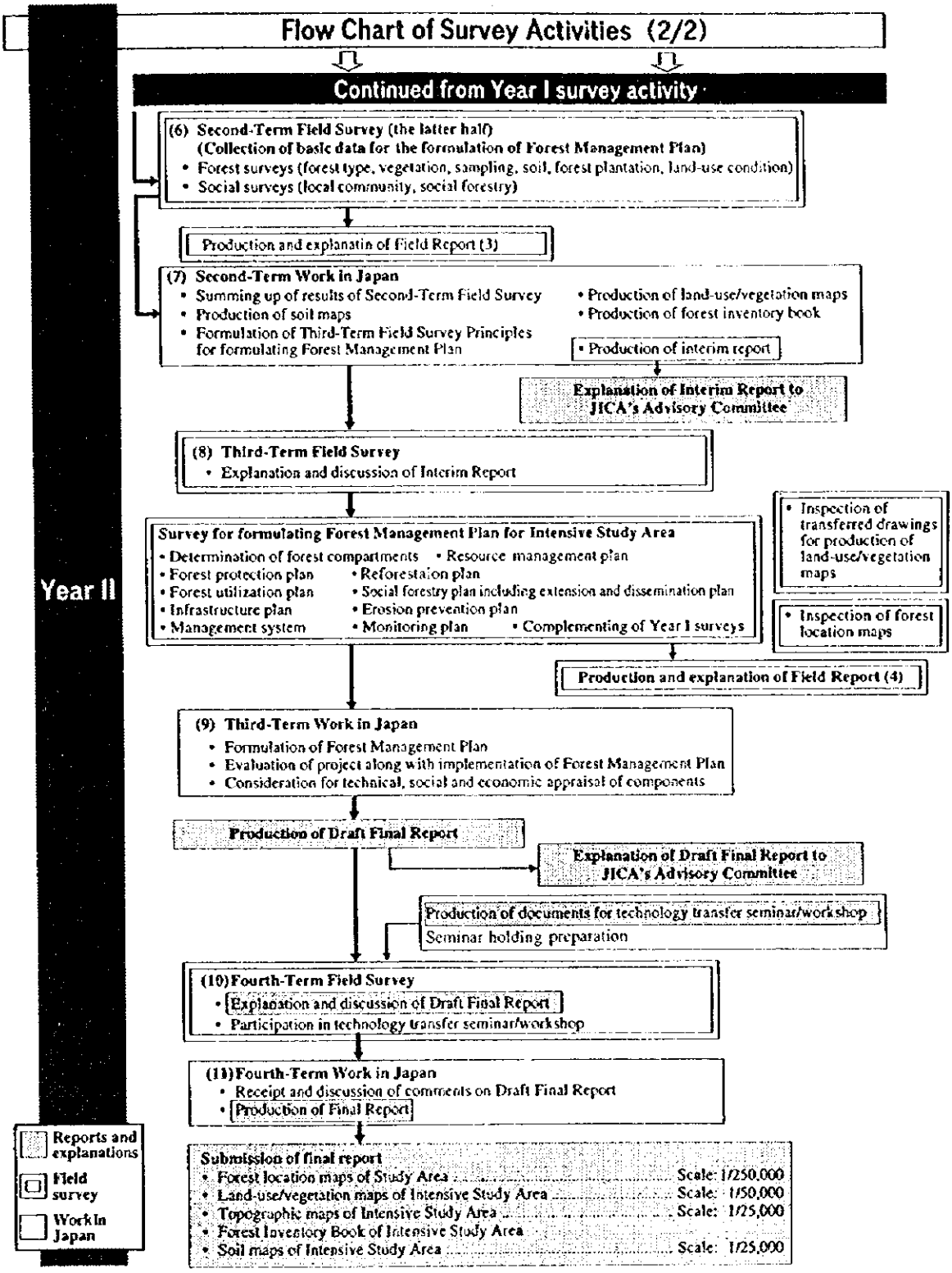


Fig. 1 Flow Chart of Survey Activities


Flow Chart of Survey Activities (2/2)
Continued from Year I survey activity
Year II
(6) Second-Term Field Survey (the latter half)
(Collection of basic data for the formulation of Forest Management Plan)
• Forest surveys (forest type, vegetation, sampling, soil, forest plantation, land-use condition)
• Social surveys (local community, social forestry)
Production and explanatin of Field Report (3)
(7) Second-Term Work in Japan
• Summing up of results of Second-Term Field Survey
• Production of soil maps
• Formulation of Third-Term Field Survey Principles for formulating Forest Management Plan
• Production of land-use/vegetation maps
• Production of forest inventory book
• Production of interim report
Explanation of Interim Report to JICA's Advisory Committee
(8) Third-Term Field Survey
• Explanation and discussion of Interim Report
Survey for formulating Forest Management Plan for Intensive Study Area
• Determination of forest compartments
• Resource management plan
• Forest protection plan
• Reforestation plan
• Forest utilization plan
• Social forestry plan including extension and dissemination plan
• Infrastructure plan
• Erosion prevention plan
• Management system
• Monitoring plan
• Complementing of Year I surveys
• Inspection of transferred drawings for production of land-use/vegetation maps
• Inspection of forest location maps
Production and explanation of Field Report (4)
(9) Third-Term Work in Japan
• Formulation of Forest Management Plan
• Evaluation of project along with implementation of Forest Management Plan
• Consideration for technical, social and economic appraisal of components
Production of Draft Final Report
Explanation of Draft Final Report to JICA's Advisory Committee
Production of documents for technology transfer seminar/workshop
Seminar holding preparation
(10) Fourth-Term Field Survey
• Explanation and discussion of Draft Final Report
• Participation in technology transfer seminar/workshop
(11) Fourth-Term Work in Japan
• Receipt and discussion of comments on Draft Final Report
• Production of Final Report
Submission of final report
• Forest location maps of Study Area ..... Scale: 1/250,000
• Land-use/vegetation maps of Intensive Study Area ..... Scale: 1/50,000
• Topographic maps of Intensive Study Area ..... Scale: 1/25,000
• Forest Inventory Book of Intensive Study Area
• Soil maps of Intensive Study Area ..... Scale: 1/25,000
Reports and explanations
Field survey
Work in Japan

Chapter 2: BASIC STUDY

2-1. Natural Conditions

2-1-1. Location and Area

The Study Area is comprised of a highland and a lowland. The highland is the southern part of Abyssinia Highland and the low land is along the border with Sudan. The Study Area, measuring 1.73 million ha, extends from 7° to 8°30' north latitude and from 34°30' to 36°45' east longitude. It contains 10 NFPAs.

One of the ten NFPAs, the Belete-Gera NFPA was selected as the Intensive Study Area, and is located in the south eastern part of the Study Area. Measuring 150,000 ha, the Intensive Study Area extends from 7°23' to 7°54' north latitude and from 36°02' to 36°43' east longitude. Locations of the 10 NFPAs are roughly depicted in Appendix Fig. 1, although the borders of some NFPAs have not yet been clearly demarcated.

2-1-2. Climate

The average annual temperature in Ethiopia's south western highland region is about 20°C, which is slightly higher than that in Addis Ababa, the capital. The average temperature in the western lowland rises to 27.6°C. Appendix Fig. 2 shows the temperature and precipitation at major localities. Addis Ababa and Gambela have a summer rainy season, with rainfall concentrating in the period between June and September. Precipitation in Metu, Gore, Bonga, and Jimma, located in the south western highland, is the highest in Ethiopia, with rainfall spreading throughout the year. Total annual precipitation in this area exceeds 1,500 mm.

Tab. 1 lists climatic data from the Jimma weather station between 1976 and 1995. The climate in Jimma closely resembles the climate in the Belete-Gera NFPA, the Intensive Study Area. Appendix Fig. 3 shows the year-to-year fluctuation of monthly precipitation in Jimma. The highest annual precipitation was recorded at 1,760.7 mm in 1993; the lowest at 1,219.7 mm in 1979.

2-1-3. Topographical and Geological Conditions

Of the 10 NFPAs that make up the Study Area, the Abobo-Gog NFPA is the only one that is located in the lowland area, consisting mostly of flat terrain of 500 m to 650 m altitude. The remaining nine NFPAs are mostly on highlands of 1,400-2,500 m altitude. With the concentration of many headstreams, these highlands consist of moderately undulating hills for the most part, while in some areas steep-sloped mountains with deep valleys prevail. Similarly, the topography of Intensive Study Area is mainly gently undulating hills in the 1,000-3,000 m range. Steep mountainous terrain can be found in some areas.

Tab.1 Meteorological data, JIMMA Station (Lat. 7°4'N, Long. 36°5'E, Alt. 1,725m)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Monthly Rainfall (mm) 1976~1995 (Mean)	50.0	54.3	87.6	132.1	176.6	218.0	199.7	220.3	182.4	96.5	59.7	33.6	**1510.8**
Daily Avg. Max. Temperature 1976~1995(Mean) (°C)	28.4	28.8	29.2	28.4	27.3	25.7	24.1	24.6	25.5	26.7	27.4	27.8	
Daily Avg. Min. Temperature 1976~1995 (Mean) (°C)	7.8	10.0	11.4	12.6	13.1	13.3	13.2	13.3	13.0	10.9	8.6	7.2	
Daily Avg. Mean Temperature 1976~1995 (Mean) (°C)	18.1	19.4	20.3	21.0	20.2	19.5	18.7	19.0	19.3	18.8	18.0	17.5	
Daily Mean Sun Shine Hours 1976~1995 (Mean) (hr.)	7.25	6.63	6.48	6.00	5.90	5.04	3.59	4.07	5.26	6.78	7.56	7.22	
Monthly Rainfall (mm) /Highest year	323.9/84	120.2/76	157.7/87	301.3/80	252.0/81	323.5/76	269.6/90	356.0/92	298.7/83	229.4/77	211.5/82	161.3/89	
/Lowest year	0/86	7.2/81	30.9/88	15.6/77	102.2/89	113.6/81	96.1/80	133.9/86	114.6/79	11.1/94	1.5/88	0/88	

(Source: National Meteorological Service Agency, Government of Ethiopia, March 1996)

Geology of Ethiopia is old. Its oldest rocks are granite and metamorphic rocks dated back to the Precambrian period over 600 million years ago. During the period from the Eocene to Oligocene phase of the Tertiary period, eruptions of basic basalt formed an expansive lava plateau. In the subsequent Pliocene phase, volcanic activity resumed covering the plateau with welded tuff. The geological map of southwestern Ethiopia, is shown in Appendix Fig. 4.

In the Study Area, the western lowland is covered with sedimentation formed during the Quaternary period. The western part of the highland features crystalline bed rocks, while most of the highland consists of basalt and tuff, both of which are volcanic rocks and lava of the Tertiary period. The subsurface geology of the Intensive Study Area is composed mostly of basalt and tuff.

2-1-4. Soil

According to the "Soil Map of the World (1/5,000,000), Volume VI (Africa)," published by FAO/UNESCO, the western lowland of the Study Area mainly has a soil that is classified as Chromic Vertisols alluvial soil. In the highland region, predominant soil is Eutric Nitosols (conventionally named Terra-Rossa, or Reddish-Brown Laterite) with a reddish-brown color. Soil in the Study Area is generally deep; however, at some sites the soil is shallow with rock outcrops. Soil is primarily fine-textured with a high clay content, although medium-textured soil and gravel are mixed in some localities.

Flat land predominates in the lowland. In the highland region, topography ranges from undulating to steep slopes. Appendix Fig. 5 shows the soil map of southwestern Ethiopia (from the "Soil Map of the World" published by FAO/UNESCO). (Note: To accommodate the soil unit revision introduced in the 1988 "Soil Map of the World, Revised Legend," Nitosols has been changed to Nitisols.)

In the Intensive Study Area, major soil types are Haplic Nitisols, Humic Nitisols, and Dystric Calmbisols. Eutric Cambisols, Humic Cambisols, Mollic Leptosols, Lithic Leptosols, Umbric Leptosols, and Gleyic Luvisols are contained in part or in composite forms.

2-1-5. Hydrology

Appendix Fig. 6 shows the basins of major rivers in southwestern Ethiopia. There are three basins: Abay in the north, Baro in the west, and Gibe in the south. The center of the Study Area encompasses headwater of Baro River, which is the upstream of White Nile. From the highland, Baro, Gilo and Akobo Rivers flow toward west. Tributaries of Abay River, which is the upstream of Blue Nile, flow northword from the highland.

From the Bonga NFPA and the Belete-Gera NFPA (the latter being the Intensive Study Area), Gibe River and Gojeb River (the latter being a tributary of the Omo River) flow southword, eventually into Lake Rudolf of Kenya.

The Intensive Study Area is situated in the basin of Gojeb and Gibe Rivers. Belete Forest is located to the north of Gojeb River. The southern portion of the forest descends sharply toward Gojeb River. Belete Forest contains a network of streams, most of which flow into Gojeb River.

Gera Forest is also situated to the north of Gojeb River. Naso River runs from north to south through the centerpart of the forest, delivering tributary water from the highland to Gojeb River. In the northeastern part of the Gera Forest a small river flows into Gibe River. Another rivulet which leads to Didesa River, a tributary of Abay River, is located in the northwestern part of the forest.

As a whole, the highland in southwestern Ethiopia is the origin of many major rivers. Without forest cover, it would be impossible to supply ample amounts of water to those rivers.

2-1-6. Vegetation

Forest in the southwestern part of Ethiopia, including the Study Area, is characterized by highland rain forest, the result from the relatively ample precipitation throughout the year. In general, forest in the Study Area is in a fair condition, comparing to forest in other regions. Nevertheless, closed high forests without any human disturbance are found only in remote mountainous areas. Forests with easy access are in most cases selectively felled for commercially valuable timber in the past, and/or in the process of invasion at present by expanding forming including coffee planting in the forest.

For example, in Kombolcha village of the Belete Forest, as a result of selective cutting, there are no large trees of commercial value in the forest. Trees remain in the forest are mainly *Polyscias fulva* (*Araliaceae* family), *Manilkara butji* (*Sapotaceae* family), *Olea capensis* (*Oleaceae*), *Syzygium guineense* (*Myrtaceae*), *Bersama abyssinica* (*Melianthaceae*), *Millettia ferruginea*, *Albizzia gummifera* and *Albizzia grandibracteata* (the latter three are members of the *Leguminosae* family). Restoration of the closed high forest is underway.

Regeneration of *Aningeria adolfi-friederici* (*Sapotaceae*) is observed in the forest. Pioneer species, such as *Croton machrostachys* and *Macaranga capensis* (both of the *Euphorbiaceae* family), are found in the openings of cut-over sites.

Felling of four important species is prohibited in the area. The are *Juniperus procera* (*Cupressaceae*), *Podocarpus gracilior* (*Podocarpaceae*), *Hagenia abyssinica* (*Rosaceae*), and *Cordia africana* (*Boraginaceae*). However, during the field survey only few trees of *Juniperus procera* and *Hagenia abyssinica* were observed.

From Gore at 2,000 m at the western end of the south-western highland to Gambela at only 450 m, vegetation gradates from humid forests to semiarid type. In particular, vegetation begins to manifest savanna as the elevation declines to below 1,000 m, with the number of species noticeably decreasing. Dominant species in areas below 1,000 m are *Celtis*

gomphophylla, *Celtis integrifolia* (both of *Ulmaceae*), and *Acasia seyal*. Land below 1,000 m is not suitable for agriculture, except some flat locations along rivers. Consequently, forests in these low-altitude areas are free from human disturbance, although burning is frequently practiced in forests near villages.

Within the Study Area, pure bamboo (*Arundinaria alpina*) thickets exist in humid areas at high altitudes. Forest plantations in the Study Area contain many dense stands, which are virtually free of damages from diseases and pests. Species planted are *eucalypts* (*Eucalyptus camadulensis* and *E. saligna*), *Cupressus lusitanica*. (*Cupressaceae*) and *Pinus patula* (*Pinaceae*).

Farmers plant *eucalypts* near their houses. They use the trees for construction and firewood, and sell surplus logs in the markets for cash income.

2-2. Socioeconomic Conditions

2-2-1. Objectives of the Local Community Study

Objectives of the local community study are: (i) to obtain basic information on the social and economic conditions of the rural communities relevant to the Intensive Study Area; (ii) to identify their needs in general and needs for the forestry development in particular; and (iii) to prepare basic data necessary for the formulation of Forest Management Plan.

2-2-2. Study Method

(1) Collection of Existing Data and Information

Existing data such as administrative structures, population, agricultural production, ethnic groups composition, religion and living conditions have been collected from government agencies and institutions including FWSLTRD, CSA, JZADO and DADO.

(2) Interviews with Local Residents

Interviews with local residents were conducted to understand the current status of land use, agricultural and livestock production, living conditions, role of women, etc.

(3) Local Community Survey entrusted to the Local Consultant

In order to obtain basic data on the socioeconomic situation of rural communities and their needs for forestry development, the local community survey using questionnaire was entrusted to a local consultant in Addis Ababa. The Survey was commenced in May 1996 and its final report was submitted in November 1996.

The Survey comprised two parts; one aimed at obtaining socioeconomic data from the leaders of the villages, the other aimed at obtaining the same information from households members. Seventy (70) households have been sampled from 10 villages in Belete Area, and 130 households from 22 villages in Gera Area.

Contents of the following sections are primarily based on the results of the Local Community Survey conducted in 1996.

2-2-3. Social Conditions in the Target Villages

(1) Target Villages

The Intensive Study Area (Belete-Gera NFPA) is located in the western part of Jima Zone in Oromia Region. Jima Zone is administratively divided into 13 districts including Gera, Kersa, Seka Chekorsa, and Limu Seka. Belete Forest is located in Seka Chekorsa District and

most of Gera Forest is located in Gera District.

Each district is subdivided into several villages. In 1994 when the Census was conducted, Seka Chekorsa District was divided into 97 villages and Gera District into 50 villages. In March 1996, these villages were reorganized into 50 in Seka Chekorsa District, and 27 in Gera District.

As stated in the preceding section, the Local Community Survey was conducted in 32 villages which are completely or partially within the Intensive Study Area. The population and the number of households in these villages are presented in the following table.

Tab. 2 Population and number of households of surveyed villages

Location	Population	No. of Households
Belete Area	48,772	11,012
Gera Area	27,799	6,371
Total	**76,571**	**17,383**

*Population is based on the 1994 census

(2) Location of the Target Villages

Belete area belongs administratively to Seka Chekorsa District and is located southwest of Jima. Seka town, the capital of the District, is located 20 km from Jimma on the way to Belete Forest. Villages in Belete Area distribute along the main road which is crossing through the Belete Forest in a east-west direction.

Gera area belongs administratively to Gera District. For approximately 40 km the paved road from Jima leads to Agaro town which is located to the northwest of Jimma. From Agaro following a gravel road westwardly for approximately 50 km Chira town, the capital of Gera District, can be reached. Villages in Gera Area are located along the road which connects Agaro and Chira.

Locations of these villages are presented in Appendix Fig. 7.

(3) Population, Religion, and Ethnic Composition

In Belete area (10 villages), there are 11,012 households with a population of 48,772 (1994). The 66 female-headed households account for 6% of the total households. Of the total households, Muslims account for 90%, and the remaining 10% are Christians. Oromo is the dominant ethnic group taking up 77.1% of the population. Amhara constitute 4.6% of the population. The rest (18%) are of Yemsa, Keffa, and other ethnic groups. (Refer to Appendix Tab. 1)

In Gera area (22 villages), there are 6,371 households with 27,779 population in 1994. The female-headed households (32) account for 5% of the total households. Of the total households, Muslims account for 80%, and the remaining 20% are Christians. Most of the population (92.7%) are of Oromo, while Amhara constitutes 4.7%, Keffa, Kefficho, and other ethnic groups constitute 2.6% of the total population. (Refer to Appendix Tab. 2)

(4) Education

In Belete area, there are 10 public schools with 1,521 male and 927 female pupils. These are elementary schools having classes up to sixth grade.

In Gera area, there are 9 elementary schools and a secondary school. Total number of pupils in elementary schools is 1,114 males and 517 females. A secondary school is located in Chira town, which attracts students from adjacent villages, such as Gurekesso and Challa, also.

(5) Health Services

In Belete area, there are two clinics, located in Kishe and Atro Gefere. Several health posts are located in other villages. Prevailing diseases are colds, pneumonia, skin diseases, diarrhea, eye diseases, and malaria.

In Gera area, there are 4 clinics, one each in Dusta, Gamina, Selaja, and Kobokocho. A health post is located in Gera village. Skin diseases, colds, diarrhea, asthma, eye diseases, and pneumonia are prevailing diseases.

(6) Farmer Organizations

A Peasant Association (PA) was established in each village in 1970s. Villagers secure their land holding through the membership of a PA. In some villages, Service Cooperatives have been established to collectively process and market the agricultural products (e.g. maize).

(7) Daily Workload of Women

In Belete area, average working hours of women is 15 hrs/day, which consists of preparation of meals (23.3%), shopping and selling goods in the market (17.5%), firewood collection (13.9%), child care (8.8%) and laundering (8.2%). Preparation of meals takes the most time, followed by selling and buying goods in the market and firewood collection. (Refer to Appendix Tab. 3)

In Gera area, average working hours of women is 15 hours, consisting of preparation of meals (25.3%), grinding (13.7%), laundering (13.2%), firewood collection (11.2%), pounding (10.6%), child care (6.3%). Preparation of meals takes the longest time, followed by grinding, laundering and firewood collection. (Refer to Appendix Tab. 4 (1), (2))

2-2-4. Economic Situation

(1) Economic Activity

In Belete area, agriculture is the major economic activity of the villagers. According to the survey conducted in 1996, 55 households (78.6%) indicated that food crops production (e.g. maize and teff) is their main source of income, while 13 households (18.6%) reported that coffee is the main source. The remaining 2 households indicated that chat production and commerce are their main source of income. The number of respondents who reported their secondary sources of income are 31 from livestock, 15 from coffee, 12 from chat, 11 from crops production (e.g. teff), and 2 from commerce. (Double answers have been applied.)

In Gera area, agriculture is also the main economic activity. According to the survey conducted in 1996, 82 households (63%) indicated that food crops production (e.g. maize and teff) is their main source of income, while 45 households (34.6%) reported that coffee is the main source. The remaining 3 households indicated livestock and honey as the main source. 77 respondents reported their secondary sources of income are from livestock, 45 from crops, 16 from honey, 14 from coffee, and 1 from firewood. (Double answers have been applied.)

(2) Household Income

In Belete area, the average household income source consists of food crops including coffee (85.4%), livestock (8.9%), forestry products such as honey and firewood (1.1%), and other activities such as wage labor and commerce (4.7%). Out of the total crops produced, 47% are consumed domestically. Great part of livestock income is derived from the sale of cattle, goat and sheep. Majority of forestry income is derived from collection and sale of honey. Some of forestry income is derived from firewood in some villages (Yanga Deo and Sabaka Debiye). (Refer to Appendix Tab. 5)

In Gera area, the average household income source consists of food crops including coffee (70.6%), livestock (19.8%), forestry products such as honey and firewood (8.7%), and other activities such as wage labor and commerce (0.8%). Out of the total crops produced, 51% are consumed domestically. The great part of livestock income is derived from the sale of cattle, goat, sheep, etc. The majority of forestry income is derived from the sale of honey. Part of forestry income is derived from firewood in some villages (Yanga Deo and Sabaka Debiye). (Refer to Appendix Tab. 6 (1), (2))

(3) Collection of Firewood

Collection of firewood is the daily task of women (mostly housewives) and children. Firewood is collected mainly for domestic use. It is not common that firewood is collected for sale.

The average time spent for the collection of firewood is 2.1 hours in Belete area, while it is 1.7 hours in Gera area. Households in Belete area take more time to collect firewood. The respondents in Komo Hari, Atro Sufa, and Mirgano Boso expressed that they feel it difficult to collect firewood because it takes 3 to 3.6 hours per trip.

In Gera area, some respondents reported that they spent more time (1.9 to 2.1 hours) than the average (1.7 hours) to collect firewood. However these respondents have not complained any difficulty in collecting firewood. (Refer to Appendix Tab. 7 (1)-(3))

(4) Honey Collection

Honey is collected by men (mostly heads of households) to obtain secondary house income. Great part of honey collection is conducted from April to June. Some villagers do the collecting during the period between December and February. Honey collection prevails in the Gera area, particularly in villages such as Gura, Kelaharere, Afalo, Challa and Nasowabo, which are situated in the southern part of Chira town. Honey is partly consumed at home and partly sold to the shops in Chira town.

2-2-5. Needs of the Community

(1) Expressed Needs to Improve Daily Life

During the 1996 survey villagers of 200 households were asked to rank the needs they perceive to improve their daily life. Results of ranking is shown below. (See details in Appendix Tab. 8(1)-(6))

i) Overall ranking in Belete area

Ranking	Items	Ranking	Items
1	House improvement	6	School
2	Road improvement	7	Farmland
3	Clinic	8	Farm credit
4	Drinking water	9	Agricultural production
5	Farm tools	10	Supply of electricity

It is assumed that the reason for the highest ranking of house improvement is mainly due to the short supply of construction and furniture materials.

ii) Variance among villages in Belete area in ranking

Most villages gave priority to house improvement, road improvement, and clinic.

Exceptionally, house improvement is ranked the 5th at Komo Hari and Shabe Mofa. Although the overall ranking for the supply of firewood is low, it is ranked the 2nd at Sonbo Daru and the 5th at Komo Hari.

iii) Overall ranking in Gera area

Ranking	Items	Ranking	Items
1	House improvement	6	School
2	Road improvement	7	Health services
3	Agricultural production	8	Farm credit
4	Clinic	9	Farm tools
5	Increase in income	10	Improved farmimg technology

As is the case in Belete Area, it is assumed that the reason for the highest ranking of house improvement is mainly due to shortage of construction and furniture materials.

iv) Variance in ranking among villages of Gera area

For most villages, priority is given to house improvement, road improvement, and agricultural production. However, house improvement is ranked below 5th in Chira, Selaja and Gera. Although the overall ranking for the suppy of firewood is low (lower than 10th), it is ranked 8th at Gamina and 9th at Nasowabo.

(2) Expected Benefits from Forest

In order to identify the needs for forestry development, inquiries have been made to the villagers. Villagers were asked to list and rank the benefits they expect to receive from forest. The result of ranking is compiled and listed below.

i) Belete area

Ranking	Items	Ranking	Items
1	Construction materials for home use	6	Medicinal plant
2	Firewood for home use	7	Food (e.g. fruits)
3	Construction materials for sale	8	Fodder
4	Prevention of soil erosion	9	Furniture-making materials for home use
5	Materials for handicraft	10	Furniture-making materials for sale

The needs for construction materials and firewood are ranked high. It is noteworthy that prevention of soil erosion is ranked the 4th.

ii) Gera area

Ranking	Items	Ranking	Items
1	Firewood for home use	6	Furniture-making materials for home use
2	Construction materials for home use	7	Furniture-making materials for sale
3	Construction materials for sale	8	Materials for handicraft
4	Prevention of soil erosion	9	Food
5	Environmental effects	10	Medicinal plant

As is the case in Belete area, needs for construction materials and firewood are ranked high, particularly needs for firewood is ranked the first. Materials for furniture for home use is ranked the 7th, which is higher than Belete area.

2-3. Initial Environmental Survey

2-3-1. Objectives

The Forest Management Plan includes development activities and programs to protect the environment. It is important to foresee the impact of these development activities on the natural, social and economic environment. Therefore, an initial environmental survey was conducted on the existing natural conditions (e.g., topography, geology, soil, hydrology, climate, vegetation, wildlife, natural landscape) and socio-economic conditions (e.g., land use, transportation, employment, firewood, agricultural production, grazing).

2-3-2. Survey Methods and Results

Each aspect of the above mentioned natural, social and economic conditions was studied using methods, such as data collection/analysis and on-site field study. Management practices included in the Forest Management Plan that will likely affect the environment are logging, afforestation, reforestation, nursery practice, construction of forest roads, conservation of forestlands, and forest protection. Land-use activities outside the scope of the Forest Management Plan are grazing, cultivation, tree planting to protect farmlands, and tree planting for firewood near the villages.

Among the above mentioned activities, the following three were investigated with special emphasis in the initial environmental survey, since these issues are the results of deforestation and forest deterioration, cultivation and grazing:

- Soil erosion and degradation (field study)
- Water resources, such as volume and quality (data collection and field study)
- Living environment of local residents (social and economic study)

[Results of Survey]

(1) Natural Environment

(i) Topography: The Intensive Study Area mostly consists of gently undulating hills with elevations of 1,000-3,000 m, although steep mountainous terrain exists in some parts.

(ii) Geology: The geological structure throughout the Intensive Study Area consists of crystalline bed rocks from the Precambrian period. Above that are volcanic rocks and lava of the Tertiary period. The subsurface geology above the volcanic rocks and lava is composed mostly of basalt and tuff.

(iii) Soil: Red-brown and brown clayey soil is extensively dispersed in the Intensive Study

Area. This soil was generated by the weathering of its parent materials--basalt and tuff. In terms of the soil unit used in the FAO/UNESCO soil classification, the soil in the Intensive Study Area mainly consists of Haplic Nitisols, Humic Nitisols, and Dystric Calmbisols. At some areas shallow soil with rock outcrops predominant, with the soil being mainly of Umbric Leptosols and Mollic Leptosols. At some depressions, sites such as marshes, Gleyic Luvisols dominates.

(iv) Hydrology: The Intensive Study Area receives an ample amount of rainfall throughout the year, and encompasses the headstreams of many major rivers. The soil in the forest region has a large water-retaining capacity, making it possible for a number of water-rich rivers to be originated from this region. In places where forests have been converted into grasslands or farmlands, the maximum water-retaining capacity of soil is easily reached by showers of intense rainfall, causing the top soil to be washed away. Thus, the color of the water in the river is often brown in many places.

(v) Climate: According to the climatic data collected at the Jimma weather station, the nearest station from the Intensive Study Area, the average temperature for the 20-year period from 1976 to 1995 was 17.5°C. The average maximum and minimum daily temperatures were 27.8°C and 7.2°C, respectively. The average annual precipitation was 1,510.8 mm, with the greatest annual precipitation recorded at 1,760.7 mm in 1993 and the lowest at 1,219.7 mm in 1979. The average daily length of sunshine was 5.98 hours, with the maximum recorded at 10.3 hours in December 1987 and the minimum at 2.0 hours in August 1992.

The Intensive Study Area receives an ample amount of rainfall throughout the year. Particularly, highland areas situated above the 2,000 m level are often shrouded in clouds. It is reasonable to assume that these areas receive more rainfall than the Jimma weather station where the elevation is 1,740 m. In this regard, data obtained from the Gore weather station (approximately 90 km northwest of the Intensive Study Area and situated at a 2,002m altitude) provides better estimation for the rainfall in the highland area. It indicated an average annual rainfall of 2,242.3 mm during the past 38-year period, with the highest precipitation recorded at 3,448.6 mm in 1969 and the lowest at 1,633 mm in 1968.

Monthly rainfall data from Jimma indicate sharp fluctuations from one year to another. In some years, no rain at all was recorded in the dry season which is from October to February, while in other years the monthly precipitation reaches about 100 mm in the dry season. In January 1984, the monthly rainfall climbed to 323.9 mm. According to the climatic data collected by the Team during the initial environmental survey the Gera Forest region, located in the north-western part of the Intensive Study Area, receives considerably more precipitation than the Jimma area.

(vi) Vegetation: The natural forests in the Belete-Gera NFPA are highland rain forests composed mainly of broad-leaved trees. In undisturbed closed high forests, dominant species (by volumes) are *Olea welwitschii, Scheflera abyssinica, Pygeum africana, Elaeodendoron buchananii, Diospyros abyssinica,* and *Albizia gummifera.* Those forests in close proximity

of villages, farmlands, and grazing fields have received heavy human disturbance.

Forest plantations account for less than 1% of the total forest area in the Belete-Gera NFPA. They distribute mostly in the Belete Forest. Most of the planted trees are exotic species, such as *Cupressus lusitania*, *Pinus patula*, and *Eucalyptus* spp. Their growth are favorable. Trees of *Eucalyptus* spp. are also preferentially planted in the homestead plantations by local farmers.

(2) Socio-economic Environment

(i) Land-use: Although the forests in the Belete and Gera districts are under the jurisdiction of the federal government, they are actually managed by JZADO. Local residents benefits from the forest through by acquiring small-diameter firewood and construction log, collecting coffee beans from naturally grown coffee plants (*Coffea arabica*), and obtaining honey from the forests. In some cases, coffee plants are planted in sites where natural forest trees are selectively cut. There are villages where farmers have cleared the forest to expand their crop land and grazing fields. In mountainous areas, dense forests of highland bamboo (*Arundinaria alpina*) exist, but the use of bamboo is limited to construct fences and make domestic articles by local residents.

(ii) Transportation: In the Intensive Study Area, the Belete and Gera District each has one all-weather main road. Additionally, there are a number of local roads which cannot accommodate motor vehicles during the raining season. Other small roads connect villages, permitting only the treads of man and animals. Buses, taxis and trucks are operated on the main roads that link major villages. Other small villages are made accessible by foot or riding horses, mules and donkeys.

(iii) Firewood: Firewood is normally obtained by gathering dead trees and fallen branches from forests, or by growing trees for firewood in homestead plantations.

(iv) Agricultural production: Major farm products in the Intensive Study Area are teff (*Eragrostis tef*), wheat, rye, barley, maize, beans, red peppers, and *Ensete* (Abyssinian banana). The Intensive Study Area provides a productive agricultural land owing to the moderate temperature and abundant rainfall.

(v) Grazing: Areas along forest borders (part of those areas where converting into grasslands are underway), grasslands, and post-harvest crop lands are used for grazing cattle, sheep, and goats.

2-3-3. Expected Environmental Impacts

Based on the analysis of gathered data and initial environmental survey, a prediction was attempted concerning the possible impact of the Forest Management Plan on various aspects of the regional environment. The initial environmental survey indicated that the impact would be minimal if no forestry production and land development were carried out in forest areas. Since timber production is planned in the Intensive Study Area, some negative impacts are predictable. Major adverse impact could be from the construction of new forest roads and the extension and/or maintenance of existing forest roads. Measures such as the furnishing of roadside gutters and the establishment of regulations for soil conservation of forest roads would be incorporated in the Forest Management Plan.

When reforesting bare grounds and farmlands in practice, emphasis would be placed on the prevention of soil erosion. The most serious consequences of human disturbance to forests are the loss of top soil with nutrients and organic matter, soil compaction, and the decline of soil permeability. All of these will seriously impede regeneration of forest cover.

The Intensive Study Area does not include any wildlife sanctuaries, historic monument preserves or aboriginal reserves as defined by national or international conventions.

2-4. Forest Policy and Land Tenure System

2-4-1. National Forest Policy

To cope with the rapid depletion of forests, the Transitional Government of Ethiopia issued the "Forest Conservation, Development and Utilization Proclamation" on March 28, 1994. This proclamation became the fundamental government policy on forests and forestry, reflecting the deep concern over the rapid destruction and deterioration of forest resources in Ethiopia. Written in both Amharic and English, the Proclamation is applicable to state, regional and private forests, and is comprised of the following four sections:

In Part 1, "General," major terms used in the Proclamation are defined, and forests are classified according to ownership.

Part 2, "Conservation and Development of Forests," outlines the measures concerning: (a) Designation, Demarcation and Registration of Forests; (b) Conservation, Development and Management of State and Regional Forests; (c) Conservation and Development of Private Forest; (d) Protected Forests; (e) Prevention of Forest Fires.

In Part 3, "Utilization of Forests," measures are provided pertaining to: (f) Utilization of State and Regional Forests; (g) Utilization of Protected Forests.

In Part 4, "Miscellaneous Provisions," a variety of other forest and forestry matters are set forth: namely, (h) Research and Training; (i) Transport and Storage of Forest Products, (j) Prohibited Activities; (k) Forest Guards and Inspectors on Movement of Forest Products; (l) Duty to Cooperate; (m) Penalty.

As mentioned above, the proclamation covers the entire scope of forests and forestry.

At about the same time (December 1994), with the help of the World Bank, UNDP, FAO, GTZ and SIDA, the formulation of EFAP as the Ethiopian version of TFAP was completed. EFAP is comprised mainly of the following four sections: (a) the tree and forest production program, (b) forest resource and ecosystems management program, (c) forest industries development program, and (d) firewood energy efficiency development program.

EFAP states that effective management of the remaining forest resources depends on the design and implementation of a comprehensive program to survey and to take inventory of the country's forest resources. It urges the formulation of a "Forest Management Plan" as part of the above-cited (b) forest resource and ecosystems management program.

In 1997, however, it was made clear that this responsibility now rests with the Regional State Governments. Back in 1989 SFCDD, the former body of FWCDD, initiated the consolidation of state forests and the management has been succeeded by FWCDD, which has established 58 NFPAs over a total land area of 4.8 million ha (including 1.9 million ha of non-

forest areas), determined the forest zones, conducted forest inventory surveys, and would formulate forest management plans for all of these NFPAs.

Nevertheless, FWCDD has been able to draw up forest management plans for the following NFPAs alone, due to financial and technical coustraints;

i) Tiro Boter-Becho (Oromia Region, 240 kilometers southwest from Addis Ababa)
ii) Munessa-Shashemene (Oromia Region, 240 kilometers south of Addis Ababa)
iii) Menagesha-Suba (Protection forest, under direct jurisdiction of the central government, 45 kilometers west from Addis Ababa)
iv) Wof-Washa (Protection forest, Amhara Region, 130 kilometers northeast from Addis Ababa)

2-4-2. Regional Policies on Forests and Forestry

The Intensive Study Area is under the jurisdiction of the Oromia Regional State Government. Although lacking specific plans for forests and forestry now, the Oromia Region is preparing to draw up a forestry action program within the EFAP framework. In addition, the Regional State of Oromia has been carrying out its "Five-Year Development Plan of the Oromia Region" since 1996.

This plan includes both forest and forestry measures. Forests in this region cover 2.5 million ha, approximately 7% of the Region's total area. The plan expresses concerns over the rapid decline of its limited forest coverage. The major cause of forest destruction is conversion to farmlands, which resulted in clear felling of approximately 60,000 ha up to 100,000 ha of forest stands according to about 3 % of the total forest areas every year. Conversely, the annual reforestation area amounts to only 9.4% of the converted area.

Therefore, the "Five-Year Development Plan of the Oromia Region" adopted forest conservation as one of its main objectives. Its specific forestry target is to produce 1 billion seedlings and afforest a total area of 112,800 ha during the plan's five-year period. Furthermore, the Regional State of Oromia in January 1997 issued a notification prompting the initiation of "Forest Protection Committees", which will be formed at both district and village levels to discuss steps for preventing forest destruction and illegal activities in the forest by farmers.

2-4-3. Forest and Forestry Administration

As a result of the reorganization of the Ethiopian Government in August 1995, FWCDD was transferred from MNRD&EP to MoA without any change in its organization and jurisdiction. In June 1997, MoA reorganized FWCDD into a new FWSLTRD with three administrative teams (see Fig. 2).

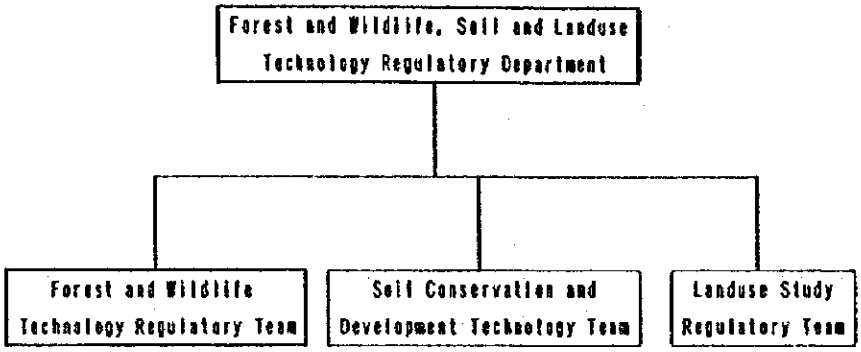


Fig. 2 Organizational Structure of Forest and Wildlife, Soil and Land-use Technology Regulatory Department

The Ethiopian Government has delegated some of its authorities to the Regional States since the establishment of federal system. The cases are found in the state forest management as well, where Regional States are responsible. Of which jurisdiction, the central or regional government, each NFPA falls under is yet to be determined. At present both Belete-Gera NFPA and Babya-Fora NFPA are under Oromia Regional State jurisdiction. Tiro Boter-Becho NFPA and Munesa Shashemane NFPA where Enterprise has been established, are supervised by the Oromia Regional State, while Munagesha-Suba NFPA remains under the direct jurisdiction of the central government.

The Regional State of Oromia administers forest and forestry affairs through OADB, which has an extension wing and a regulatory wing. This regulatory wing is further divided into five departments, one of which is FWCD. FWCD administers affairs related to forests and forestry (Fig. 3).

Each zonal office is structured in a manner similar to the Regional State of Oromia Government. JZADO has a deputy head for extension and a deputy head for regulatory action. The latter deputy head oversees five teams, one of which is FWPT (Fig. 4). FWPT manages forests and carries out other required forestry activities, using the quarterly budget funded by the regional state. (The 1996/97 budget for Jimma Zone's FWPT is 59,227 Birr.).

FWPT's activities include:

- Collecting of seeds and producting seedlings
- Planting
- Tending (weeding, pruning, ...etc.)
- Thinning and the sale of thinned logs
- Supervising the felling of natural-stand, control of felling volume and carrying out the stumpage sale.

The lowest level of zonal forest and forestry administration's hierarchy is the "forest guards," who are deployed in various villages. Forest guards are employed by either JZADO or DADO.

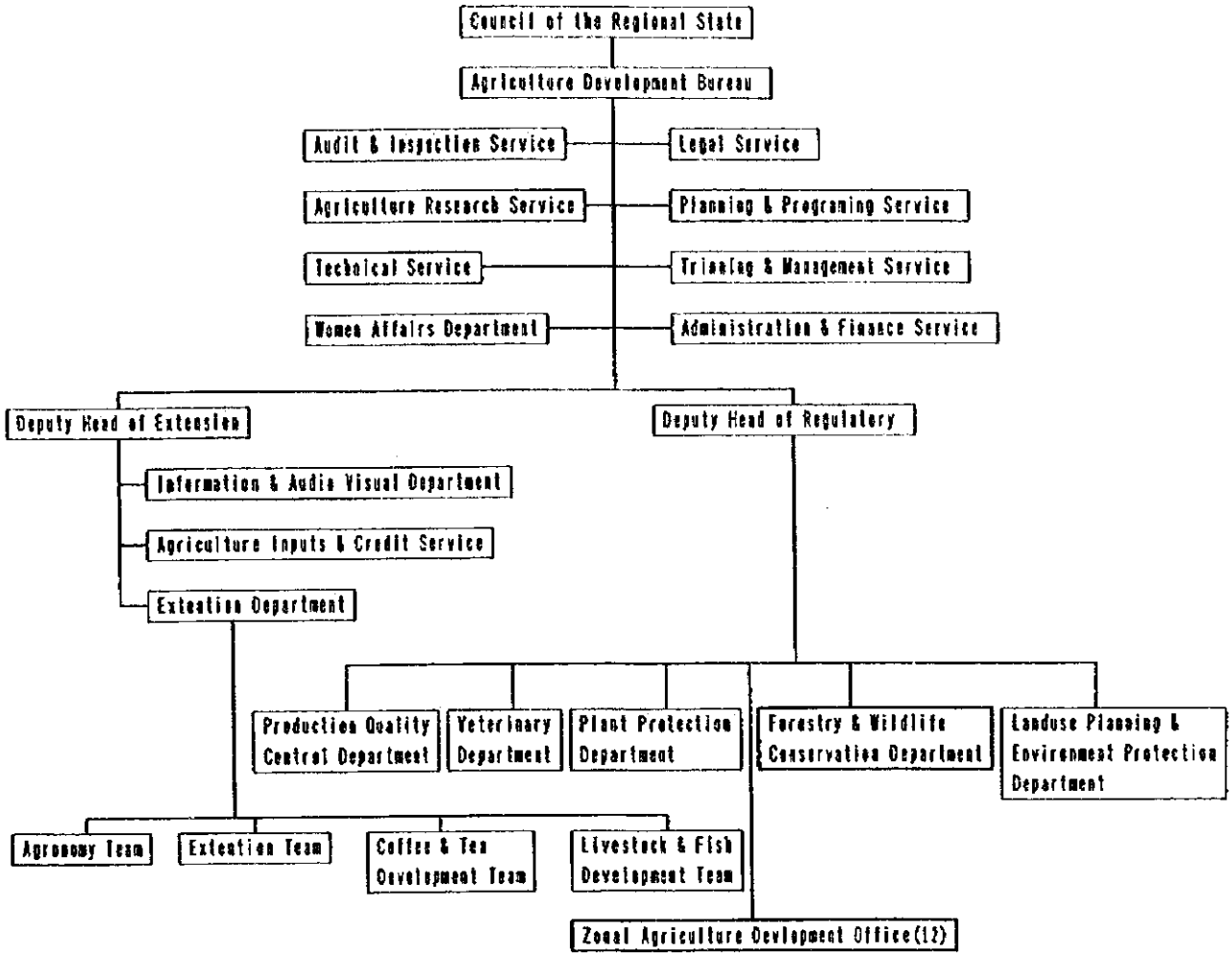


Fig. 3 Organizational Structure of Regional State of Oromia on Forest/Forestry

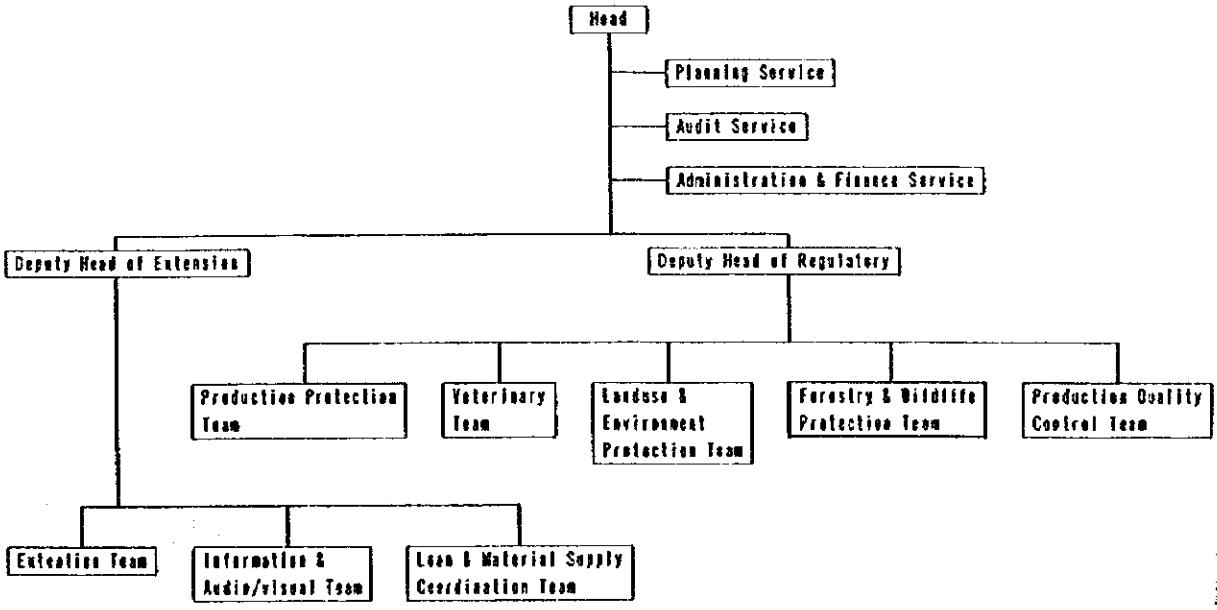


Fig. 4 Organizational Structure of Jimma Zonal Agriculture Development Office

2-4-4. Land Tenure System

(1) Pre-Revolution

During the imperial era Ethiopia's land ownership system was extremely complex. A mixture of several types of feudal land ownership existed in various parts of the country.

- "Rist" - Inheritable lands of each family, which holds the ownership of land as a whole, prevailed in the Amhara and Tigre regions.
- "Gult" - Lands, together with administrative and taxing powers, were granted by the emperor to its high-ranking courtiers. The term of ownership was normally limited to the period when the courtiers were in office, or to their lifespans.
- "Rist/Gult" - This land ownership right was similar to the special "Rist" rights. It was granted to imperial family members, and was widely exercised throughout the country, except for Amhara Region.
- "Semon" - These lands were owned by churches and were exempted from property tax.
- In addition to the above mentioned types of land ownership, there were lands owned by the emperor and his court.

(2) Post-Revolution

After the takeover of power by a socialist military junta in 1974, the ownership of lands was transferred to the state in accordance with the "Rural Land Proclamation of March 1975." Farmlands were divided into 800-hectare blocks, and a peasant association was to be organized in each block. Members of a peasant association, given a common right to use the land block, were respectively allotted a farming plot not exceeding 10 ha.

Most large-tracts, formerly privately owned lands, were transformed into state farms, while other expansive private lands were claimed by state as settlements and tracts for producers' cooperatives. Although citizens were accorded with the usufructuary right over land, they were prohibited from selling, leasing, renting and mortgaging the lands.

In 1991 the socialist regime collapsed, and the current federal government was established after a period of ruling by a transitional government. Nevertheless, Ethiopia's land ownership system has not changed basically from that initiated by the socialist government through the "Rural Land Proclamation" of March 1975.

A proclamation regarding investments, which includes relaxation of the restriction over land-related legal rights has been issued in 1997 according to a local informant. Details, however, are not available as of January 1998.

2-5. Aerial Photographs and Topographical Map

2-5-1. Aerial Photographs (Aerial Photography, Development and Inspection)

(1) Aerial Photography

The project included the taking of monochrome aerial photographs of the Study Area of 27,000 km^2 at a scale of 1/25,000. Swedesurvey, a Swedish aerial photo company, was commissioned for the photography, and one photo supervisor was assigned for the job.

During the first phase from January 1996 to mid-February 1996, Swedesurvey completed 50% of the works, under direct contract with JICA.

The remaining work was completed during the second and last phase from October 1996 to February 1997. However some parts of the designated area could not be photographed due to climatic conditions. The photographed area covered 25,309.1 km^2, that is approximately 94% of the total area. The missing parts correspond to mountain summits that are usually hidden by clouds and difficult to photograph. As those missing parts did not significantly hinder the subsequent operations, the aerial photography works were terminated.

(2) Development

After the completion of the aerial photography, EMA implemented the development and printing of the photos.

The development and printing of the films taken in the first phase were follows:

Negative film development	one set
Monochrome contact prints	one set
200% enlargment monochrome prints	3 sets

The development and printing of the films taken in the second phase were follows:

Negative film development	one set
Monochrome contact prints	two sets
Monochrome contact prints of the Intensive Study Area	4 sets

(3) Inspection

For both phases one and two, the Study Team inspected the aerial photographs in Ethiopia.

The contact prints were developed in Ethiopia soon after the photos were taken, and each print was inspected to judge whether it met the overlap and sidelap specifications.

2-5-2. Topographical Map

Topographical mapping of the 1,500 km^2 Intensive Study Area at a scale of 1/25,000 was carried out. The Intensive Study Area covered Gera (1,170 km^2) and Belete (330 km^2) area. However, 820 km^2 of this area had already been covered by an existing 1/50,000 topographical map. The existing 1/50,000 topographical map was enlarged to a scale of 1/25,000 by photo processing, and the final draft of the new 1/25,000 map was traced on a polyester base. A new topographic map of the area that was not covered by the existing 1/50,000 map was made by stereoplotting images acquired using the SPOT 3 satellite imagery produced by France.

For imagery acquisition, the "red service program" was applied to preset the intersection angle to a value that it is not too acute, in order to obtain the highest possible accuracy. The imagery data were acquired between October 1996 and January 1997, then the images suitable for the establishment of a topographical map were selected. The images taken on October 15 and November 1st were used for the plotting of the Gera area, and those taken on October 31st and November 1st for the Belete area.

Stereoplotting was implemented with a Planicomp C-100 analytical plotter, of the German ZEISS, using BINGO, a special SPOT software.

The stereoplotting of the map at a scale of 1/25,000 delineated the contour lines at 20 m for the intermediate contour lines, and 100 m for the index contour lines.

Concerning the control points used for orientation, common natural features of the existing 1/50,000 topographical map and of the newly acquired images were selected. The coordinates of those points were determined using the topographical map, and those points were used as control points for the horizontal position and the height.

Stereoplotting, compilation and drafting operations were carried out by adjoining the new data with the existing 1/50,000 topographical map.

The map symbols were unified as much as possible with those of the existing 1/50,000 map.

In view of their importance in subsequent works, the newly completed 1/25,000 topographical maps and the existing 1/50,000 topographical maps were used to compile a 1/50,000 roll size topographical maps -- 2 sheets for the Gera area and 1 sheet for the Belete area.

2-6. Soil Survey

2-6-1. Objectives

Soil survey results provide basic data for the formulation of plans concerning reforestation, forest road construction, erosion control and so on as part of the Forest Management Plan. Soil survey results also provide data for identifying land-use problems and proposing soil conservation guidelines.

2-6-2. Survey Method

(1) Content of Survey

A soil profile survey was carried out to collect soil classification data needed for the production of soil maps of the Intensive Study Area. Soil survey results were reviewed and soil classification, upon which soil maps were produced, was performed and analyzed.

(2) Survey Site

Topography, vegetation, and roads leading into forests were verified by comparing aerial photographs with the existing 1/50,000 topographical maps. Then sites for conducting soil profile survey were selected on the basis of topographical conditions, soil types and the vegetation cover. 12 sites in the Belete Forest area and 20 sites in the Gera Forest area (see Fig. 5) were chosen for soil profile surveys. In addition, simple pit tests were performed in order to confirm the ranges and borders of soil types.

(3) Method of Soil Profile Survey

At each soil profile survey site, a sample point was selected to represent surrounding conditions, and a pit was dug at the selected point. Although a standard soil profile requires a pit measuring 1 m wide and 1-1.5 m deep, a depth of less than 1 m is permitted when bed rock is encountered at a shallow depth. After the completion of digging, the sample soil profile was flatten and smoothed out by using a trowel or pruning shears.

Then the section, attached with a scale on the left and a plate indicating the survey area and date on top, was photographed. A sketch of the profile, soil horizons, soil colors, soil textures, structures, hardness, gravel distribution, roots, etc. were recorded in soil profile charts (see Appendix Fig. 8 for a example of the soil profile charts). These information were recorded in accordance with FAO's "Guidelines for Soil Profile Description (2nd ed. 1977)." Specific records and symbols used are reported in Appendix Tab. 9. The vegetation (names of trees) and land use conditions at each survey site were also recorded.

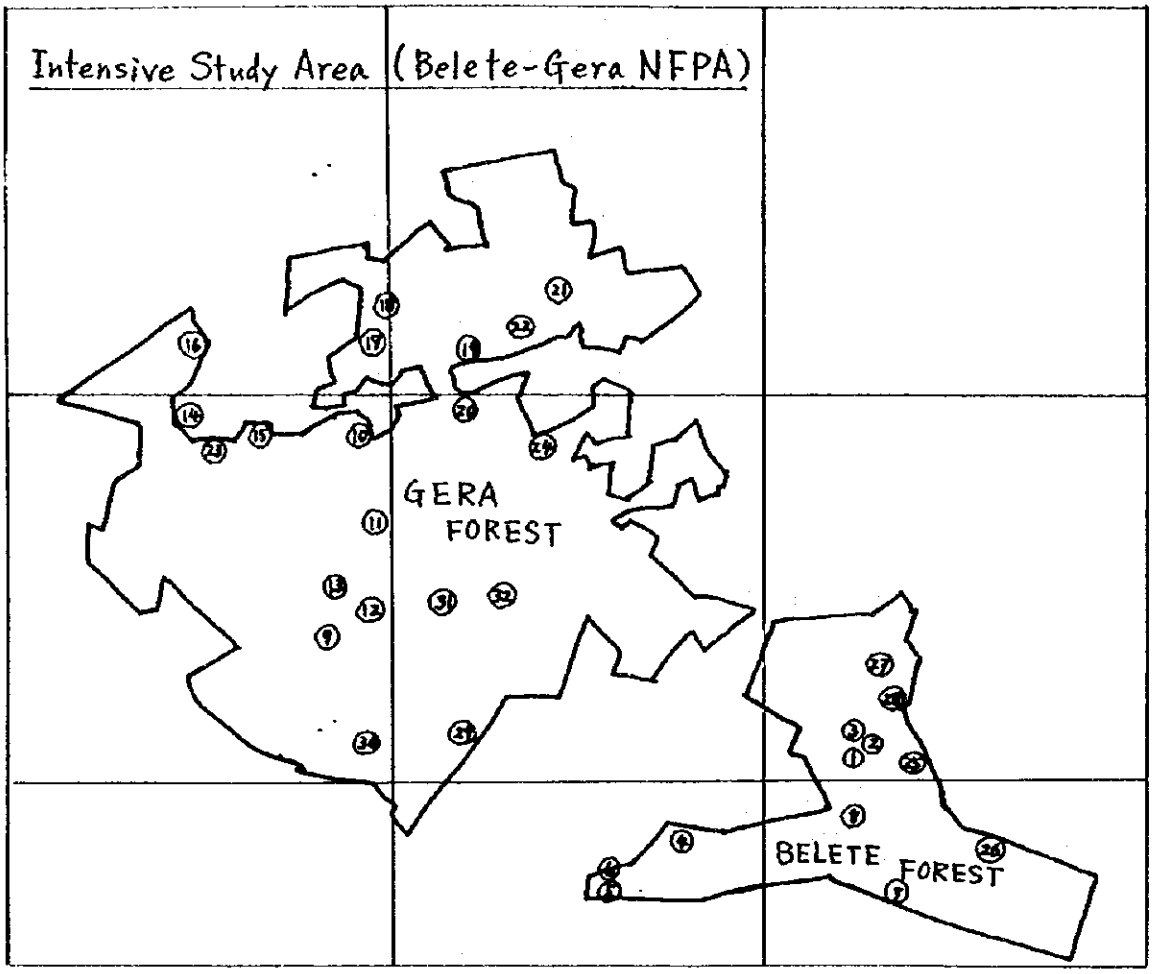


Fig. 5 Locations of soil survey plots

2-6-3. Soil Survey Results and Soil Classification

Soil profile descriptions follow the format shown in the Soil Profile Chart (Appendix Fig. 9). Results of soil profile survey are summarized in Appendix Tab. 10. Soil classification was performed for each survey site in accordance with FAO/UNESCO's "Soil Map of the World, Revised Legend (1988)."

FAO/UNESCO's "Soil Map of the World (1/5,000,000), Volume VI: Africa, 1977" indicates that soil in the Intensive Study Area are of Ne13-3b, Ne12-2c, and Be49-3c type.

Ne13-3b denotes a mixed form of the following soil units.

Dominant soil unit	Ne	:	Eutric Nitosols
Associated soil	Vp	:	Pellic Vertisols
Inclusions	Be	:	Eutric Cambisols
	I	:	Lithosols
	Lp	:	Plinthic Luvisols
Soil texture	3	:	Fine
Slope (relief)	b	:	Undulating

Ne12-2c denotes a mixed form of the following soil units:

Dominant soil unit	Ne	:	Eutric Nitosols
Associated soil	Be	:	Eutric Cambisols
Inclusions	I	:	Lithosols
	Vp	:	Pellic Vertisols
Soil texture	2	:	Medium
Slope (relief)	c	:	Steeply

Be49-3c denotes a mixed form of the following soil units:

Dominant soil unit	Be	:	Eutric Cambisols
Associated soil	Ao	:	Orthic Acrisols
Inclusions	I	:	Lithosols
	Vp	:	Pellic Vertisols
Soil texture	3	:	Fine
Slope (relief)	c	:	Steeply

Being a small-scale soil map, the "Soil Map of the World (1/5,000,000), Volume VI: Africa" covers the Intensive Study Area and surrounding lowlands as well.

FAO/UNESCO has been revising the legend, using data accumulated all over the world since its first publication in 1964. This survey used the latest version of the legend. Corresponding 1974 version's legend is listed below.

Soil Unit Legend (1974)		Soil Unit in Revised Legend (1988)
Ne : Eutric Nitosols	--->	NTh: Haplic Nitisols
Be : Eutric Cambisols	--->	CMe: Eutric Cambisols
Vp : Pellic Vertisols	--->	VRe: Eutric Vertisols
		VRd: Dystric Vertisols
I : Lithosols	--->	LPq: Lithic Leptosols
Lp : Plinthic Luvisols	--->	LVg: Gleyic Luvisols
		PTd: Dystric Plinthosols
Ao : Orthic Acrisols	--->	ACh: Haplic Acrisols

The subsurface geology throughout the Intensive Study Area consists of crystalline bed rocks dated Precambrian period at its deepest stratum. Lying above the bed rocks are basic volcanic rocks and lava of the Tertiary period. Those volcanic rocks and lava are composed mostly of basalt and tuff.

Reddish-brown and brown clayey soil containing gravel is extensively prevailing in the Intensive Study Area. This soil is the results of the weathering of its parent materials--basalt and tuff. The present soil survey found that the soil in the Intensive Study Area mainly consists of Nitisols and Cambisols in most of the undulating highland regions. Leptosols are dominant in the peak, ridge and precipitous areas. In the limited depressions, such as marshes, in the highland regions, Luvisols is prevalent.

The distribution of soil units in the Intensive Study Area is as follows in relation to vegetation and topographic conditions:

Forest (including grassland, farmland), Plateau

Dominant	:	Haplic Nitisols	(NTh)
		Humic Nitisols	(NTu)
		Dystric Cambisols	(CMd)
Associated	:	Eutric Cambisols	(CMe)
		Humic Cambisols	(CMu)

Forest (including grassland), Mountain(Rocky)

Dominant	:	Umbric Leptosols	(LPu)
Associated	:	Lithic Leptosols	(LPq)
		Mollic Leptosols	(LPm)
		Dystric Leptosols	(LPd)

Grassland (including forest), Marsh areas

Dominant	:	Gleyic Luvisols	(LVg)
Associated	:	Haplic Luvisols	(LVh)

A list of soil type classifications of the survey plots is presented in Tab. 3.

Tab. 3 Soil type classification of soil survey plots

Profile No.	Soil Unit(FAO/UNESCO Soil classification Revised Legend, 1988)
No. 1	Dystric Cambisols (CMd-2/3bc stony)
No. 2	Eutric/Dystric Cambisols (CMe/CMd-3c stony)
No. 3	Humic/Eutric Cambisols (CMu/CMe-2/3c stony)
No. 4	Humic Nitisols (NTu-3c)
No. 5	Dystric Cambisols/Humic Nitisols (CMd/NTu-2/3b)
No. 6	Dystric Cambisols (CMd-2/3c)
No. 7	Haplic Nitisols (NTh-3b)
No. 8	Haplic Nitisols (NTh-3c)
No. 9	Haplic Nitisols (NTh-3c)
No. 10	Gleyic Luvisols (LVg-3a)
No. 11	Dystric Cambisols (CMd-3b stony)
No. 12	Humic Nitisols (NTu-3bc)
No. 13	Humic Nitisols (NTu-3bc)
No. 14	Dystric Cambisols (CMd-3b stony)
No. 15	Haplic Nitisols (NTh-3c stony)
No. 16	Humic Nitisols (NTu-3c stony)
No. 17	Haplic Nitisols (NTh-3c stony)
No. 18	Haplic Nitisols (NTh-3bc stony)
No. 19	Humic/Haplic Nitisols (NTu/NTh-3c stony)
No. 20	Haplic Nitisols/Mollic Leptosols (NTh/LPm-3c stony)
No. 21	Haplic Nitisols (NTh-3b stony)
No. 22	Haplic Nitisols (NTh-3bc)
No. 23	Umbric Leptosols (LPu-3c stony)
No. 24	Humic Nitisols (NTu-3b)
No. 25	Haplic Nitisols (NTh-3c)
No. 26	Mollic Leptosols (LPm-3c stony)
No. 27	Haplic Nitisols (NTh-3c)
No. 28	Haplic Nitisols (NTh-3b)
No. 29	Haplic Nitisols (NTh-3c stony)
No. 30	Humic Nitisols (NTu-3bc)
No. 31	Haplic Nitisols (NTh-3b)
No. 32	Haplic Nitisols (NTh-3c)

2-6-4. Production of Soil Map

A soil map of the Intensive Study Area was produced from two base maps. One was a 1/25,000 topographical map obtained by enlarging an existing 1/50,000 topographical map. The other was a 1/25,000 topographical map drawn from SPOT satellite images. The soil map depicts the distribution of various soil types. On the map, delineation is made for one soil type or a composition of several soil types (soil composition).

(1) Explanation of Soil Map

Definitions and characteristics of major soil types or soil compositions found in the Intensive Study Area are described below, descriptions are adopted from the FAO/UNESCO "Soil Map of the World, Revised Legend (1988)".

Nitisols (NT) Soils having an argic B horizon showing a deliving clay distribution (a decline of clay from its maximum to not more than 20% within 150 cm depth); also showing gradual to diffuse horizon boundaries between A and B horizon; having nitic properties in some subhorizon within 125 cm of the surface; lacking the tonguing which is diagnostic for Podzoluvisols; lacking ferric or vertic properties; lacking plinthite within 125 cm of the surface.

Haplic Nitisols (NTh) not strongly humic and having an argic B horizon that is red to slightly dusky red.

Humic Nitisols (NTu) Nitisols having an umbric or a mollic A horizon, and being strongly humic.

Cambisols (CM) Soils having a cambic B horizon and no diagnostic horizons other than an ochric or an umbric A horizon or a mollic A horizon overlying a cambic B horizon with a base saturation (by NH_4OAc) of less than 50%; lacking salic properties; lacking the characteristics diagnostic for Vertisols or Arenosols; lacking gleyic properties within 50 cm of the surface.

Eutric Cambisols (CMe) Cambisols having an ochric A horizon and a base saturation (by NH_4OAc) of 50% or more at least between 20 and 50 cm from the surface but which are not calcareous within this depth; lacking vertic properties; having a cambic B horizon which is not strong brown to red; lacking ferralic properties in the cambic B horizon; lacking gleyic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Dystric Cambisols (CMd) Cambisols having an ochric A horizon and a base saturation (by NH_4OAc) of less than 50% at least between 20 and 50 cm from the surface; lacking vertic properties; lacking ferralic properties in the cambic B horizon; lacking gleyic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Humic Cambisols (CMu) Cambisols having an ochric A horizon or a mollic A horizon overlying a cambic B horizon with a base saturation (by NH_4OAc) of less than 50%; lacking vertic properties in the cambic B horizon; lacking gleyic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.

Leptosols (LP) Soils which are limited in depth by continuous hard rock or highly calcareous material (calcium carbonate equivalent of more than 40%) or a continuous cemented layer within 30 cm of the surface, or having less than 20% of fine earth over a depth 75 cm of the surface; having no diagnostic horizons other than a mollic, umbric, or ochric A horizon, or a petrocalcic horizon, with or without a cambic B horizon.

Dystric Leptosols (LPd) Leptosols having an ochric A horizon and a base saturation (by NH_4OAc) of less than 50% in at least some part of the soil; lacking hard rock and a continuous cemented layer within 10 cm and permafrost within 200 cm of the surface.

Mollic Leptosols (LPm) Leptosols having a mollic A horizon which does not contain or immediately overlie calcareous material with a calcium carbonate equivalent of more than 40%; lacking hard rock and a continuous cemented layer within 10 cm and permafrost within 200 cm of the surface.

Umbric Leptosols (LPu) Leptosols having an umbric A horizon; lacking hard rock and a continuous cemented layer within 10 cm and permafrost within 200 cm of the surface.

Lithic Leptosols (LPq) Leptosols which are limited in depth by continuous hard rock or a continuously cemented layer within 10 cm of the surface.

Luvisols (LV) Soils having an argic B horizon which has a cation exchange capacity equal to or more than 24 cmol(+) kg^{-1} clay and a base saturation (by NH_4OAc) of 50% or more throughout the B horizon; lacking a mollic A

horizon; lacking the E horizon, abruptly overlying a slowly permeable horizon, the distribution pattern of the clay and the tonguing which are diagnostic for Planosols, Nitisols and Podzoluvisols respectively.

Haplic Luvisols (LVh) — Luvisols having an argic B horizon which is not strong brown to red; lacking an albic E horizon; lacking a calcic horizon and concentrations of soft powdery lime within 125 cm of the surface; lacking vertic properties; lacking ferric properties; lacking gleyic and stagnic properties within 100 cm of the surface.

Gleyic Luvisols (LVg) — Luvisols showing gleyic properties within 100 cm of the surface.

The definition of diagnostic horizons are explained as follows in FAO/UNESCO's "Soil Map of the World, Revised Legend (1988)":

Mollic A : "Fertile earth" topsoil, well structured and dark with moderately high organic matter and base saturation > 50% (cf. umbric A).

Ochric A : A horizon of dry area; pale, low organic matter and/or thin or hard and massive; excluding finely stratified material, e.g. alluvium.

Umbric A : "Infertile earth" topsoil, with moderately high organic matter and base saturation < 50% (cf. mollic A) but excluding fimic horizons.

Albic E : Bleached, usually sandy material, lacking clay and free iron oxides.

Argic B : Horizon with higher clay content than overlying horizon (e.g. by illuvial deposition).

Cambic B : In situ altered B - most B horizons not meeting criteria for argic, natric, spodic or oxic.

Diagnostic properties are defined as follows in FAO/UNESCO's "Soil Map of the World, Revised Legend (1988)":

Calcareous material : Strong effervescene with 10% HCl, or > 2% $CaCO_3$ equivalent.

Ferralic properties : B horizons with CEC of < 24 cmol(+) kg^{-1} clay.

Ferric properties : Red mottles and/or concretion.

Gleyic properties : Reduced conditions caused by groundwater saturation; capillary fringe reaches surface; evident Fe reduction and segregation; > 95% of matrix white to black (N), or blue to green (GY, BG, G or B) colours, unless low or inert Fe colouring.

Nitic properties : Soil material of ≧ 30% clay, possessing easily broken moderate to strong angular blocky structures with shiny ped faces.

Permafrost : Permafrost is a layer in which the temperature is perennially at or below 0℃.

Salic properties : Top 30 cm of soil with EC > 15 dS m^{-1} or pH > 8.5, with EC > 4 dS m^{-1}.

Stagnic properties : Reduced conditions caused by surface water saturation; mottling and/or Fe-Mn concretions or low chromas.

Strongly humic : Soil material with > 1.4% organic carbon.

Tonguing : Penetration by albic E into argic B; depth of "tongues" must be greater than widths and be > 15% of the mass of the upper part of the argic B.

Vertic properties : Of clay soils with vertisols features but not qualifying as true vertisols.

At the location of soil profile survey, only one soil type can be assigned. However, various soil types may be found within short distance between each other. Therefore, while making soil map, it is necessary to group those soil types into a soil composition. As a result, the soil mapping unit consists of both soil types and soil compositions.

Symbols used for soil compositions are arranged in a way that the dominance is indicated. For example, in the case of Haplic Nitisols being the dominant soil type and Eutric Cambisols being the associated soil type, the symbol is NTh-CMe. Similarly, if Humic Cambisols is the dominant, and Humic Nitisols is the associated, then the symbol used is CMu-NTu. Where the dominant soil unit is Haplic Nitisols, the associated soil Dystric Cambisols and the inclusion is Umbric Leptosols; the symbol used is NTh-CMd-LPu.

The soil in the Intensive Study Area is mostly fine-textured. And the topography is marked by many undulating hills, with slopes ranging from moderate to precipitous. Symbol for indicating soil texture and slope is 3b/c. The symbols in the soil map, therefore, are post-fixed by -3b, -3c or -3b/c. Furthermore, because the fine-textured soil in the Intensive Study Area contains gravel at many sites, the word "stony" has been added to the symbols.

2-6-5. Discussion of Soil Survey Results

The results of soil profile surveys indicate that the soil types existing in the Belete-Gera NFPA, which is the Intensive Study Area, are mainly Nitisols, Cambisols and Leptosols. At some sites, Luvisols was found as associated soil.

The soil profile surveys were performed in an undulating highland region ranging from 1,000 m to 3,000 m altitude. In the predominant highland area with a relatively thick soil layer, the main soil types are Haplic Nitisols, Humic Nitisols, Dystric Cambisols, Eutric Cambisols, and Humic Cambisols. In areas such as mountain peaks, steep slopes and stream banks, where the soil layer is thin, the prevalent soil types are Umbric Leptosols, Lithic Leptosols, Mollic Leptosols, and Dystric Leptosols. In depressions such as marshes and lowlands along rivers in the highland region, Gleyic Luvisols and Haplic Luvisols are the dominant soil types.

Although it is difficult to determine the relation between vegetation and soil type, slight differences in soil conditions were found between locations with favorable vegetation cover and those without. At Gena, Timba and Loyi sites in the Gera Forest and at Tugo-Milki sites in the Belete Forest, where vegetation is in good condition, the pH reading indicated: (a) a clearly acidic state in deep soil layers, (b) relatively thick soil layers, and (c) a medium degree of soil hardness. These suggest that the soil at these sites is less compact and has more pores, so that the growth of trees is facilitated.

At Maru and Wala sites along the Gojeb River in Gera Forest, at Muje (located in the north-central part) and at Kombolcha (located in the western part), where natural forests have been destroyed or left untended after cutting, the soil is slightly acidic but is hard. As a compacted soil hinders the expansion of tree roots, vegetation in an area with compacted soil is dominated by shallow-root trees, shrubs, and grasses. Soil hardness, therefore, caused the decline of natural-forest.

At lowland sites and Gojeb River basin in the western Belete Forest, where the climate is fairly dry, the soil's pH reading is high. These locations have some forest plantations, with the majority being grassland, where some areas are planned for forestation in the future. Forestation at the Kishe site will especially require measures to prevent surface soil runoff because of its position on a steep slope and due to the presence of a considerable amount of gravel in the soil. Nevertheless, soil at the Kishe site is suitable for forestation. The results of soil surveys in forest plantation indicated that the *Cupressus* spp. and *Pinus* spp. forest plantations have a thin, compacted, and dry surface soil. In the *Cupressus* spp. forests, in particular, forest floor vegetation is virtually non-existent, and the soil bears the scars of gully erosion. Gully erosion occurs when the soil has become too hard and too compacted to allow a large amount of rainfall to be absorbed into the ground.

Note that it is still possible to restore vegetation on a soil surface with gully erosion by letting more sunlight penetrate into the forest.