REPORT
ON
THE STUDY OF DEVELOPMENT SURVEY
FOR
EXPANDED AFFORESTATION WORK
IN
SAME DISTRICT OF KILIMANJARO REGION,
THE UNITED REPUBLIC OF TANZANIA

AUGUST 1988

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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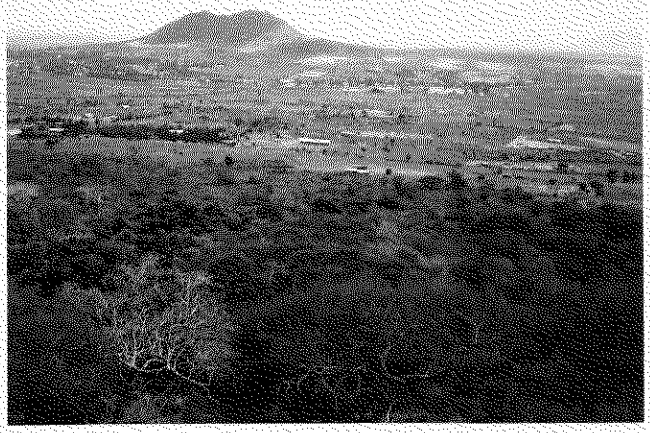
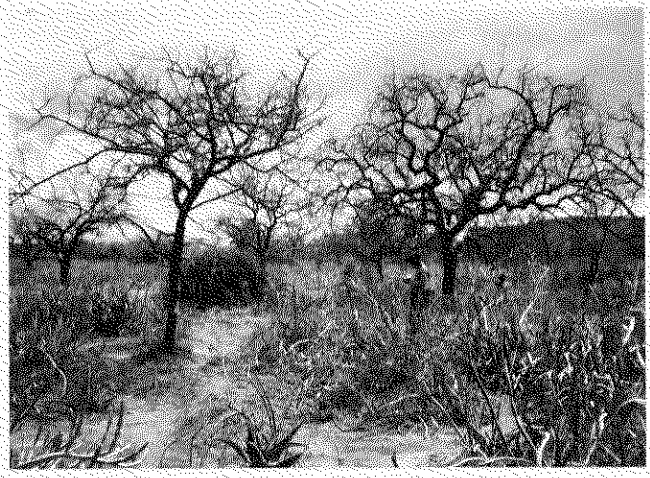
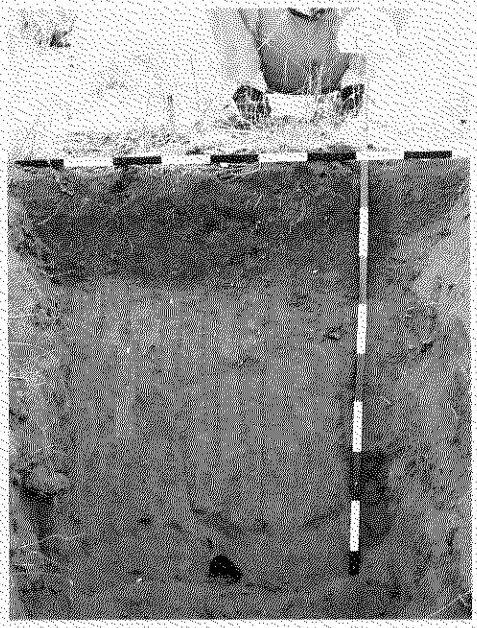


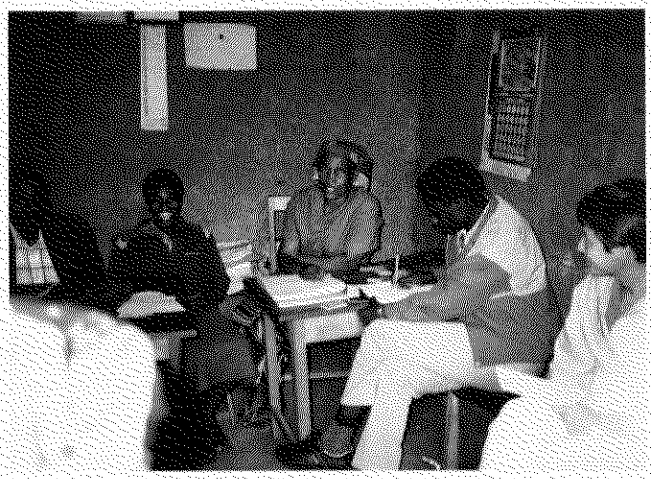
Prospect of Same and Koko Hill from Vumari Forest Reserve.



Thornbush savanna is distributed widely in lowlands.

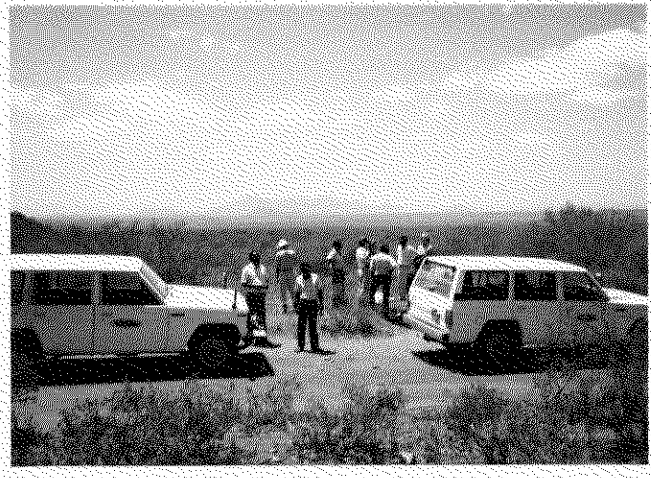


Cambisols is distributed in the study area. (Soil profile)



Scene on the survey by questionnaire at ward office.

Agro-forestry is seen mainly in highlands. (Cultivated banana and coffee under the trees)



Scene of the discussion about Semi-arid Forest Management Plan in the field.

PREFACE

In response to the request by the Government of the United Republic of Tanzania, the Government of Japan has decided to conduct a survey on the project for Feasibility Study of Social Forestry and Semi-arid Forest Management Plan and entrusted the survey to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a survey team headed by Mr. Takashi Hasegawa representative of the Japanese joint venture in charge of the said survey three times in the period from January 14, 1987 to March 28, 1988.

The team had a series of discussions on the project with the officials concerned of the Government of Tanzania and conducted field surveys in the project area.

After the team returned to Japan, further studies were made and a mission was dispatched to Tanzania to explain and discuss the report. As a result, the present report has been prepared.

I hope that this report will serve for the sound management of the forest in Tanzania and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Tanzania for their close cooperation extended to the team.

August, 1988

Kensuke Yanagiya
President
Japan International Cooperation
Agency

CONTENTS

Preface

1. Summary

1.1 Circumstances of the Study

(1) Background and history of the survey

The United Republic of Tanzania (hereinafter referred to as Tanzania) has 44 million hectares of forests which account for 47% of its total land area. The greater majority of these forests comprise of "Miombo woodland" and savanna. Excess felling for fuelwood and over grazing in recent years, as well as irregular climatic changes have drastically reduced the forest area and deteriorated forest productivity and environment conservation functions.

To cope with these circumstances, the Tanzanian Government started to promote the development of social forestry about 20 years ago but has had difficulty in attaining the objective.

For this reason, the Tanzanian Government requested the Japanese Government for technical assistance in the development of social forestry.

In response to this request, the Japanese Government dispatched a contact mission for a period from February 5 to 20, 1986, followed by a preliminary survey team from August 5 to 22 of the same year. The survey team concluded an agreement on the scope of work with the Ministry of Lands, Natural Resources and Tourism, of the Tanzanian Government to conduct a forestry development planning survey. The main object of this survey was to conduct a feasibility study of social forestry with about 200,000 hectares of land in the Same District, Kilimanjaro Region, as the study area, and to formulate a forest management plan for about 20,000 hectares of a model area within the study area. It was agreed that the forestry development planning survey in Kilimanjaro, Tanzania, will be undertaken based on this scope of work.

(2) Reasons for selection of study area and model area

About 200,000 hectares of land in Same District, Kilimanjaro Region, were selected as the study area for the following reasons:

The Japanese Government has conducted various technical cooperations intensively in Kilimanjaro Region.

The Kilimanjaro Region is in acute shortage of fuelwood. The region also offers varied conditions such as semi-arid lowlands and moderate warm and humid highlands.

The reason about 20,000 hectares of land including Same was designated as the model area, is that this area is the center of both administration and traffic, thereby having the advantage of effectively serving as a showcase for the demonstration of social forestry. The area could also serve as a model of different types of social forestry.

(3) Objectives and details of the survey

The main objectives of the survey are to conduct a feasibility study of social forestry, to formulate a semi-arid forest for the study area of 200,000 hectares approximately, to formulate a semi-arid forest management plan for the model study area of approximately 20,000 hectares, and to transfer forest management technology to Tanzania through these operations, thereby contributing to the promotion of the Tanzanian Government's forestry policies and to the economic development of the local community.

This study was conducted from December 1986 for two years. The following flow chart summarizes the details of this study.

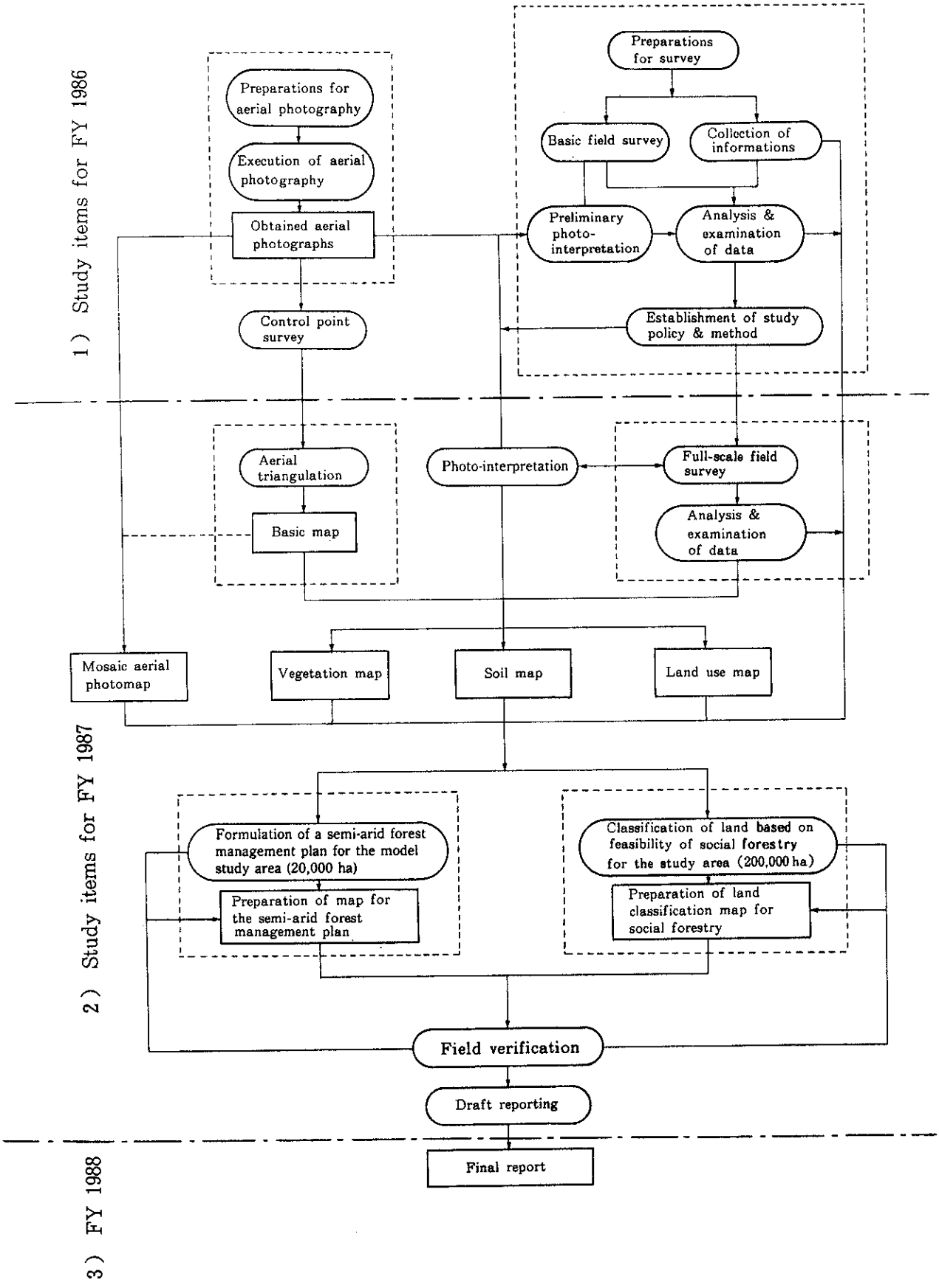


Fig. 1-1 Flow of the Study

(4) The persons concerned

The names of the members of the advisory team, survey teams and Tanzanian officials concerned are described as follows.

① Advisory Team

Kozo Yamagaki	Forestry Agency, Ministry of Agriculture, Forestry and Fishery
Takashi Kato	Forestry and Forest Products Research Institute
Yasushi Morikawa	- ditto -

② Survey Team

Takashi Hasegawa	Japan Forest Technical Association
Kinji Hachiya	- ditto -
Atsuta Watanabe	- ditto -
Tadashi Tsukiji	- ditto -
Motohiko Kikuchi	- ditto -
Kiyoshi Mochizuki	- ditto -
Atsushi Hisamichi	- ditto -
Sumio Ichikawa	- ditto -
Takeshi Ichinose	- ditto -
Yasuyuki Kuwahata	PASCO International Inc.
Kiyoto Hayakawa	- ditto -
Michimasa Nakai	- ditto -
Yosuke Ishigami	- ditto -
Kiyobumi Tamari	- ditto -
Shigeyuki Seo	- ditto -

③ Japanese Embassy in Tanzania

Yasushi Kurokochi	Ambassador
Shogo Takeuchi	First Secretary and others

④ JICA in Tanzania

Yoshinori Sano	Former Director
Nobuo Toida	Director
Hiroshi Murakami	Counselor
Muneo Segawa	Expert (F.D) and others

⑤ Tanzanian Officials

E.M. Mnzava	Director, Forestry and Beekeeping Division
B.K. Kaale	Former Head, Village Forestry Section
F.B. Kilahama	Head, Village Forestry Section and others

⑥ Kilimanjaro Region

Paul Kimiti	Regional Commissioner, Kilimanjaro Region
G. Mgendi	Development Director, Kilimanjaro Region
J.J. Mpiza	Planning Officer, Kilimanjaro Region
C.O. Kivumbi	Forest Officer, Kilimanjaro Region and others

⑦ Same District

Y.B. Lukoya	Commissioner, Same District
E.R. S. Chambo	Executive Director, Same District
A. Juma	Natural Resource Officer, Same District
R. Mtipula	Catchment Forest Officer, Same District
A.A Mdee	Forest Officer, Same District and others

⑧ Counterparts

B.K. Kaale	Former Head, Village Forestry Section
F.B. Kilahama	Head Village Forestry Section
F.R. Nyaky	Forest Officer, Forest Management Section
W. Njau	Forest Officer, Forest Management Section
L. Okello	Forest Officer, Forest Inventory Section
C.K. Ruffo	Forest Officer Research (Tanzania Forest Research Institute), Botanist
E.Z. Moshi	Tanzania Forest Research Institute, Pedologist
J. Massam	Forest Officer-Ruvu Fuelwood Project
L.E. Azaria	Land-Use Planning Officer, Hado Project
C.O. Kivumbi	Regional Forest Officer, Kilimanjaro Region
G.S. Masawe	Livestock Development Officer, Kilimanjaro Region
O. Kidami	Forest Officer, Kilimanjaro Region
D.A.B. Mantungwa	Assistant Forest Officer, Kilimanjaro Region
A. Juma	Natural Resources Officer, Same District
E.M. Mbwambo	Forest Assistant Officer, Same District

1.2 Outline of the Study Area

(1) Outline of Tanzania

① Topographical features and climate

Tanzania is situated in the central part of the eastern coast of the African Continent, between latitude 1° and 12° south and longitude 4° and 29° east. It has an area of approximately 94 million hectares, consisting of highland areas with elevations ranging from 1,000 to 1,500 meters (about 50% of the country's territory), mountainous areas with elevations exceeding 1,500 meters the highest point being Mt. Kilimanjaro of 5,895 meters (about 15%) and plains and hilly areas below 1,000 meters elevation (about 35%).

The climates of Tanzania may be divided into the following four main types:

- Tropical oceanic climate in the coastal area
- Savanna climate in the central highland area
- Tropical rainforest climate in the lakeside area
- Moderate and everlasting spring climate in the mountainous area

Many of the areas where savanna climate prevails have an annual rainfall of less than 600 mm.

② Socio-economic conditions

Tanzania has a population of 19 million according to the survey carried out in 1982 and the population size has expanded almost two and a half times during the last 35 years. It is expected that the population of the country will grow to 37 million by the year 2,000. Although the averaged density of the population of Tanzania stands at a rather lower figure of 20 persons per square kilometer, most of the population is concentrated in the coastal and mountainous areas.

Tanzania is a typical agricultural country, where the agriculture sector occupies overwhelmingly 86% of the total population and contributes almost 50% of GDP.

But it should be noted that due to severe meteorological conditions prevailing throughout the country, the cultivated land areas account for only 5.5% of the total area of the country, while everlasting grasslands occupy approximately 40% and the remaining part of the country is covered by forests and other woody vegetations.

③ Forestry

The forest and woody areas of Tanzania cover about 44 million hectares or 47% of the country's territory and 34 million hectares out of this vast forest and woody area are deemed to be suitable for forestry activities. The high tropical rainforest covers only 2% of Tanzania's forest and woody area, while savanna occupies around 74% and intermediary types of forest account for 24%.

The annual increment of forest in Tanzania is estimated at 7 million cubic meters for timber, and 20 million cubic meters for fuelwood. Although any reliable statistical data demonstrating the total wood consumption of the country is not available, the annual consumption of the fuelwood is expected to amount to 40 million cubic meters based upon the assumed per capita fuelwood consumption of 2 m^3 per year. Therefore, it may be possible to state that annually 20 million cubic meters of fuelwood have been overcut for the last several years.

The forestry policy of Tanzania was first aimed at the designation and management of forest reserves and 13 million hectares in total have been designated as forest reserves. The main purposes of designation have changed to those of a rather public nature such as water resource conservation from increase of lumber production at the earlier stages.

Industrial afforestation was set for the next administrative target of the Government's forestry policy and man-made forests of 79,000 hectares have been realized under the industrial afforestation program. Recently, industrial afforestation efforts have been concentrated upon the Sao Hill area for the production of pulp and paper material.

In addition to implementing the basic forestry policies as aforesaid, the Government launched the Village Afforestation Program aiming for the promotion of the inhabitants' own activities for fuelwood production and soil conservation about 20 years ago. Campaigns therefore have been extensively carried out throughout the country. However, the expected target has not been successfully attained so far. This can be easily understood from the fact that although annually 200,000 hectares of land should be afforested under the current program, actually afforested area ranges from only 10,000 to 20,000 hectares every year.

The Forestry and Beekeeping Division is set up under the Ministry of Lands, Natural Resources and Tourism for nationwide forestry activities administration. The division is simply referred to as Forestry Division in this report. Village Forestry Section under the Division is in charge of the planning and promotion of village afforestation but most of the duties have been transferred to local authorities such as the District Forest Officers under District Councils controlled by the Ministry of Local Government, Cooperatives and Marketing.

At the regional administration level, Regional Forest Officers are in charge of the planning and coordination of forestry administration of the districts and are under the instruction of the Regional Development Director's Office which is controlled by the Prime Minister's Office of the Central Government.

(2) Outline of the study area

The study area covers approximately 200,000 hectares of land located in the central part of the Same District, the southernmost area of the Kilimanjaro Region.

The Kilimanjaro Region is located in northeastern part of Tanzania.

The size of the study area is about 55 km from south to north and about 40 km from east to west. A national highway and a railway run in parallel through the central part of the study area from south to north, and the topography of the eastern part and western part of the highway and railway is quite contrastive; the eastern part is highland and mountainous area, while the western part is lowland and plains.

Although the mountainous areas of the South Pare Mountain Range with Mt. Shengena have a very steep topography, intensive farming has been traditionally developed and implemented by favor of moderate temperatures, an adequate amount of annual rainfall and the area is well populated.

On the other hand, the lowlands have elevations ranging from 600 meters above sea level to 1,000 meters with a rather flat topography and are classified as savanna with very small precipitation and are used mainly for grazing. It is reported that some parts of this area have an annual rainfall of less than 400 mm. Although considerable development efforts have been made in the area for farming agricultural products, a large yield will not be expected there from.

1.3 Basic Surveys

(1) Aerial photography and preparation of topographical maps

Aerial photography for the study area had been carried out from January 21, 1987 through February 4, 1987 and 754 photographs of 1 : 20,000 scale in total were taken for the designated 21 runs.

Based upon the aerial triangulation work prepared with the said aerial photographs and control point survey conducted at the study area, topographical maps were prepared and eleven topographical maps of 1 : 20,000 scale and 10-meter contour interval (5-meter contour intervals for flat areas) were completed. In addition, eleven mosaic aerial photomaps were also completed using the aerial photographs.

(2) Vegetation and forest type survey

The vegetation and forest type survey was carried out at 43 designated control points within the study area. The study area was classified into 25 categories in terms of vegetation and forest physiognomy based upon the interpretation of the aerial photographs and the results of the field survey, and eleven vegetation and forest physiognomy maps were completed indicating such classified categories. The ratios of area by major categories are; 10% for tropical evergreen forest, 23% for tropical deciduous dry forest, 59% for savanna, 7% for mountainous grassland and 1% for other categories. It is obvious that savanna is the most dominant vegetation in the study area. The forest and woody areas account for approximately 77% of the study area.

(3) Soil survey

The soil profile was investigated at 52 soil pits designated within the study area. The study area was classified into 7 categories in terms of soil based upon

the interpretation of the aerial photographs and the results of the field survey, and eleven soil maps were completed to show the distribution of each category of soil. The ratios of area by major soil categories are; 42% for Cambisols, 39% for Nitosols, 10% for Lithosols, 7% for Vertisols and 3% for other categories of soil. It is found that the study area abounds in soils suitable for afforestation (Cambisols and Nitosols) and soils inadequate for afforestation (Lithosols, Vertisols and others)are limited.

(4) Land use survey

The study area was classified into 12 categories in terms of land use based upon the interpretation of the aerial photographs and the results of the field survey, and eleven land use maps were completed to show the distribution of land uses. Forest reserves, game reserves and game controlled areas designated in the study area were also identified in the said land use maps, and the forest and woody areas were divided into 3 sub-groups depending on the magnitude of the grazing intensity, i.e. high, middle and low according to the grazing intensity. The ratios of area by major land use categories are; 77% for forest and woody areas (consisting of low grazing intensity area 23%, middle grazing intensity area 17% and high grazing intensity area 37%), 18% for dry crop fields, 2% for sisal plantation and 3% for grazing land or pasture.

(5) Survey of the socio-economic conditions

Aural surveys on socio-economic conditions were carried out in 20 villages and 1 town, out of the 50 villages and 1 town located within the study area. In addition, personal interviews were carried out at 22 locations within the study area through questionnaires.

The survey revealed that most of the inhabitants within the study area are engaged in both farming and livestock rearing. Maize and beans are the most important farm products followed by cassava, banana and sweet potato in the study area. In addition to the above main crops, sorghum, millet and cotton are grown in the lowland area, while coffee, wheat, vegetables and fruits are raised in the highlands. It is reported that the fertility of the cultivated land has deteriorated throughout the study area due to inadequate soil fertility maintenance and poor farm management techniques.

Livestock rearing is rather extensively implemented and the averaged number of livestock kept by a household amounts to 28 in the lowland areas where grazing is prevailant, and to 8 in the highland areas where rearing in pens is dominant.

Almost all of the household fuels are supplied by fuelwood and females and children are usually engaged in fuelwood collection in coppice forest within a 5 kilometer range of their settlement consuming approximately 5 hours everyday. Most of the inhabitants interviewed claimed a shortage of fuelwood. It is expected that the shortage of fuelwood supply will be further worsened.

Many of the inhabitants claimed that they had some experience in afforestation, and a community-wide afforestation program was established at 20 locations out of the designated 21 surveyed locations. But all of such programs were made assuming seedlings would be supplied from the Central Government and therefore, it is not correct to state that the inhabitants are fostering the social forestry by themselves.

1.4 Feasibility Study of Social Forestry

(1) Definition of social forestry and the procedures for land classification survey

Social forestry is understood in that tree planting is mainly dependent upon self-help efforts of the inhabitants. Planting of seedlings, afforestation or reforestation, improvement and maintenance of natural forests are carried out to secure fuelwood, building material,fruits,fodder and other forestry products, to conserve water resources, to maintain and conserve land productivity and to improve environmental conditions of settlements.

Land classification for the feasibility study of social forestry was carried through the following procedures:

- to classify the study area into 14 zones based upon topography, results of the basic survey and other data and information,
- to identify the characteristics of the zones,
- to designate menus most suitable for the identified characteristics of each zones.

Identification of the characteristics and suitability of menu for each zone were carried out for every unit mesh (the mesh is sized 500 meters by 500 meters with 25 hectares area and approximately 8,300 meshes were formed within the study area), utilizing computer capabilities. The measures taken for social forestry were discussed and decided for each zone based upon the said computer processed data and the results of the field survey. Technical manuals and a guideline of methods for promotion of social forestry were also studied.

(2) Zoning of the study area and the characteristics of the zones

Promotion measures adopted for the promotion of social forestry were carefully studied and decided depending upon the natural conditions including topographical features and climate, and upon socio-economic conditions including land use, and the inhabitants' intentions and ways of life. In this regard, the study area was divided into 14 zones. The criteria for such classification and the characteristics of each zone are shown in the following Table 1-1, Fig. 1-2.

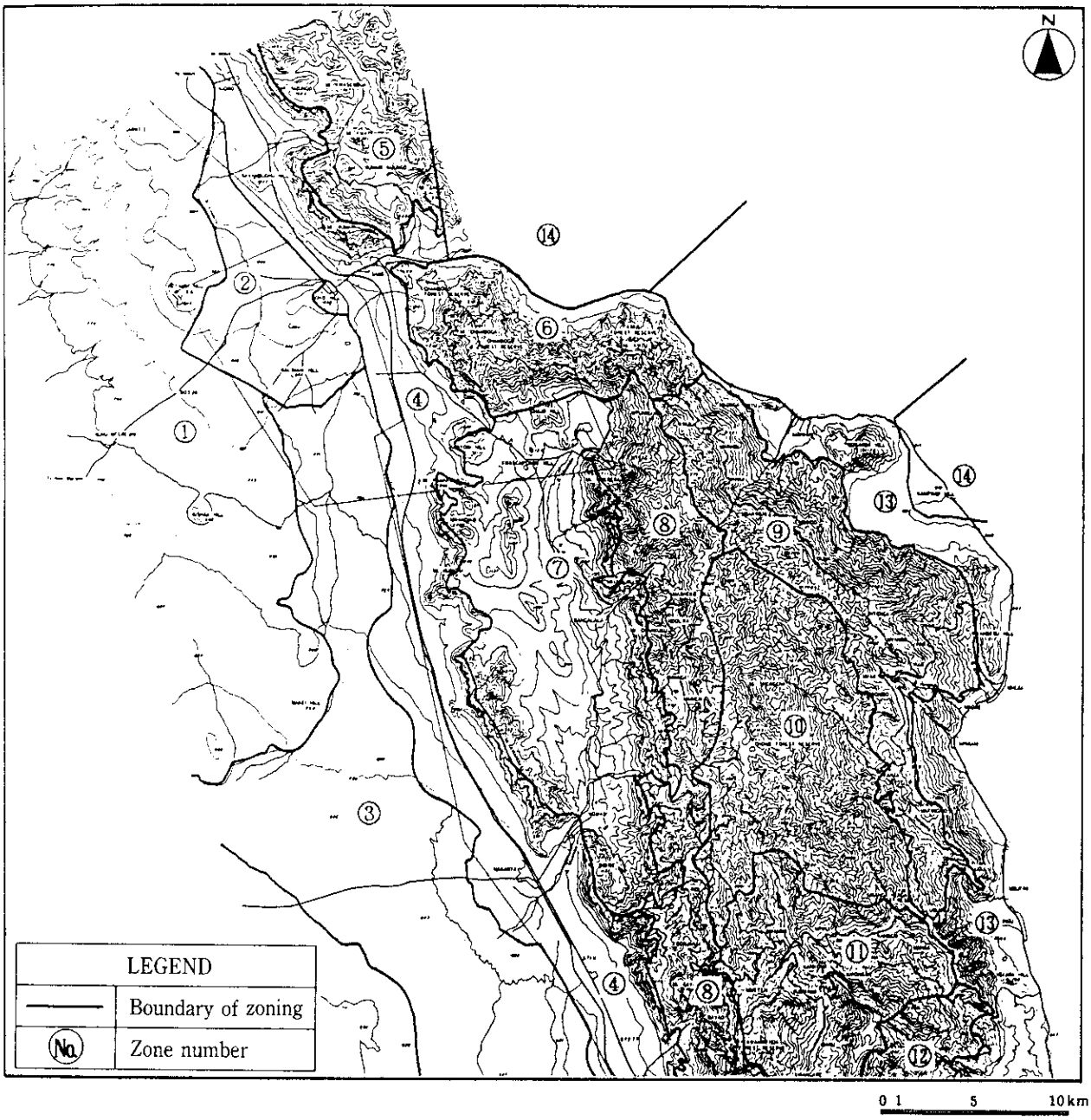


Fig. 1-2 Zoning Map

Table 1-1 Criteria for Classification and Characteristics of Zones

Zone	Criteria of classification	Characteristics of zone
1	Hilly area with small undulations (3° or more in inclination) Borders with zones 2 and 3: 3° in inclination	— Hills with elevations below 1,000 meters — Savanna — Overgrazing throughout the area by local inhabitants and Masai. Scarce houses and cultivated land — Affected by wind erosion. Establishment of windbreaks and the planting of shade trees are desired.
2	Located in the north of zone 3 where afforestation is in progress.	— Almost flat with elevations of more or less 800 meters — Savanna is dominant but cultivated land accounts for 10% of the entire area. Overgrazing — Houses found along roads — Affected by wind erosion — Afforestation of windbreaks and fuelwood forest and the planting of shade trees are strongly desired.
3	Flat land (inclination less than 3°) Borders with zones 1 and 4: 3° in inclination	— Flat with elevations of more or less 700 meters — Savanna — Few houses and cultivated land, overgrazing throughout the area — Most of the area is flooded in the rainy season — Black cotton soil amounts to one third of the entire area — Affected by wind erosion
4	Western piedmont of the Central Pare Mountain Range Borders with zones 5, 7 and 8: Top of the first west fault scarp	— Elevations range from 600 meters to 1,700 meters and area with elevations below 1,000 meters covers about 87% of the area — National highway and railway run in the central part of the area from south to north — Housing is scarce except in the populated areas of Same and Makanya — Land use: Savanna covering 70% of the entire area is dominant and mainly used for grazing — Dry crop field and sisal plantation occupy 15% and 8% of the area respectively — Milk cow rearing in pens and charcoal production — Erosion by rain and wind — Establishment of windbreaks, grazing forest, fuelwood forest and environmental conservation forest is strongly desired. Water-source conservation is also needed
5	Hilly area in the southern end of the Central Pare Mountain Range	— Elevations ranging from 900 meters to 1,700 meters. Area with elevations from 1,000 meters to 1,250 meters covers about 70% of the area. Considerably undulating throughout the area. — Higher precipitation is observed. — Houses are scattered. — Deciduous dry forests cover almost 80% of the area and are mainly utilized for grazing. Dry crop fields (10%) and pastures cover (10%) of the entire area respectively. — Soil erosion is observed at steep slopes due to tree overcutting and overgrazing. Establishment and improvement of soil conservation forests and the planting of fodder forests are desired.
6	Forest reserve	— Although elevations range from 800 meters to 1,900 meters, area with elevations from 1,000 meters to 1,250 meters covers about 90% of the entire area. — Very steep Major portion of the area is covered by deciduous dry forest. Cultivation and grazing by trespassers are observed.

Zone	Criteria of classification	Characteristics of zone
7	Hilly area on the western slope of the South Pare Mountain Range; Mwembe River basin Borders with zone 8: Top of the second west fault scarp	— Elevations range from 700 meters to 1,900 meters. Area with elevations from 750 meters to 1,000 meters covers major portion of the area. Hilly throughout the area. — Houses are scattered except populated area of Mwembe. — Land use: Dry crop fields 17%, sisal plantation 2% pastures 12%; remaining part of the area is covered by deciduous dry forests and savanna utilized for grazing. Beekeeping is popular in the south. — Western part and hillside of the south are being devastated by overgrazing. — Establishment of fuelwood forests and soil conservation forests and the planting of fodder trees and fruit trees are desired.
8	Strip of plateau on the western highland in the South Pare Mountain Range Borders with zone 9: Watershed Borders with zone 11: Top of the third west fault scarp	— Highland area with elevations from 800 meters to 2,000 meters. Rather steep throughout the area. — Densely populated. — Intensive agriculture is prevailing throughout the area. — Slightly higher precipitation with foggy weather. — Dry crop fields occupy about 55% of the entire area. Forest and woody area mainly consists of mountainous grasslands and deciduous dry forests. — Old forest plantations are dotted. Tannin is collected from the secondary stands of black wattle. — Shortage of fuelwood supply is not keenly perceived in the area. Afforestation in the mountainous grasslands and the planting of shade trees and fruit trees are desired.
9	Northwest slope of the South Pare Mountain Range Borders with zone 13: North: 5° in inclination South: Top of the east fault scarp	— Although elevations range from 600 meters to 2,000 meters, the area with elevation from 1,000 meters to 1,750 meters covers 92% of the entire area. Very steep throughout the area. — Densely populated. Intensive agriculture is prevailing throughout the area and dry crop fields occupy 73% of the entire area. — Although livestock rearing is not flourishing, rearing in pens is found — Higher precipitation. — Affected by soil erosion on the steep slopes. — Old forest plantations with good growth are scattered. The planting of shade trees and fruit trees and afforestation in mountainous grasslands and of soil conservation forests are desired.
10	Forest reserve	— Elevations range from 1,250 meters to 2,462 meters. The highest area within the study area and very steep throughout. — The area is mainly covered by tropical evergreen forest (86% of the area) and mountainous grasslands (13%). Trespassers' cultivated lands are found.
11	Central highland in the South Pare Mountain Range Borders with zone 13: Top of the east fault scarp Border with zone 12: Extending to populated area	— Highland with elevations from 1,000 meters to 2,000 meters. Very steep. Most densely populated area within the study area. Intensive agriculture is prevailing and dry crop fields amount to 79% of the area. — Higher precipitation. — Cattle rearing in pens is found. — Old forest plantations are found. Good growth of forests are observed. — Planting of shade trees, fruit trees and flower trees and afforestation in mountainous grasslands and of soil conservation forests are desired.

Zone	Criteria of classification	Characteristics of zone
12	Southern highland in the South Pare Mountain Range with sparse population	— Very steep area with elevations from 700 meters to 1,300 meters. — Lower precipitation — Sparsely populated with few cultivated lands. — Deciduous dry forests are seriously devastated by over-grazing.
13	Eastern piedmont of the South Pare Mountain Range	— Elevations range from 500 meters to 1,500 meters and an area with elevations below 700 meters covers almost 70% of the entire area. — Relatively higher precipitaion — Abundant water volume at rivers — There are some populated areas along the old national highway, inhabited by Masai. — Dry crop fields and sisal plantations amount to 26% and 6% of the entire area respectively and water paddy fields and palm plantations are also found. — Major parts of the area are covered by deciduous dry forests. — Establishment of fuelwood forests, soil conservation forests and environmental conservation forests is strongly desired. Planting of fruit trees is also desired.
14	Game reserve	— Elevations range from 600 meters to 1,300 meters. Two-thirds of the area are gentle slopes. — Trespassers' cultivating and grazing lands are found.

(3) Menus for social forestry

In due consideration of the natural and socio-economic conditions of the designated 14 zones and of the comments and opinions of the administrative officers and staff in charge of forestry at the Central Government of Tanzania and regional/district authorities, the following menus were selected for the promotion of social forestry in the study area covering 200,000 hectares:

① Establishment and conservation of fuelwood forests to keep the supply and demand balance of fuelwood; one of the most urgent issues within the study area.

② Agro-forestry in the lowlands which aims to enhance fodder production, to prevent wind damage of farm products and wind erosion of soil in parallel with increased production of fuelwood and farm products.

③ Agro-forestry in the highlands, in order to prevention of soil erosion by rain, and the planting of shade trees for farm products, and fruit production are also among the aims in addition to such targets as defined in agro-forestry in lowlands.

④ Restriction of grazing and implementation of silvo-pastoral systems, which minimize damage of forests due to the overgrazing widely carried out in lowland areas, to revive the productivity of the forests.

⑤ Establishment of fodder tree forests, specifically aimed at the promotion of livestock rearing in pens.

⑥ Improvement of land conservation forests, which aims to prevent devastation of the slopes and soil erosion of riverside areas.

⑦ Improvement of water catchment forests, to secure a satisfactory water supply—shortage of water supply is also one of the urgent issues to be solved in the study area.

⑧ Establishment of urban environment conservation forests, to revegetate the populated areas in cities and along the trunk road and railway.

⑨ Conservation of forest reserve, where forest and vegetation shall be improved to satisfy the aims of both forest reserve and game reserve.

The objectives and methods of, and expected bodies to implement such menus are as follows:

A. Establishment and conservation of fuelwood forests:

Subject: — Areas in highly productive forest land where a shortage of fuelwood supply is emerging

Objectives: — Growing of multi-purpose trees (for fuelwood, fodder, timber, poles, beekeeping, fruit, medicine and other products) mainly for production of fuelwood

Methods: — Establishment of forests of fuelwood trees
— Restricting felling and improving scattered forests by extending the planting area and other possible measures
— Improving and spreading both charcoal production techniques and cookstoves

Implemented by: — Individual inhabitants, the community, schools, churches and the government

B. Agro-forestry in lowlands

Subject: — Relatively large-scaled farming areas in the lowlands where mechanization is in progress

Objectives: — Maintaining and increasing the productivity of farmlands by shading, fertilization, soil conservation and other measures; preventing wind damage of farm products
— Protecting crops from animals
— Growing multi-purpose tree species

Methods: — Developing windbreaks for the protection of farmlands
— Developing densely grown hedges
— Practicing row planting at interval in fields
— Planting soil improving trees capable of improving the carring capacity in fallow fields

Implemented by: — Individual inhabitants, the community and the government

C. Agro-forestry in highlands

Subject: — Highland areas where intensive agriculture is prevailing

Objectives: — Growing multi-purpose trees with the main purpose of fuelwood production in parallel with agricultural production
— Maintaining and increasing the productivity of the land

Methods: — Practicing the mixed planting of shade trees, soil improving trees and fruit trees in the fields

— Practicing row planting in the fields, contour planting, terracing on the hillsides and the sowing of forage crops
— Planting trees along boundaries and roads

Implemented by: — Individual inhabitants and the community

D. Restriction of grazing and the silvo-pastoral system

Subject: — Mainly lowland areas affected by overgrazing

Objectives: — Conserving land and increasing the productivity of forests and pastures
— Growing multi-purpose trees for the production of fuelwood and other products

Methods: — Promoting natural regeneration and the recovery of productivity of forests and grasslands by introducing a rotational grazing system
— Planting fodder trees
— Establishing grasslands

Implemented by: — Individual inhabitants and the community

E. Establishment of fodder tree forests

Subject: — Agricultural areas mixed with pastures and/or scattered forests

Objectives: — Promoting livestock rearing in pens
— Growing multi-purpose trees for the production of fuelwood and other products

Methods: — Developing fodder tree forests in the vicinity of livestock pens
— Establishing grasslands

Implemented by: — Individual inhabitants and the community

F. Improvement of land conservation forests

Subject: — Areas threatened with erosion by rain, wind or running water

Objectives: — Protecting land by preventing erosion

Methods: — Restricting grazing and farming on the steep slopes
— Practicing forest conservation measures and afforestation including the installation of structural works such as network shelves and the improvement of the forest by the planting of trees
— Conserving and developing riverine forests

Implemented by: — Community and the government

G. Improvement of water catchment forests

Subject: — Water source for settlements and farmland

Objectives: — Developing the functions of water catchment forests

Methods: — Restricting grazing and/or felling of trees
— Improving scattered forests by enrichment planting and other appropriate measures

Implemented by: — Community and the government

H. Establishment of urban environment conservation forests

Subject: — Populated areas of cities/towns and vicinities of trunk traffic lines

Objectives: — Improving the living environment
— Growing multi-purpose trees for the production of fuel-wood and other products

Methods: — Building parks
— Planting trees for revegetation in the built-up areas
— Planting roadside trees

Implemented by: — Individual inhabitants, community, schools, churches and the government

I. Conservation of forest reserve

Subject: — Forest reserves and game reserve

Objectives: — Developing intended functions of forest reserves and game reserve

Methods: — Eliminating trespassers
— Improving scattered forests by planting and other appropriate measures

Implemented by: — Government

(4) Selection standard of suitable sites for the social forestry's menus

① Selection standard

The selection standard of suitable sites for the social forestry's menus was studied and decided as hereunder:

② Selection of site by mesh and mapping of suitable sites classification

Suitable sites for each menu were selected by computer processing using the above mentioned selection standard and eleven maps of suitable sites classification were made to a scale of 1:20,000. The designated 14 zones have following areas suitable for each menu of social forestry:

Table 1-2 Selection Standard of Suitable Sites for the Social Forestry's Menus

Menus	Selection standard (for extracting of mesh data)
A. Establishment and Conservation of fuel-wood forests	– Forest lands and grazing lands – Inclination: less than 20° for lowland, less than 30° for highland – Rocky land Lithosols are excluded. – Distance from settlements: * The distance may be disregarded for all forest lands scarcely affected by grazing. * The distance shall be more or less 2 km in lowland and more than 2.1 km in highland for forestlands seriously affected by grazing. (Grazing lands or pastures and forests seriously affected by grazing are classified as A'. In the area classified as A conservation of natural forests will be necessary, while afforestation and planting shall be extensivelly carried out in the area classified as A' since scattered forests are prevailing in such area.)
B. Agro-forestry in Lowlands	– Lowland (Zones 1, 2, 3, 4, 5, 7 and 13) – Fields (Areas with an inclination of over 21° are classified as B'. Particular attention shall be paid to soil conservation in B' area.)
C. Agro-forestry in Highlands	– Highland (Zone 8, 9, 11 and 12) – Fields (Areas with an inclination of over 21° are classified as C'. Particular attention shall be paid to soil conservation.)
D'. Restriction of grazing and the silvo-pastoral system	– Lowlands – Grazing lands and forest lands seriously affected by grazing – Inclination below 20° – Nitosols, Vertisols and Fluvisols – Distance from settlements: more than 2.1 km (Since all of the area is forestland seriously affected by grazing, the subject area is classified as D' and D area is not recognized.)
E'. Establishment of fodder tree forests	– Highlands – Grazing lands and forest lands seriously affected by grazing – Inclination below 30° – Cambisols and Rendzinas – Distance from villages: within 2 km (Since all of the area is forestland seriously affected by grazing, the area is classified as E' and E area is not recognized.)
F. Improvement of land conservation forests	– Forestland and grazing lands or pastures. – Inclination: more than 21° for lowland, more than 31° for highland – Distance from villages: within 2 km – Rocky land and Lithosols througout the area (Grazing lands and forestlands seriously affected by grazing are classified as F'. An extensive planting shall be carried out to improve scattered forests.)
G. Improvement of water catchment forests	– Forestlands, grazing lands and reservoirs – Inclination: more than 21° for lowlands more than 31° for highlands. – Rocky land Lithosols are excluded. – Distance from villages: more than 2.1 km (Grazing lands and forestlands seriously affected by grazing are classified as G'. An extensive planting shall be carried out to improve scattered forests.)
H. Establishment of urban environment conservation forest	– More than 51 households
I. Conservation of forest reserves	– Forest reserves and game reserve.

Table 1-3 Area of Suitable Site for Social Forestry by Each Zone

Unit: ha
( ) Percentage

Menu \ Zone		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Establishment and Conservation of Fuelwood Forests	A	1,000 (2.5)	25 (0.4)	1,000 (3.6)	6,275 (23.7)	275 (3.7)	0 (0.0)	2,375 (11.6)	500 (3.9)	500 (3.5)	0 (0.0)	175 (1.8)	400 (16.0)	2,375 (16.6)	0 (0.0)	14,900 (7.2)
	A′	75 (0.2)	600 (8.5)	25 (0.1)	1,250 (4.7)	25 (0.3)	0 (0.0)	1,600 (7.8)	1,400 (10.8)	300 (2.1)	0 (0.0)	75 (0.8)	100 (4.0)	525 (3.7)	0 (0.0)	5,975 (2.9)
	Sub-total	1,075 (2.7)	625 (8.9)	1,025 (3.7)	7,525 (28.4)	300 (4.0)	0 (0.0)	3,975 (19.4)	1,900 (14.7)	800 (5.6)	0 (0.0)	250 (2.6)	500 (20.0)	2,900 (20.3)	0 (0.0)	20,875 (10.1)
Agro-forestry in Lowlands	B	0 (0.0)	650 (9.3)	75 (0.3)	5,725 (21.6)	750 (10.0)	0 (0.0)	3,175 (15.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2,400 (16.8)	0 (0.0)	12,775 (6.1)
	B′	0 (0.0)	0 (0.0)	0 (0.0)	50 (0.2)	125 (1.7)	0 (0.0)	625 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1,950 (13.6)	0 (0.0)	2,750 (1.3)
	Sub-total	0 (0.0)	650 (9.3)	75 (0.3)	5,775 (21.8)	875 (11.7)	0 (0.0)	3,800 (18.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4,350 (30.4)	0 (0.0)	15,525 (7.4)
Agro-foresty in Highlands	C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	575 (4.4)	300 (2.1)	0 (0.0)	250 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	1,125 (0.5)
	C′	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6,600 (50.9)	10,075 (70.3)	0 (0.0)	7,525 (76.2)	250 (10.0)	0 (0.0)	0 (0.0)	24,450 (11.7)
	Sub-total	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7,175 (55.3)	10,375 (72.4)	0 (0.0)	7,775 (78.7)	250 (10.0)	0 (0.0)	0 (0.0)	25,575 (11.7)
Grazing Control and Silvo-pastoral system	D′	35,725 (89.0)	5,725 (81.4)	26,550 (96.0)	7,200 (27.2)	3,050 (40.8)	0 (0.0)	6,200 (30.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1,750 (12.2)	0 (0.0)	86,200 (41.5)
Establishment of Fodder Tree Forests	E′	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	425 (3.3)	1,000 (7.0)	0 (0.0)	325 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	1,750 (0.8)
Improvement of Land Conservation Forests	F	250 (0.6)	0 (0.0)	0 (0.0)	1,800 (6.8)	75 (1.0)	0 (0.0)	2,950 (14.4)	925 (7.1)	375 (2.6)	0 (0.0)	225 (2.3)	275 (11.0)	2,950 (20.5)	0 (0.0)	9,825 (4.7)
	F′	3,100 (7.7)	0 (0.0)	0 (0.0)	2,025 (7.6)	450 (6.0)	0 (0.0)	1,825 (8.9)	950 (7.3)	1,125 (7.9)	0 (0.0)	350 (3.5)	0 (0.0)	675 (4.7)	0 (0.0)	10,500 (5.0)
	Sub-total	3,350 (8.3)	0 (0.0)	0 (0.0)	3,825 (14.4)	525 (7.0)	0 (0.0)	4,775 (23.3)	1,875 (14.4)	1,500 (10.5)	0 (0.0)	575 (5.8)	275 (11.0)	3,625 (25.2)	0 (0.0)	20,325 (9.7)
Improvement of Water Catchment Forests	G	0 (0.0)	0 (0.0)	0 (0.0)	425 (1.6)	400 (5.4)	0 (0.0)	600 (2.9)	925 (7.1)	100 (0.7)	0 (0.0)	225 (2.3)	1,400 (56.0)	825 (5.8)	0 (0.0)	4,900 (2.4)
	G′	0 (0.0)	0 (0.0)	0 (0.0)	375 (1.4)	1,550 (20.7)	0 (0.0)	900 (4.4)	425 (3.3)	475 (3.3)	0 (0.0)	150 (1.5)	75 (3.0)	350 (2.4)	0 (0.0)	4,300 (2.1)
	Sub-total	0 (0.0)	0 (0.0)	0 (0.0)	800 (3.0)	1,950 (26.1)	0 (0.0)	1,500 (7.3)	1,350 (10.4)	575 (4.0)	0 (0.0)	375 (3.8)	1,475 (59.0)	1,175 (8.2)	0 (0.0)	9,200 (4.5)
Establishment of Urban Environment Conservation Forests	H	0 (0.0)	25 (0.4)	0 (0.0)	350 (1.3)	0 (0.0)	0 (0.0)	175 (0.9)	75 (0.6)	75 (0.5)	0 (0.0)	50 (0.5)	0 (0.0)	425 (3.0)	0 (0.0)	1,175 (0.6)
Conservation of Forest Reserve	I	0 (0.0)	0 (0.0)	0 (0.0)	1,025 (3.9)	775 (10.4)	8,875 (100.0)	0 (0.0)	175 (1.3)	0 (0.0)	14,525 (100.0)	525 (5.3)	0 (0.0)	100 (0.7)	1,525 (100.0)	27,525 (13.2)
Total		40,150 (100.0)	7,050 (100.0)	27,650 (100.0)	26,500 (100.0)	7,475 (100.0)	8,875 (100.0)	20,425 (100.0)	12,975 (100.0)	14,325 (100.0)	14,525 (100.0)	9,875 (100.0)	2,500 (100.0)	14,325 (100.0)	1,525 (100.0)	208,150 (100.0)

* Area is calculated by multiplying the size of one mesh by the number of meshes.

(5) Menus of social forestry by zone

In the consideration of selection of the sites for each menu of social forestry using computer and information obtained through the field survey, menus for the promotion of social forestry to be implemented at the designated 14 zones and the priorities among the menus are carefully examined and decided as shown in the following table:

Table 1-4 Priority of Suitability of Social Forestry in Each Zone

	Zone / Menu	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	Establishment and conservation of fuelwood forests	○	◎	○	◎	○		◎	○	○		○	◎	◎	
B	Agro-forestry in lowlands	○	◎	○	◎	○		◎						◎	
C	Agro-forestry in highlands								◎	◎		◎			
D	Restriction of grazing and silvo-pastoral system	◎	○	◎	○	◎		◎					○	○	
E	Establishment of fodder tree forests					○		○	○	○		○			
F	Improvement of land conservation forests	○		○	○	◎		○	○	○		○	○	◎	
G	Improvement of water catchment forests				◎	○		○	○	○		○	○	○	
H	Establishment of urban enrivonment conservation forests		○		◎			○	○	○		○		○	
I	Conservation of forest reserve				○	○	◎				◎				◎

◎ : The menu of higher priority in each zone
○ : The menu of priority in each zone

Basic understandings in selecting the higher priority menus for each zones are as follows:

Since in Zones 1 and 3, the limitation of overgrazing and the restoration of forest productivity are the most urgent issues to be solved, the restriction of grazing and the implementation of the silvo-pastoral system was adopted as a high priority of the menu.

In Zone 2, agro-forestry in the lowlands aiming mainly at the establishment of windbreaks, and the establishment and conservation of fuelwood forests to provide a stable fuelwood supply for the inhabitants of Same were selected as a high priority of the menu to further enhance agricultural development currently in progress throughout these zones.

In Zone 4, agro-forestry in the lowlands and the restriction of grazing and the implementation of the silvo-pastoral systems were selected for the same reasons as those in Zone 2. In addition, the improvement of water catchment forests and the establishment of urban environment conservation forests were recommended to secure a sufficient water supply and to revegetate the populated areas at Same and Makanya and on the trunk road and railway.

Restriction of grazing and the implementation of the silvo-pastoral system, and the improvement of land conservation forests were taken as a high priority of the menu in Zone 5 to recover and improve the deciduous dry forests seriously affected by overgrazing.

Since Zones 6 and 10 are designated as forest reserve and Zone 14 is disignated as game reserve, conservation of the forest reserves was given higher priority.

In Zone 7, farming and livestock rearing have been traditionally developed and exploited, and therefore, agro-forestry in the lowlands and the restriction of grazing and implementation of the silvo-pastoral system were given a higher priority as well as the establishment and conservation of fuelwood forests.

Agro-forestry in the highlands was selected as a higher priority of the menu in Zones 8, 9 and 11, since these zones are intensive agricultural areas in highlands with a higher density of population.

In Zone 13 which is an agricultural area in the lowlands with some populated areas therein, the establishment and conservation of fuelwood forests, agro-forestry in the lowlands and the improvement of land conservation forests were given a higher priority.

(6) Technical manual on social forestry

The technical manual for small-scale afforestation centered on agro-forestry is described below since the large-scale afforestation preliminarily aiming at fuelwood production out of the technical manual for social forestry in the study area will be described in the Semi-arid Forest Management Plan as will be mentioned later.

① Technical manual common to each menu of social forestry

a. Nursery

o Location of nursery

In selecting the nursery, pay attention to the securing of water sources and the convenience of management transportation and the installation of as many nurseries as possible with as small capacities as possible.

o Nursery practice

Since the planting tree species for social forestry are diversified, the nursery practices and techniques suitable for the respective tree species is required.

b. Planting

The most important point for planting is securing the water for the planting of the trees. The trees should be planted deep and low. A catchment method such as trench is used and watering is practised according to the situation.

c. Tree species

In selecting the tree species, the intention of inhabitants, weather conditions, characteristics of tree species, applications and the like should be taken into consideration. Especially the table showing the following tree species is given: tree species for which planting is desired by the inhabitants, as obtained from the inhabitants' intention investigation, and the tree species which are generally used for social forestry in Tanzania.

d. Harvest and regeneration

Since it is desirable to utilize the coppicing force as much as possible, various regeneration by coppice methods are given.

e. Protection of trees

In order to prevent various damage such as forest fires, and by livestock and wild animals, it is necessary to obtain the inhabitants' understanding and cooperation. Fences and hedges etc. should be provided where necessary.

② Technical point for each menu

The major technical points for each menu of social forestry are described as follows.

a. Establishment and conservation of fuelwood production forests

The technical points for the establishment and conservation of fuelwood forests are described in the Semi-arid Forest Management Plan.

b. Agro-forestry in the lowlands

As agro-forestry in the lowlands of this area, the following planting techniques will be introduced.

o Line planting

o Hedges

o Establishment of windbreaks

o Introduction of Taungya

c. Agro-forestry in the highlands

As the object of agro-forestry in the highlands, the following planting techniques will be introduced.

- Dispersed trees planting
- Row planting
- Boundary tree planting

d. Restrictions of grazing and the silvo-pastoral system

The rotational grazing system and the introduction of pasture grass will be implemented.

e. Establishment of a fodder tree species

The establishment of a fodder tree species within a small area will be implemented around the vicinity of the houses. Mixed planting with pasture grass will also be implemented.

f. Improvement of land conservation forests

As the maintenance of land conservation forests, the following planting technique and facilities will be introduced.

- Contour strips
- Trees along contour ridges
- Gully reclamation

g. Improvement of water catchment forests

The technique for the establishment and conservation of fuelwood forests and the improvement of land conservation forests will be applied.

h. Urban environment conservation forests

The planting of trees in towns and along roads and at the vicinities of buildings and parks will be implemented.

i. Conservation of forest reserve

The technique for the establishment and conservation of fuelwood forests and the establishment of land conservation forests will be applied.

(7) Guidelines for the extension of social forestry

① Obstacles to the extension of social forestry

Possible obstacles deemed to hinder the prospective extension of social forestry may be found in the following points, although the country has twenty years experience in social forestry:

a. On the side of the inhabitants:

- Generally, they do not keenly perceive the shortage of fuelwood supply.
- They do not fully understand the basic role and importance of trees and forests.
- The allotment of lands for afforestation and tree planting is not enough.
- Proprietorship of planted trees and distribution of products and/or income are not specifically stipulated.
- A fairly long period of time is usually needed before the planted trees become productive.
- The periods suitable for afforestation and tree planting work usually fall in the

same periods as the farming work during the year.

- ○ Afforestation does not bring a large amount of cash earnings to the inhabitants.
- ○ They do not have funds enough to procure their seedlings by themselves.

b. On the side of the administrative authorities:

- ○ The basic roles and importance of social forestry are not always understood among the many administrative issues of the country.
- ○ Necessary instruction for social forestry is not sufficiently provided in school education.
- ○ Extension workers are not sufficiently deployed throughout the country.
- ○ Necessary funds and equipments are not supplied for the extension of social forestry.
- ○ Budget is not sufficiently allotted to the production and distribution of seedlings to the inhabitants.
- ○ Cooperative actions for social forestry with non-governmental organizations including churches are not sufficiently carried out.

② Recommendable measures for the extension of social forestry

Following measures should be taken to overcome the obstacles in extending social forestry:

a. On the side of inhabitants:

- ○ Necessary instruction on social forestry shall be given to increase their understanding.
- ○ Actual activities of afforestation for social forestry shall be demonstrated to them.
- ○ The fundamental nature of social forestry— a long term program for all the inhabitants—shall be clearly understood among inhabitants.

b. On the side of administrative authorities:

- ○ Extension workers in forestry shall be increased and effectively deployed throughout the country, and they shall cooperate with agricultural extension workers for the promotion of social forestry.
- ○ Enhanced instruction and training programs shall be implemented for the extension workers.
- ○ Information and instruction on social forestry shall be given to general staffs and officers of administrative organizations throughout the country.
- ○ Information and instruction of social forestry shall be given to school teachers.
- ○ Information and instruction on social forestry shall be given to non-governmental organizations such as churches and ladies' societies.
- ○ Information and instruction on social forestry shall be made available to leaders of local communities.
- ○ Activities for the promotion of social forestry shall be made in vairous ways and manners to attract the people and encourage their involvement.
- ○ Any incentives may be given to inhabitants to enhance their participation in

social forestry activities.

③ Key points for the promotion of social forestry menus

The key points of motivation and forestry technology are listed in this text 5-3 for each of the nine menus of social forestry. For example, the key points for the establishment and conservation of fuelwood forests are as follows:

a. Key points for motivation

- o Current situation of decreasing forest resources and future outlook
- o Current situation and future outlook of fuelwood demand
- o Current level of worktime consumed for fuelwood collection and obtainable advantages if such worktime were utilized for other production activities including farming
- o Any difficulties in case of no fuelwood supply:
  monetary burden for petroleum fuel and other energy sources, possible deterioration of land fertility when hulls and stalks of crops and/or livestocks' dungs are utilized for fuel instead of fertilizers
- o Cash earnings from charcoal production
- o Products to be obtainable in several years

b. Key points for forestry technology:

- o Selection of tree species to meet the dominant natural conditions
- o Period and time interval for planting
- o Thinning schedule
- o Extension of the cutting period: increment of annual increment per hectare and timber production
- o Points to be considered for planting in semi-arid area
- o Preventive measures against insects/diseases and fire
- o Method of regeneration by coppicing

(8) Education and training of the extension staff

① Education and training programs.

One of the most important measures in extending social forestry is to secure the necessary number of staff to be engaged in the spreading of social forestry among the people.

The following four categories of administrative staff shall be educated and trained sufficiently:

a. Forestry extension staff to be newly appointed.
b. Forestry administrative staff including foresters.
c. Agricultural extension staff.
d. Other administrative staff.

The program should mainly consist of field practice and also be elaborately instructed to the trainees in addition to the forestry technology and engineering.

② Education and training facilities.

Headquarters education and training facilities shall be set up at Moshi and field training facilities shall be installed at Same.

Proposed equipment and facilities are a training building, a lodging house, equiped with audio visual aids, and vehicles etc.

1.5 Semi-arid Forest Management Plan

(1) Policies for the formulation of the plan

Approximately 20,000 hectares of land including Same was selected as a model study area. This semi-arid area, in the Kilimanjaro Region Study Area of 200,000 ha, was selected primarily due to the extent of its problems.

The objective of the formulation of the plan is to establish the necessary social forestry technique in Tanzania and contribute to the promotion of the local community by formulating and implementing the plan for the afforestation and management of useful forests in the model study area.

The plan is formulated under the following policies:

- Forests will be developed as promotion of social forestry.
- Main emphasis will be placed on the production of fuelwood.
- Efforts will be made for the maintenance of water catchment forests, soils and environment.
- The plan period will be set at 10 years which will be divided into two phases: Phase I of 5 years and Phase II of 5 years.
- During the 5 years of Phase I, trial forest will be established and efforts will be made to establish afforestation and management techniques for the semi-arid area.

(2) Classification by management unit

In order to formulate the forest management plan in accordance with the site conditions, approximately 20,000 ha of the model study area was divided into the following six units:

Unit ①: Includes Zone 2 and part of Zone 1 in the classification of suitability. Though agricultural development has been in progress in recent years, there are a lot of overgrazed savanna.

Unit ②: Northern part of Zone 4 in the classification of suitability, centering on Same town.

Unit ③: Northern part of Zone 3 in the classification of suitability. Water remains in a lot of places during the rainy seasons and there are few farm lands.

Unit ④: Part of Zone 4 in classification of suitability. This unit has high soil productive capability though mainly savanna, and is expected to become a future forestry zone.

Unit ⑤: Northern part of Zone 7 in the classification of suitability including part of Zone 8. Agricultural zone centering on Mwembe.

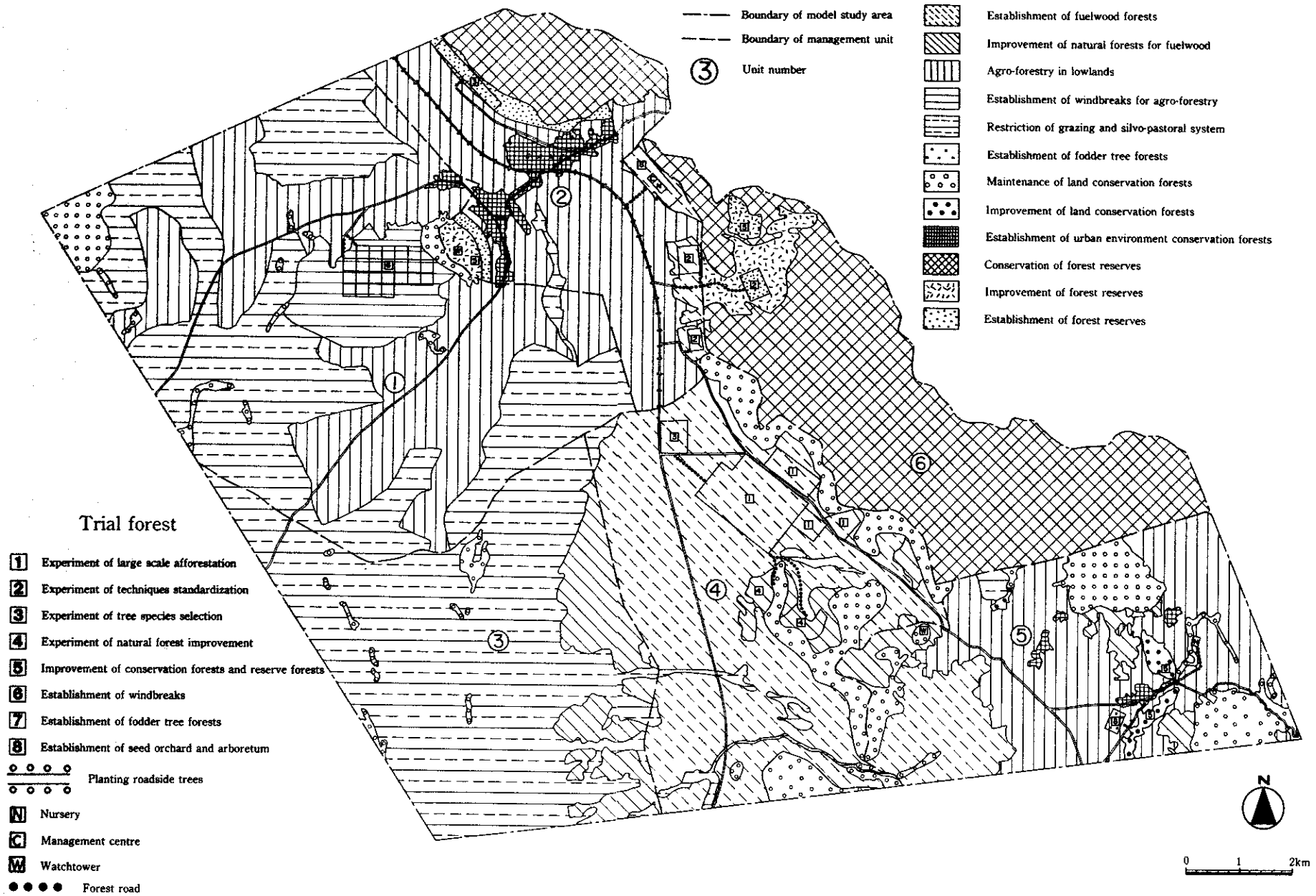


Fig. 1-3 Semi-arid Forest Management Plan

Unit ⑥: Zone 6 in the classification of suitability. Chambogo Forest Reserve

(3) Major points in the forest management plan for each managing unit

a. Classification of suitability for social forestry for each managing unit

Suitability of social forestry was classified taking into consideration the natural conditions and socio-economic conditions at the site on the basis of the classification of suitability for social forestry based on mesh data. The area of each managing unit is as shown Fig 1-3.

Table 1-5 The Area of Suitable Site for Social Forestry by Each Management Unit

(ha)

	Management Unit / Menus	①	②	③	④	⑤	⑥	Total
A	Establishment and conservation of fuelwood forests	—	175	534	2,718	616	—	4,043
B	Agro-forestry in lowlands	2,329	1,458	—	—	1,525	—	5,312
D	Restriction of grazing and Silvo-pastoral System	2,996	—	2,794	148	—	—	5,938
E	Establishment of fodder tree forests	—	—	—	—	30	—	30
F	Improvement of land conservation forests					**		
G	Improvement of water catchment forests	222	—	61	575	580	—	1,438
H	Improvement of urban environment conservation forests*	16	189	—	—	46	—	251
I	Conservation of forest reserves	—	702	—	—	—	2,823	3,525
	Total**	5,563	2,524	3,389	3,441	2,797	2,823	20,537

* Area of towns.
** Includes mining area of 26 ha.

b. Major points of the forest management plan for each management unit

Unit ①:

To conserve the farm land and produce fuelwood by establishing large-scale windbreaks each about 40 m in width. The agro-forestry in the lowlands is a high priority of the menu. In order to systematically utilize savanna forests for grazing, the next major point is the restriction of grazing and the silvo-pastoral system such as the practice of rotational grazing.

Unit ②:

To afforest the urban environment conservation forests: greening in Same town and the planting of road-side trees along national roads and railway, is a characteristic menu. Since this unit is also a strategic traffic point and will serve effectively as a showcase for the establishment of demonstration forests and social forestry. Establishment new nurseries, construct the management and training facilities and provide the base for forest management for the model study area.

Unit ③:

Since water remains in a lot of places during rainy seasons, only grazing is feasible in addition to the utilization as farm land for the time being. Accordingly, this unit is primarily for restraints on grazing and the silvo-pastoral system.

Unit ④:

Since the agricultural land has not been developed, but the soil condition is suitable for the growth of trees, this unit is most suitable for establishment of large-scale fuelwood production forests. There are also a lot of forests in which natural forest working is possible.

Unit ⑤:

Since soil erosion occurs because of cultivation and grazing over many years, the most important problem is agro-forestry in the lowlands with the main emphasis on land conservation. The maintenance of the land conservation forests and environment conservation forests in Mwembe settlement, and the afforestation of firewood production and fodder tree forests are also required. Moreover expansion of the Mwembe nurseries and the maintainance of the facilities.

Unit ⑥:

In order to accomplish the designated objective of Chambogo forest reserve, enrichment planting and other silvicultural practices should be implemented for the forest lands and areas with inferior forest type which are misused for cultivation and grazing.

(4) Forest management plan

a. Management plan for fuelwood production forests

Approximately 4,000 hectares of fuelwood production forests were planned out of about 20,000 hectares of the model study area, and a detailed soil survey was implemented for the proposed sites. As a result, the afforestation possibilities of these sites were classified into class I sites, about 700 ha, class II sites about 1,300 ha and class III sites about 2,000 ha in view of soil structure and consistency. In this way the soil is comparatively good and the immediate establishment of large-scale fuelwood forests is urgently needed. However, they have not yet had any experience of large-scale afforestation, nor has the necessary technique been established in this area.

The plan period of 10 years was divided into two phases and a plan to attempt the development of the technique and systematization was adopted by carrying forward the afforestation on a trial forest scale which is feasible during the 5 years of Phase I.

Table 1-6 Afforestation Plan of Fuelwood Production Forests
(Trends of Area by Man-made and Natural Forests)

(ha)

Forest type	Phase I	Phase II	Objective
Man-made forest	440	1,740	2,000
Natural forest	3,600	2,300	2,040
Total	4,040	4,040	4,040

For the man-made forests, these are planned with a felling period of 10 years on the basis of 1,600 seedlings per ha and the land preparation will be implemented both manually and mechanically and potted seedlings planted. Watering afforestation tests are also performed.

On the other hand, working for natural forests has a great significance. For the dry deciduous forests with a high productivity and good forest type out of natural forests, saw timber and fuelwood will be produced by felling and the increment will be maintained by the restriction of grazing after felling in order to promote natural regeneration. For the natural forests currently requiring improvement of forest type, planting will be implemented for 50 ha in Phase I and 100 ha in Phase II. For thornbush savanna, only the collection of fuelwood and restriction of grazing will be implemented for the time being since the soil condition is inferior.

b. Agro-forestry in the lowlands

This work centers on the establishment of windbreaks which will be implemented in Unit ①. The windbreaks 40 m in width will be built at intervals of 200 m in a lattice pattern north to south, and west to east for 12.5 km (50 ha) in Phase I and 12.5 km (50 ha) in Phase II. It is desirable to establish windbreaks with a smaller width on farm land enclosed by these windbreaks.

c. Management plan in the silvo-pastoral system

The carrying capacity of the forests and savannas will be studied in order to adjust the number of grazing livestock in the area and introduce the rotational grazing system. Fodder trees and seed pasture grass will be planted as required.

d. Management plan for fodder tree forests

Demonstrative afforestation of fodder tree forests will be implemented in the vicinity of Mwembe village in Unit ⑤ for 10 ha in Phase I and 20 ha in Phase II.

e. Improvement of land conservation forests

The improvement of land conservation forests will be implemented on steep-sloped areas where serious erosion of soil occures because of overgrazing and in riverine forests where erosion occurs. Each 20 ha was planned both for Phase I and Phase II. On the other hand, the greening of Same, Mwembe and other villages respectively and the afforestation of roadside trees along

trunk roads, railway and electric wire line will be implemented for 20 ha in Phase I and 20 ha in Phase II.

f. Conservation of forest reserves

Man-made afforestation and planting will be implemented for the area where the forest type is getting worse because of cultivation and grazing, etc. out of the forest reserve, planning 30 ha in Phase I and 120 ha in Phase II.

Also to establish tree species test planting forests and planting method test forests will be implemented in the Vumari and Chambogo forest reserves near the urban area in anticipation of the demonstrative effect, planning 50 ha in Phase I.

g. Nursery management plan

The seedling production plan is as shown on the following.

Table 1-7 Seedling Production Program*

Item	Phase I	Phase II	Remarks
Fuelwood Forests***	×1000	×1000	****
(Man-made forests)	749	2,500	1,600 seedlings/ha
(Improvement of natural forests)	48	100	800 seedlings/ha
Agro-forestry			
(Establishment of windbreaks)	97	100	1,600 seedlings/ha
Establishment of fodder tree forests	18	40	1,600 seedlings/ha
Conservation forests, Forest reserves	84	190	1,000 seedlings/ha
Experiment in Nursery, Establishment of seed orchards and arboretum	84	90	
Distribution to inhabitants**	773	1,100	10 seedling/person
Total	1,853	4,120	

* For the number of production trees, it is increased by 20% over the number of trees necessary for outplanting.
** The number of seedlings are calculated by 10 seedlings per inhabitant throughout all plans assuming the annual population growth as 3%.
*** This figure includes the amount of seedlings for the test planting forests of forest reserves.
**** The figures of the seedlings are based on these planting densities.

Nursery establishment

Establishment of new Same Nursery	Annual production is 600,000 seedlings in 3 ha. As water source, new deep wells will be dug.
Expansion of Mwembe Nursery	Annual production is 200,000 seedlings in 1.5 ha. Drawing water from spring water as water source, Current nursery 0.6 ha will continue to produce seedlings for highland social forestry.

h. Forest protection plan

Measures against grazing in the forests:

To prohibit grazing in conservation forests and forests under regeneration, give instructions on proper grazing practice, and set up hedges and fences.

Measures against prevention of forest fires:

To prohibit burning of shifting cultivation and grazing land, and give thorough education for the prevention of forest fire. To establish firebreaks (along forest boundaries and forest roads and spur roads). To watch for the breakout of forest fire from watch towers at two places (during the dry season) and make regular inspections.

Measures against disease and harmful insects:

Endeavour to detect and eliminate in the early stages and to disperse the danger by the diversification of tree species used in afforestation.

i. Forest road plan

The target for density of forest roads (including spur roads) will be set at 50–60 m/ha for firewood forests.

Forest roads will be 5 m in effective width and 20 m in overall width including side gutters and firebreaks. Spur roads will be 4 m in effective width and 12 m in overall width including side gutters and firebreaks.

Table 1-8 Construction Plan for Forest and Spur Roads (km)

Road type	Phase I	Phase II	Total
Forest road	15	25	40
Spur road	35	35	70

j. Related facilities plan

In order to implement the forest management plan, a management center and the following facilities will be built. The management center with an area of about 1.6 ha will be built adjacent to the Same Nursery. The facilities to be located in the center are as shown below.

Table 1-9 Outline of Facilities for the Management Center

Facility	Area (m^2)	Remarks
Management centre	350	Meeting room, training room, office room, etc.
Garage	150	
Heavy machinery shed	200	
Equipment storage	100	
Material warehouse	100	
Workshop	200	
Fuel house	50	
Accommodation for experts	220	Guest house capacity 8 rooms
Accommodation for counterparts	400	Capacity, up to 20 persons
Watch tower	(2 towers)	Iron-made, height 6m
Guards' house	20	

k. Implementation system and training program

In order to implement the forest management plan in the model study area, it is necessary to operate it as a project. In this case, about 23 staff including 8 nursery staff are considered to be required. Personnel and financial assistance from overseas will be required. In order to extend and promote social forestry over the entire area, it is necessary to repeatedly implement the training for the forestry engineers, persons in charge of general administration, education-related people, non-governmental organization staff and inhabitant leaders.

(5) Establishment and management plan for trial forest

a. Objective and contents of plan

The plan in Phase I of the Semi-arid Forest Management Plan is to implement the establishment of trial forests. This aims at establishing techniques required for afforestation in the semi-arid zone. The afforestation plan for various trial forests, plans for seedling production and management have been formulated as described below.

b. Afforestation for trial forests

The following technique will be intensively developed:

o Systematic test of technique for large-scale afforestation

The major problem is the combination of mechanical land preparation techniques using bulldozers (terracing) and manual work (digging planting holes). The planting of 7 tree species for firewood will be planned for 40 ha, each covering 280 ha in total.

o Standardization test of the semi-arid afforestation technique

In order to establish a standard technique for this area by comparing the individual technique developed in the semi-arid area, the following test will be performed using five major species on 50 ha of the land.

Land preparation technique:

Comparison between thorough weeding and the leaving of protective species. Comparison of catchment methods, comparison of size of digging planting holes, and catchment methods, installation of water storage tank for running water, etc.

Planting technique:

Planting intervals, planting in row, in belt, and under trees and mulching, etc.

Regeneration technique:

Coppicing, sowing, selecting, two-storied forest method, etc.

Nursery technique:

Seedling and pot standards, growing of stump seedlings, hardening of seedlings for planting, etc.

- Selection test of tree species for the semi-arid area

  Test of 15 species will be performed in 4 ha, each covering 60 ha in total.

- Improvement tests of natural forests

  In dry deciduous forest ($Dd(h_1)$, $Dd(h_2)$, $Dd(\ell_1)$) with high productivity and good forest type, enrichment planting over 50 ha and the situation of regeneration by coppicing will be examined.

c. Agro-forestry in the lowlands and afforestation of fodder tree forests

- Establishment of large-scale windbreaks:

  40 m in width, 12.5 km in extension and 50 ha will be developed in Unit ① with 3 tree species.

- Establishment of demonstration fodder tree forests:

  Two tree species will be planted over 10 ha in Unit ⑤ concurrently serving as fuelwood production forests.

d. Improvement of conservation forests and forest reserve

- Improvement and the establishment of land conservation forests:

  10 ha in Unit ②, 20 ha in Unit ⑤ (including riverine forests)

- Improvement of water catchment forests: 20 ha in Unit ⑥ near Same town
- Establishment of urban environment conservation forests: Afforestation and the extension of roadside tree belts along trunk roads and railway in Unit ② (10 m width) 20 km in extension, 20 ha

  The annual plan for the afforestation of these trial forests is as shown on the following table:

Table 1-10 Annual Program for Establishment of Trial Forest

(ha)

Forest type \ Year	1	2	3	4	5	Total
Experiment of large scale afforestation		40	80	80	80	280
Experiment of techniques standardization		10	10	10	20	50
Experiment of tree species selection		10	10	20	20	60
Experiment of natural forest improvement			10	20	20	50
Establishment of windbreaks			15	15	20	50
Establishment of fodder tree forests				5	5	10
Improvement of conservation forest and forest reserves			15	25	30	70
Establishment of seed orchard and arboretum			10	10	10	30
Total		60	150	185	209	600

e. Nursery management plan

- Seedling production plan

  The annual seedling production in accordance with the afforestation plan of trial forests is as shown on the following table. The production will be shared by Same Nursery and Mwembe Nursery at the ratio of 75% to 25% respectively.

Table 1-11 Annual Program for Seedling Production*

(in thousand seedlings)

Year / Forest type	1	2	3	4	5	Total	Remarks
Experiment of large scale afforestation		77	154	154	154	539	1,600 seedlings/ha
Experiment of techniques standardization		19	19	19	38	96	1,600 seedlings/ha
Experiment of tree species selection		19	19	38	38	114	1,600 seedlings/ha
Experiment of natural forest improving			10	19	19	48	800 seedlings/ha
Establishment of windbreaks			29	29	39	97	1,600 seedlings/ha
Establishment of fodder tree forests				9	9	18	
Improvement of conservation forests and reserve forests			18	30	36	84	1,000 seedlings/ha
Establishment of seed orchard and arboretum			12	12	12	36	
Experiment of seedling cultivation		12	12	12	12	48	
(Sub-total)	0	(127)	(273)	(322)	(357)	(1,079)	
For distribution to inhabitants		185	190	196	202	773	
(Total)	0	(312)	(463)	(518)	(559)	(1,852)	

* The number of seedlings for cultivation increased by 20% over the quantity for planting.

○ Nursery operations schedule

There are two rainy seasons: short rains from the middle of October to December and long rains from March to May in this area. Both planting and seedling growing are implemented twice in accordance with these rainy seasons. Since the main planting season is March to April, seedling growing is also implemented during this season.

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Rainy season				←	—	→			←	—	→	
Collecting the surface soil	←	—	→							←	—	→
Soil preparation		←	—	→							←	— →
Sowing			←	—	→						←	— →
Pricking out				←	—	→						← — →
Care and tender	←	—	—	—	→	←	—	—	—	→		
Outplanting				←	— →				←	— →		

Fig. 1-4 Nursery Operations Schedule

f. Forest protection plan

○ Establishment of firebreaks

In the implementation of firebreaks, priority is given to the forest land, farmland boundaries and along the trunk roads.

Table 1-12 Annual Program for Establishment of Firebreaks

Year	1	2	3	4	5	Total
Firebreaks* (km)	10	15	15	10	10	60
Watchtowers (place)	1	1				2

* Boundary firebreaks only

○ Supervision and guidance on the restriction of grazing

○ Measures against disease and harmful insects

g. Forest road plan

The following annual program was formulated with the density of forest roads at 50 m/ha as the target.

Table 1-13 Annual Plan for Construction of Forest and Spur Roads

Year	1	2	3	4	5	Total
Forest roads (km)	3	4	4	2	2	15
Spur roads (km)		10	10	8	7	35

h. Related facilities plan

The management center, nursery facilities and machinery which have been planned in the forest management plan will be provided in the first year.

(6) Preparation of maps for the Semi-arid Forest Management Plan

Diagrams for the semi-arid forest management plan for about 200,000 ha of model study area and trial forest afforestation management plan were prepared on the scale of 1: 5,000. The reduced scale copies of these map sheets are attached to this report as an appendix.

2. Circumstances of the Study

2.1 Background and Circumstances of the Study

2.1.1 Background

Tanzania is situated in the central part on the eastern coast of the African Continent and has a total area of about 94.5 million hectares. With rapid growth in recent years, the population reached 22.5 million by 1984 according to an estimate based on 1977 census. It is an agricultural country with maize and coffee grown as its major crops. Of the population, 90% is engaged in agriculture. Fuelwood serves as the major energy source of the country.

Tanzania has 44 million hectares of forests which account for 47% of its total land area. Miombo woodland and savanna comprise 98% of these forests. Excess felling for fuelwood and heavy grazing in recent years, as well as irregular climatic conditions have drastically reduced the forest area and contributed to deterioration of the productivity and environmental conservation functions.

Consumption of fuelwood in Tanzania is said to exceed 40 million cubic meters. The amount that it could supply without inviting environmental devastation is less than 20 million cubic meters. This means as much as 20 million cubic meters is annually felled in excess. Kilimanjaro Region is one of the regions in Tanzania where the shortage of fuelwood is most prominent. As against its annual fuelwood consumption of 2.04 million cubic meters, Kilimanjaro could supply within reasonable limits only 0.62 million cubic meters, thereby resulting in a shortage of 1.42 million cubic meters.

To cope with this situation, the Tanzanian Government has been pursuing for about 20 years policies to recover and improve forests' production and environment conservation functions through development of social forestry. Kilimanjaro Region has been designated as the region where various measures under these policies are implemented with high priority. However, the initial policy objectives have not been accomplished yet in the region.

With these situations as the background, the Tanzanian Government on November 13, 1985 requested Japan for technical assistance in developing plans to stabilize livelihood and economic development of local residents and improve productivity of land through promotion of social forestry and to improve productivity of land through afforestation of semi-arid land.

2.1.2 Circumstances

In response to this request, Japan dispatched a contact mission for a period from February 5 to 20, 1986. The mission conducted field survey and exchanged views with officials concerned of the Tanzanian Government regarding the background of the request for technical assistance, study area, availability of local cooperation, etc.

Based on results of this contact mission, a preliminary survey team was sent to

Tanzania for a period from August 5 to 22 of the same year. The survey team concluded an agreement on the scope of work with the Land, Natural Resources and Tourism Ministry of the Tanzanian Government to conduct a full-scale forestry development survey over a period of two years, starting with fiscal year 1986.

Accordingly, the Japan International Cooperation Agency initiated work in Japan in December 1986. Along with this domestic work, the Agency has started field survey according to the scope of work by dispatching its survey team to Tanzania.

2.1.3 Reasons for Selection of the Study Area

(1) Selection of the study area

About 200,000 hectares of the Kilimanjaro Region, situated in the northeast part of Tanzania, was selected as the study area. This region was selected based on results of preliminary field surveys (which included aerial photography, mapping, surveys of natural and socio-economical conditions, feasibility study of social forestry, and formulation of the semi-arid forest management plan). The selection was also influenced by the period of the full-scale survey (2 years) and results of cost studies.

Specifically, the area for survey was set in Same District in the southern end of the Kilimanjaro Region for the following particular reasons:

a. Japan's development aid has been concentrated in the Kilimanjaro Region in the past with substantial successes, through establishment in the region of KADC (Kilimanjaro Agricultural Development Center) and KIDC (Kilimanjaro Industrial Development Center).

b. There is a serious shortage of fuelwood supply throughout Tanzania. This situation is particularly severe in Kilimanjaro Region.

c. The region is considered best suited for models of various types of social forestry to be developed under the plan because the stretch of about 800 km from Dar es Salaam to Moshi runs through flat lands with the most arid climate as well as the mountainous areas exceeding 2,000 m in altitude such as the Pare Mountain Ranges.

(2) Selection of the model study area

Of the 200,000 hectares study area, about 20,000 hectares including Same was designated as the model study area for promotion of social forests, particularly for formulation of a forest management plan with major emphasis on afforestation in semi-arid areas.

This model area was selected for the following reasons:

a. Same is the seat of administration and learning. As many schools and colleges are situated there.

b. Development of social forestry in Same has a good demonstration effect because the district is the center of transportation along the Moshi-Tanga-Dar es Salaam Trunk Road.

c. Suitable sites for afforestation in semi-arid areas are widely distributed.
d. This area includes 7 zones out of the total 14 zones of the study area and offers the possibility that various types of social forestry can be developed.
e. The area includes sites suited for seedling production such as Mwembe.

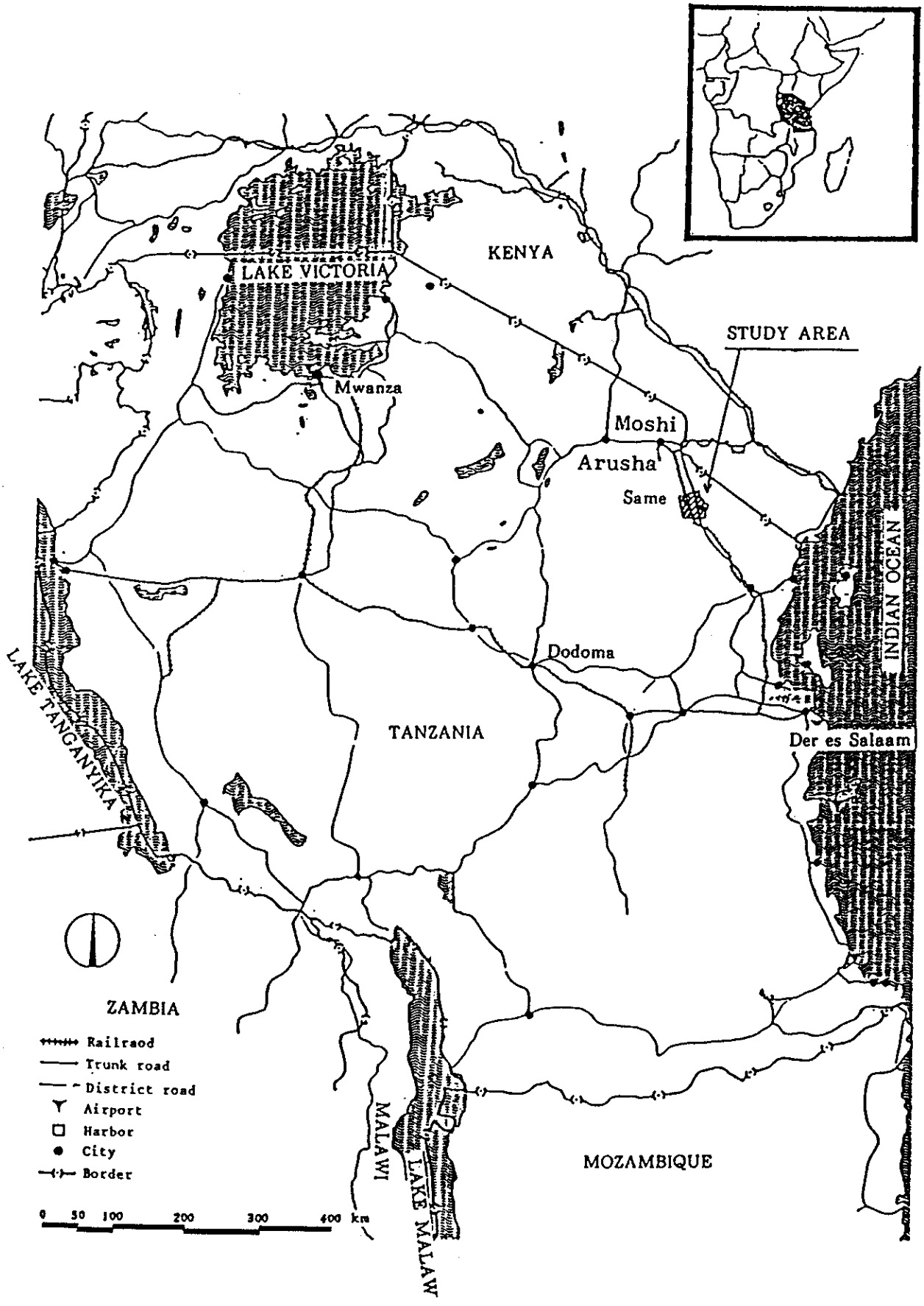


Fig. 2-1 Location of the Study Area

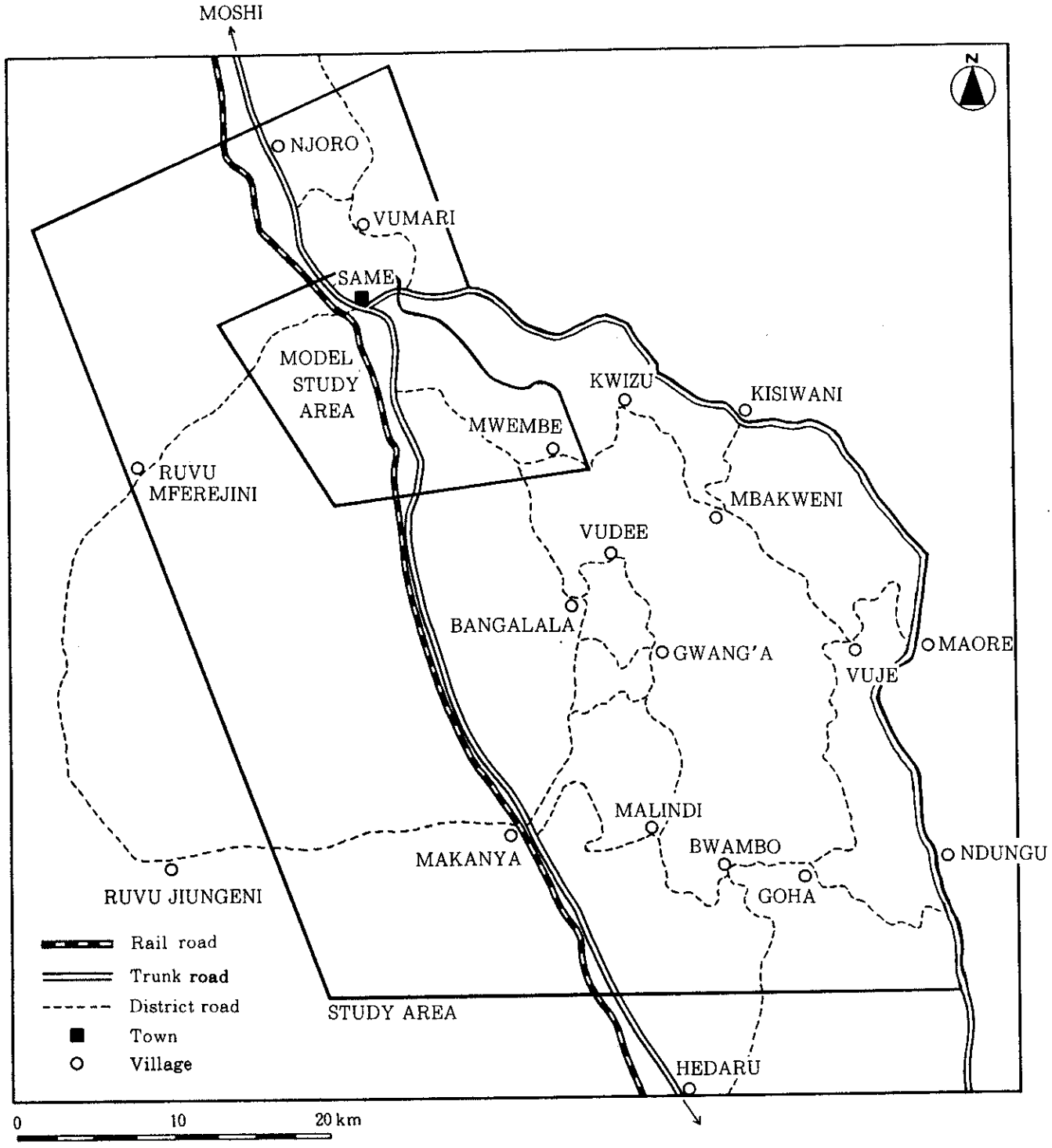


Fig. 2-2 Location of the Study Area and the Model Study Area

2.2 Objectives and Contents

2.2.1 Objectives

The objective of this survey is to investigate 200,000 hectares of the study area for classification of sites for suitability for social forestry and formulation of a semi-arid forest management plan for the 20,000 hectares model area within the study area. Efforts will be made to transfer relevant forestry techniques through all this work with the ultimate object of contributing to promotion of the Tanzanian Government's forestry policies and economic development of the local community.

2.2.2 Contents

The contents of this study are shown as follows.

(1) Study Items for Fiscal Year 1986

① Aerial Photography

a. Aerial Photography Preparations

b. Signalization

c. Aerial Photography

d. Preparation of Contact Prints and Enlarged Prints

e. Preparation of Index Map

② Control Surveying

③ Basic Study for Expanded Afforestation Work

a. Planning and Preparation

b. Field Surveys

- Collection of Information and Data
- Basic Field Surveys

c. Preliminary Interpretation of Aerial Photography

d. Analysis and Examination of Data

(2) Study Items for Fiscal Year 1987

① Preparation of Topographical Maps

a. Aerial Triangulation

b. Mapping and Compilation

c. Field Compilation

d. Drafting

② Full-scale Study for Expanded Afforestation Work

a. Planning and Preparation

b. Field Surveys

c. Analysis and Examination of Data

③ Preparation of Mosaicked Photomaps

④ Preparation of Vegetation and Forest Type Maps

⑤ Preparation of Soil Maps

⑥ Preparation of Present Land Use Maps

⑦ Feasibility Study of Social Forestry

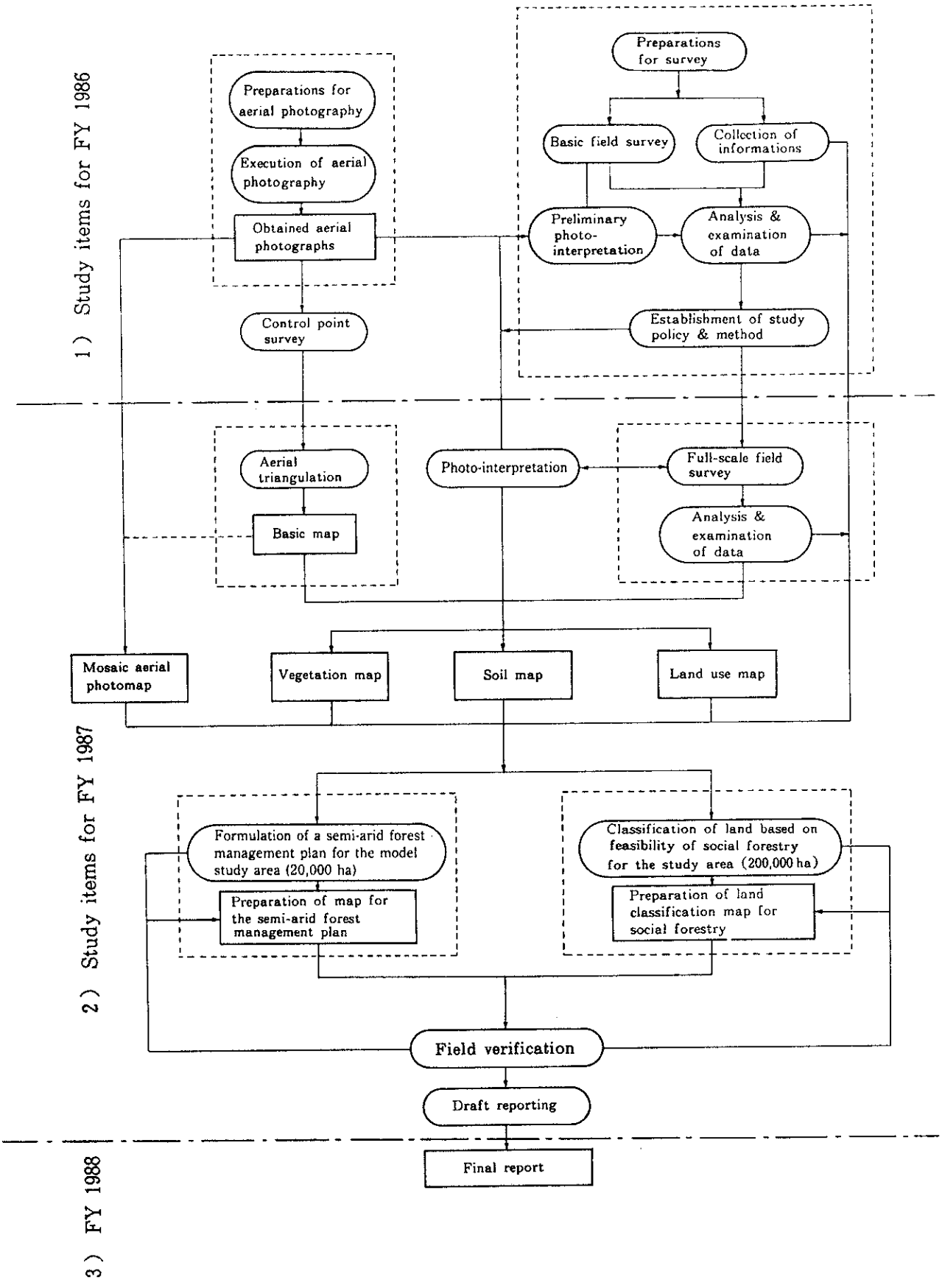


Fig. 2-3 Flow of the Study

a. Land Classification for Social Forestry Feasibility Study
b. Preparation of Land Classification Maps for Social Forestry
c. Preparation of technical manuals on social forestry
d. Preparation of Guideline for Extension of Social Forestry

⑧ Establishment of Semi-arid Forest Management Plan

a. Identification of the Characteristics of the Model Study Area and its positioning within the Study area
b. Examination of Basic Items for Establishment of Plan
c. Establishment of Forest Management Plan
d. Preparation of Implementation Maps of a Semi-arid Forest Management Plan
e. Establishment and Management Plan of Trial Forests

⑨ Field verification

⑩ Draft Report

(3) Study Items for Fiscal Year 1988

Preparation of Final Report

2.2.3 Period and Schedule

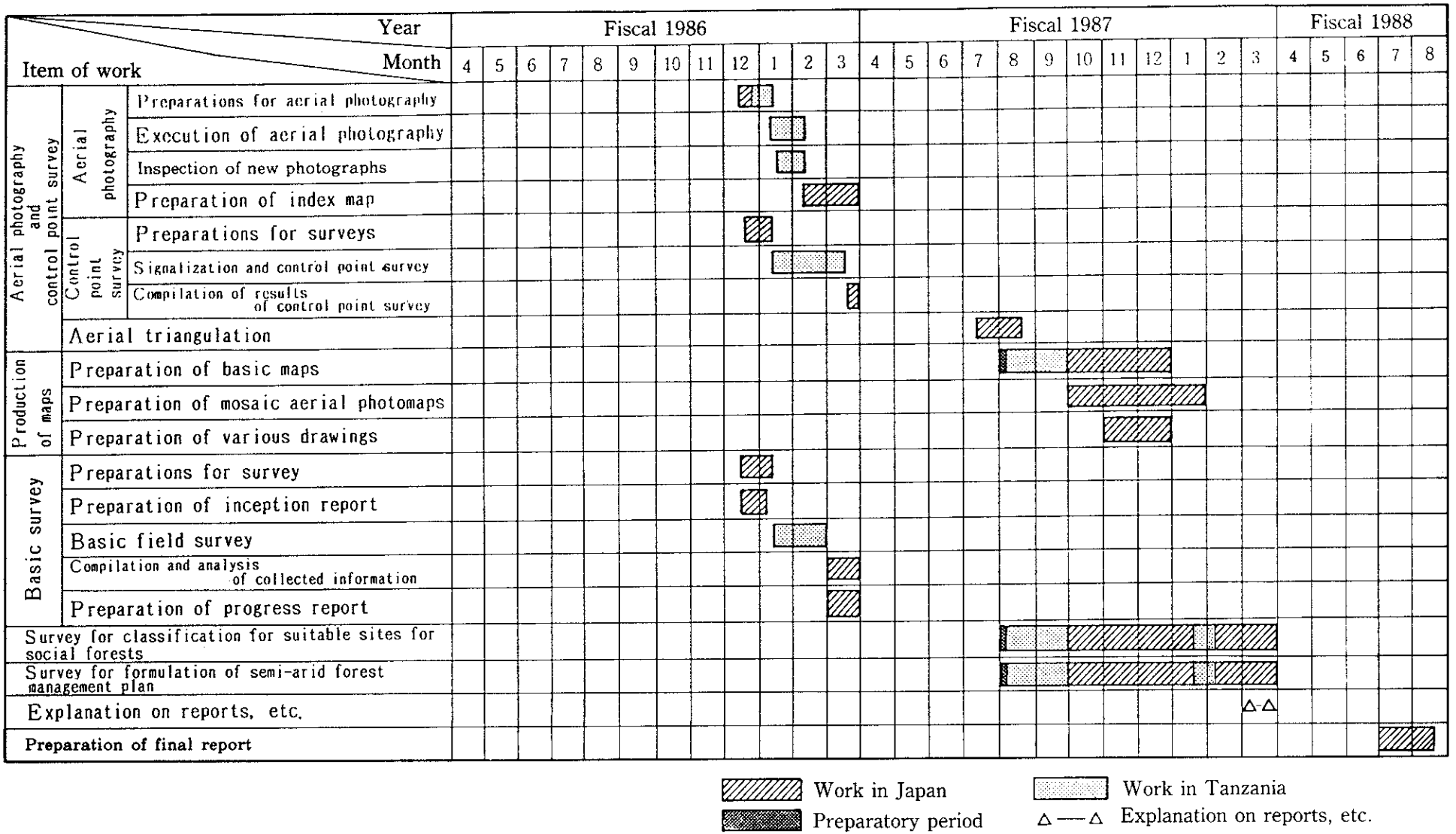
This survey was conducted over a period of 3 years from fiscal 1986 (the fiscal year in Japan starts in April and ends in March of next year) to fiscal 1988. The survey in fiscal 1986 consisted of aerial photography, survey of control points and basic survey for forest development. Based on results of these activities, a full-scale field survey, formulation of semi-arid forest management plan and classification for suitable sites for social forestry were carried out in fiscal 1987 from the end of July 1987 to the end of March 1988. Table 2-1 shows details of work performed in the survey over these two years.

2.2.4 Members of Advisory Team

The advisory team committee for this survey consists of the following members:

Kozo Yamagaki	Forestry Agency, Ministry of Agriculture, Forestry and Fishery
Takashi Kato	Forestry and Forest Products Research Institute
Yasushi Morikawa	-ditto-

Table 2-1 Overall Work Schedule



2.2.5 Survey Teams

The composition and survey period of each survey team for this survey are as follows:

(1) MEMBERS OF THE STUDY TEAM (FISCAL YEAR 1986)

Name	Assigned Duties	Source Organization
Basic Survey		
HASEGAWA, Takashi	Team Leader	Japan Forest Technical Association
WATANABE, Atsuta	Survey Planning	〃
KIKUCHI, Motohiko	Afforestation & Soil	〃
MOCHIZUKI, Kiyoshi	Land Use, Vegetation & Forest Types	〃
ICHINOSE, Takeshi	Afforestation & Soil	〃
Aerial Photograph & Control Surveying		
KUWAHATA, Yasuyuki	Coordination of Surveying & Inspection of Aerial Photographs	PASCO International Inc.
HAYAKAWA, Kiyoto	Contract with Aerial Photography & Supervision	〃
NAKAI, Michimasa	Control Surveying	〃
ISHIGAMI, Yosuke	Control Surveying	〃
TAMARI, Kiyofumi	Control Surveying	〃
SEO, Sigeyuki	Control Surveying	〃

Note: All members of the Study Team belong to the joint venture for The Study on Development Survey for Expanded Afforestation work in Same District, Kilimanjaro Region in the United Republic of Tanzania.

(2) MEMBERS OF THE STUDY TEAM (FISCAL YEAR 1987-1)

NAME	Assigned Duties	Source Organization
(Forestry Development Survey) HASEGAWA, Takashi	Overall Team Leader	Japan Forest Technical Association
HACHIYA, Kinji	Semi-arid Forest Management Plan	〃
TSUKIJI, Tadashi	〃	〃
ICHINOSE, Takeshi	Semi-arid Forest Management Plan, Socio-economic Conditions	〃
MOCHIZUKI, Kiyoshi	Land Classification in terms of Feasibility for social Forestry	〃
HISAMICHI, Atsushi	〃	〃
KIKUCHI, Motohiko	Soil	〃
ICHIKAWA, Sumio	Socio-economic Conditions (Agriculture and Livestock Farming), Soil	〃
(Field Inspection of Topographical Maps) KUWAHATA, Yasuyuki	Inspection of Topographical Maps	PASCO International Inc.

Note: All members of the Study Team belong to the joint venture for The Study on Development Survey for Expanded Afforestation work in Same District, Kilimanjaro Region in the United Republic of Tanzania.

(3) MEMBERS OF THE STUDY TEAM (FISCAL YEAR 1987-2)

NAME	Assigned Duties	Source Organization
HASEGAWA, Takashi	Overall Team Leader	Japan Forest Technical Association
HACHIYA, Kinji	Semi-arid Forest Management Plan	〃
TSUKIJI, Tadashi	〃	〃
HISAMICHI, Atsushi	Feasibility Study for Social Forestry	〃
ICHINOSE, Takeshi	〃	〃

(4) MEMBERS OF THE DRAFT REPORTING TEAM (FISCAL YEAR 1987-3)

NAME	Assigned Duties	Source Organization
HACHIYA, Kinji	Explanation	Japan Forest Technical Association
HISAMICHI, Atsushi	〃	〃

2.2.6 Tanzanian Organizations and Persons Concerned

Various organizations and officials that were involved in surveys in Tanzania are as follows:

(1) Japanese Officials

a. JAPANESE EMBASSY

Name	Position
KUROKOUCHI, Yasushi	Ambassador (~Fiscal Year 1987)
NAKAMURA, Shoichi	Ambassador (Fiscal Year 1988)
TANAKA, Saburo	Minister
TAKEUCHI, Shogo	First Secretary
SHIBUTA, Kazumasa	Expert

b. JICA

Name	Position
SANO, Yoshinori	Former Director
TOIDA, Norio	Director
IIZUKA, Shunsuke	Deputy Director
MURAKAMI, Hiroshi	Counselor
SEGAWA, Muneo	Expert (F.D.)

c. VARIOUS ORGANIZATION

Name	Position
INOUE, Junji	Project Reader of KADC
TORII, Kazuo	Coordinator of KADC
HIGUCHI, Tatsunoshin	Expert of KIDC
HIGUCHI, Hitoshi	〃
KONDO, Hiromi	〃
MORINAGA, Shigeji	Expert of Dodoma Project

(2) Tanzanian Officials

a. FORESTRY AND BEEKEEPING DIVISION

Name	Position
E.M. Mnzava	Director, Forestry and Beekeeping Division
P.E. Kimaryo	Deputy Director, 〃
B.K. Kaale	Former Head of Village Forestry Section
F.B. Kilahama	Head of Village Forestry Section
S. Mtallo	Forest Officer, Village Forestry Section
M. Matiko	〃 〃

b. KILIMANJARO REGION

Name	Position
P. Kimiti	Regional Commissioner, Kilimanjaro Region
G. Mgendi	Development Director, Kilimanjaro Region
G.M. Kiama	Administrative Officer, Kilimanjaro Region
J.J. Mpiza	Planning Officer, Kilimanjaro Region
C.N. Mollel	Natural Resources Officer, Kilimanjaro Region
C.O. Kivumbi	Forest Officer, Kilimanjaro Region
O. Kidami	Forest Officer, Kilimanjaro Region
D.A.B. Matungwa	Assistant Forest Officer, Kilimanjaro Region

c. SAME DISTRICT

Name	Position
Y.B. Lukoya	Commissioner, Same District
E.R.S. Chambo	Executive Director, Same District
A. Juma	Natural Resource Officer, Same District
R. Mtipula	Catchment Forest Officer, Same District
A.A. Mdee	Forest Officer, Same District

d. VARIOUS ORGANIZATIONS

Name	Position
J.C. Nchango	Principal, Olmotony, Forest Training Institute
L.K. Danso	HAI Project Leader
S.A.O. Chamshama	Sokoine University
A.S.M. Mgeni	〃
L. Lulandala	〃
D.C.C. Magawa	Kibaha Office
Soko	〃
T.A. Minja	Morogoro Catchment Office
C. Madeghe	Capital Development Authority (CDA)
J. Benju	〃
A.B. Trimos	〃
E.J. Kanza	Mpuapua Office, HADO Project
I. Sefu	〃
L. Deengw	〃

2.2.7 Counterparts

Name	Position
B.K. Kaale	Former Head, Village Forestry Section
F.B. Kilahama	Head, Village Forestry Section
F.D. Nyaky	Forest Officer, Forest Management Section
W. Njau	Forest Officer, Village Forestry Section
L. Okello	Forest Officer, Forest Inventory Section
C.K. Ruffo	Tanzania Forest Research Institute, Botanist
E.Z. Moshi	〃 〃 , Pedologist
J. Massam	Forest Officer, Coastal Zone Office
L.E. Azaria	Planning Officer, HADO Project
C.O. Kivumbi	Forest Officer, Kilimanjaro Region
G.S. Masawe	Livestock Development Officer, 〃
O. Kidami	Forest Officer, 〃
D.A.B. Matungwa	Assistant Forest Officer, 〃
A. Juma	Natural Resource Officer, Same District
E.M. Mbwambo	Assistant Forest Officer, 〃

3. Outline of the Study Area

3.1 Outline of Tanzania

3.1.1 Geographical Features

Tanzania is situated in the central part of east coast of the African continent between 29°20′ and 40°38′ of east longitude, and between 1° and 11°45′ of south latitude. Tanzania has an area of 93,970,000 hectares, of which 246,000 hectares are of islands including Zanzibar.

Although Tanzania has a coastal plain with a width of several tens kilometers along the Indian Ocean, a plateau which lies to the west of the plain rises more than 1,000 meters above the sea level. Mt. Kilimanjaro, Africa's highest peak (5,895m) and Mt. Meru (4,566m) stand on the border with Kenya, and other mountains in the elevation class of 2,000 to 3,000 meters stand adjoining to each other in the northern part of the country.

The central part of the country is occupied by a vast plateau with elevation of 1,000 to 1,500 meters. The western extremity of the country is bordered by the lengthy Lake Tanganyika stretching from north to south and to the southeast of the lake highlands extend exceeding 1,500 meters in elevation. The southeastern part of the country is a gently sloping hilly area with elevation between 200 and 500 meters, while a plateau with elevation of 500 to 1,000 meters lies in the southwestern part of the country.

The total area of Tanzania consists of the plateaus, 1,000 to 1,500 meters above sea level, covering approximately 50%, the highlands over 1,500 meters, covering approximately 15%, and the plain and hills below 1,000 meters, covering approximately 35%.

3.1.2 Climate

The climate of Tanzania may be roughly classified into the tropical maritime climate prevailing in the coastal areas, the savanna climate over the central plateau, the tropical rain-forest climate around Lake Tanganyika and the warm temperate climate in the mountainous areas.

In the coastal areas along the Indian Ocean, where Dar es Salaam, the country's capital city, is located, high temperature and high humidity prevail, and an annual rainfall of approximately 1,000 mm is usually recorded through the heavy rainy season (March through May) and the light rainy season (November through December). In the central plateau, the range of daily fluctuation in temperature is considerably wide and the precipitation is rather small throughout the region and the areas with annual rainfall below 600 mm are rather widely distributed. The temperature decreases and the precipitation increases with the increase in altitude, till the precipitation exceeds 1,400 mm in many places in the mountainous areas. In the areas around Lake Tanganyika, on

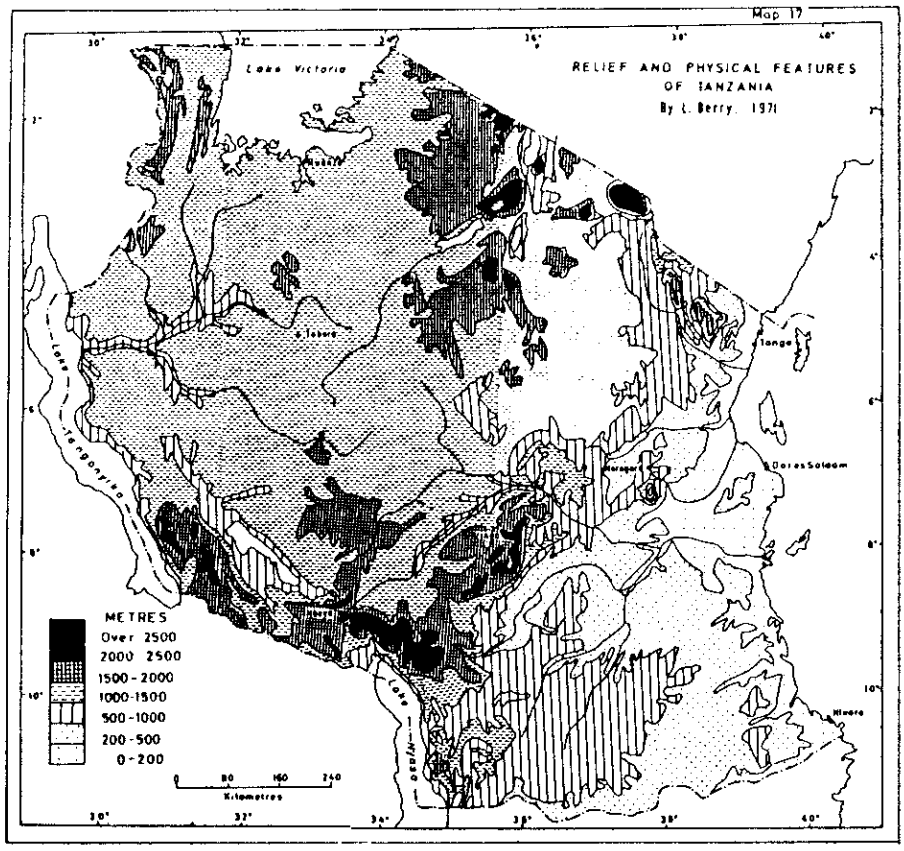


Fig. 3-1 Altitude Map
(Relief and Physical Feature of Tanzania)

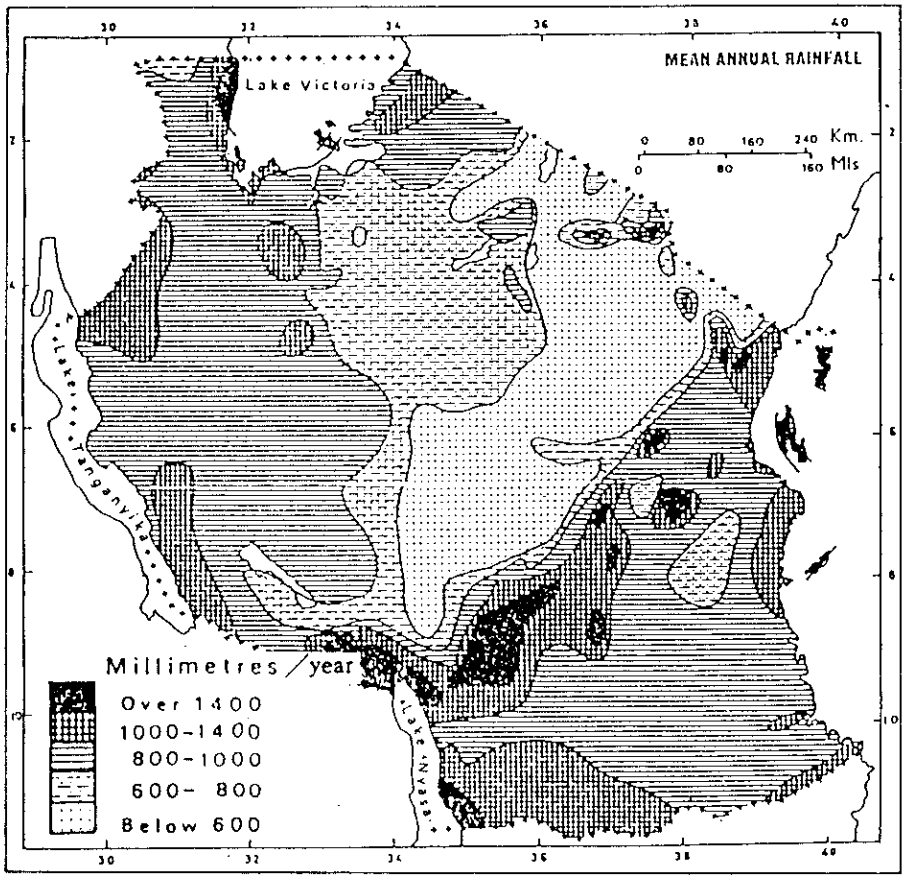


Fig. 3-2 Mean Annual Rainfall

the other hand, the temperature is low because of high altitude and the humidity is rather high.

3.1.3 Socio-economic Features

The population of Tanzania of 12,306,000 in 1967 had increased to 17,552,000 and 19,110,000 in 1979 and 1982 respectively. Since it was reported that the country had approximately 7,500,000 inhabitants in 1984, the population increased 2.5-fold during the 35 years from 1948 to 1982. It is estimated that the country's population reached to 22 million level in 1987 and a demographic forecast says that the Tanzanian population will amount to 25 million in 1990 and 37 million in 2,000.

Although the average density of population stands at a rather low figure of 20 persons/km^2, the great majority of the country's population concentrates in the areas occupying as small on area as 15% of the whole territory. The areas of higher density of population are found in the coastal regions, Lake Tanganyika regions and the mountainous regions, where plenty rainfall of is prevailing.

The gross domestic product of the country amounted to 4.5 billion US Dollars in 1982 and the per capita national income for the same year is estimated at 280 US Dollars.

The agricultural population forms 86% of the country's whole population (according to the census in 1978) and the agricultural product shares 50% of the gross domestic product (according to the census in 1984). The forestry population of Tanzania counts up to 100,000 and their product occupied 4.3% of the gross domestic product in 1982.

The number of households of farmers in Tanzania is estimated at 2.2 million, and 97% of the households subsist on small scale farming, keeping cultivated lands less than 5 hectares per household and the average farming area per household amounts to 1.2 hectares only. The total area of arable land occupies as small as 6% of the whole area of the country.

Major farm products in the relatively humid regions are maize, bananas and beans, while maize, sorghum, millet and cassava are major crops in the drier regions. Cash crops are; coffee, tea, sugar cane, pyrethrum and vegetables in the mountainous region; cotton, tobacco, peanuts and rice in the flatlands; and copra, sisal and cashew nuts in the coastal regions. In addition, beekeeping is very popular and the country is famous for its production of honey and beeswax.

Table 3-1 Land Use Classification

Items	1982	
	Area	Percentage
	(10 ㎢)	(%)
Total Territory	94,569	100.0
Land Area	88,604	93.8
Cultivated Land and perennial Crop Field	5,200	5.5
Cultivated Land	4,140	4.4
Perennial Crop Field	1,060	1.1
Permanent Grassland	35,000	37.0
Forest and Woodland	41,900	44.3
Others	6,504	6.9
Irrigated Farming Land	68	0.1

Note: "Irrigated Farming Land" is included in "Cultivated Land and Perennial Crop Field".
Source: FAO Annual Bulletin of Agricultural Production, 1981 and 1982.

Table 3-2 Major Farm Products

Item	1982		
	Production	Farming Area	Yield per hectare
	(10 t)	(10 ha)	(t/ha)
Rice (unhulled)	200 ※	150 ※	1.3
Maize	800 ※	1,340 F	0.6
Millet	150 F	220 F	0.7
Sorghum	220 F	350 F	0.6
Cassava	4,900 F	960 F	5.1
Kidney Bean (dried)	152 F	305	0.5
Cotton Seed	127 ※	382 ※	0.3
Coffee (fresh)	55 ※	110 F	0.5
Sisal	80 ※	135 F	0.6

Note: ※: figures not authorized.
F: estimated by FAO
Source: FAO, Annual Bulletin of Agricultural Production, 1981 and 1982

3.1.4 Vegetation

The vegetation of Tanzania is classified into eight types as presented hereunder according to the Vegetation Map prepared by the Tanzanian Government.

① Forest

This is defined as a continuous stand of trees which reach a height over 10m. The evergreen tree is most frequently predominant, but there are some mainly deciduous forests. The forest vegetation occurs in the areas which receive over 1,000 mm rainfall annually and not have apparent dry season. The forest occurs in area with a high ground-water table, for example adjacent to stream beds and marine coast.

② Woodland

This is defined as an open cover of trees in which the crowns do not form an interlaced canopy. The deciduous type is usually predominant and grasses and herbs form the ground cover. All woodland types occur in areas with a marked dry season. Miombo woodland, which covers large areas of western and southern Tanzania, is associated with rainfalls of between 800 and 1,200 mm per annum. Acacia woodland is sometimes associated with dried areas.

③ Bushland and thicket

These categories are defined as communities of densely growing shrubs and small trees, giving a canopy cover of more than 50%. Species may be either evergreen or deciduous. Herbs and grasses may form part of the ground layer in bushland. Distribution is generally in the drier areas with a precipitation range of 400 to 800 mm per annum.

④ Wooded grassland

Grasses and herbs, usually perennial, make up the ground layer, with trees and shrubs, giving a canopy cover of less than 50%. This vegetation type is usually associated with less well-drained areas where poorer soil aeration, so the trees are more scattered.

⑤ Grassland

The ground layer is composed of grasses and herbs. Trees and shrubs are very scattered, giving a canopy cover less than 10%. The Grassland also occur under the poor drainaged conditions of flood plains. In addition, there are secondary grassland formation maintained by burning.

⑥ Desert and semi-desert

Semi-desert has very widely scattered, low shrubs, stunted trees and annual grasses. In deserts there is a virtual absence of vegetation.

⑦ Permanent swamp

This vegetation type occurs where there is a high ground-water table or perennial flood. The vegetation may consist of grasses, reeds, sedges or rushes.

⑧ Cultivated areas

The Cultivated areas are the land where the original vegetation was completely replaced by cultivation, such that it cannot be identified in terms of the categories already described. The Cultivated area is usually found in the heavy rainy area of the highland area, the land bordering lakes, and the coastal plain.

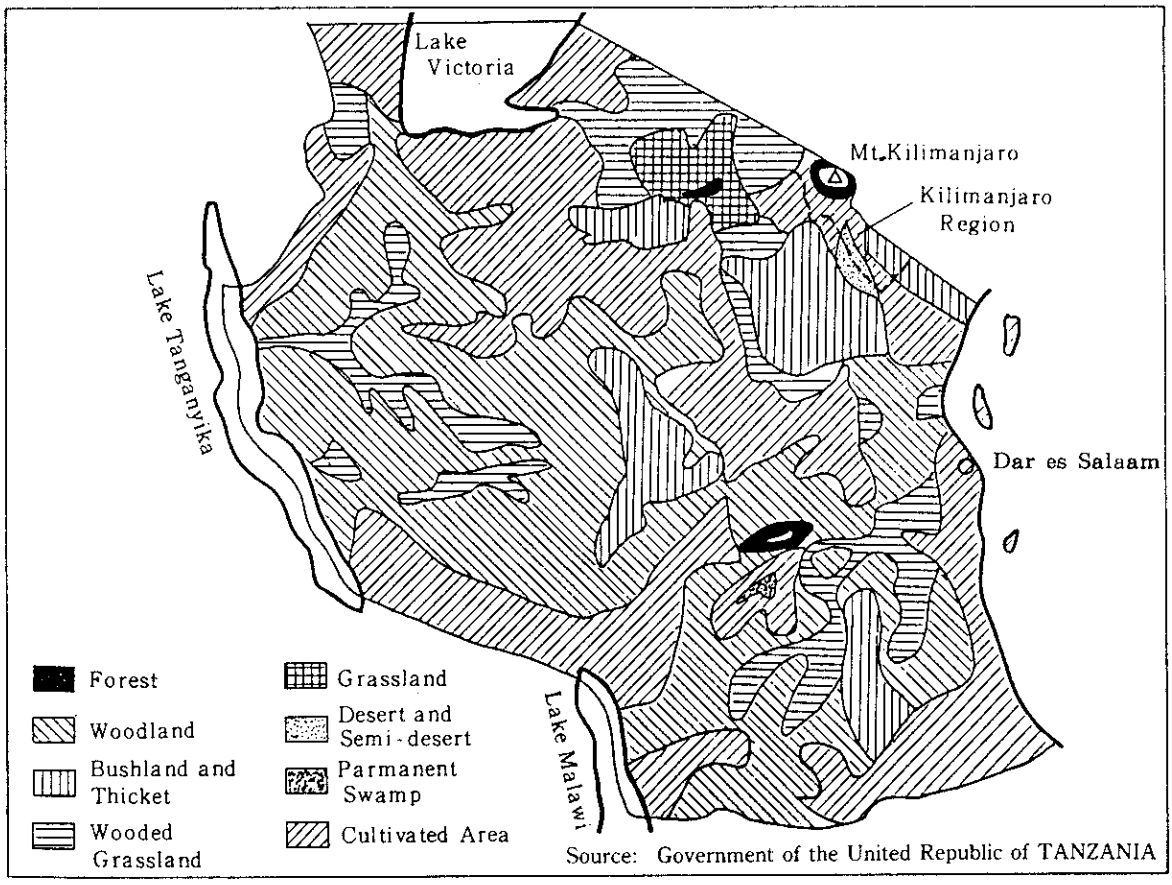


Fig. 3-3 Vegetation Map (Atlas of Tanzania 1976)

3.1.5 Forestry

(1) Outline general

The wooded area of Tanzania amounts to 44,371,000 hectares covering 47% of the country's territory. It is estimated that about 34 million hectares out of such wooded area are suitable for forestry.

The wooded area is divided into the tropical rainforest with high trees covering 936,000 hectares or only 2% of the total wooded area, the savanna covering the largest portion of the wooded area about 32,641,000 hectares or 74% of the total, and the intermediary type of forest between tropical rainforest and savanna with 10,794,000 hectares or 24% of the total wooded area.

The main tree species of tropical rainforest area coniferous trees such as *Podocarpus* spp. (Podo) and *Juniperus procera* (African pencil cedar), and broadleaf trees such as *Ocotea usambarensis* (East African camphorwood), *Olea welwitschii* (loliondo) and *Cephalospharera usambarensis* (mtambara). Mangrove forests are still found in the coastal areas and amount to approximately 100,000 hectares in total.

The main tree species of savanna belongs to *Leguminosae* family, locally called miombo, consisting of *Brachystegia, Brachylaena hutschinsii, Pterocarpus angolensis* (muninga), *Chlorophora excelsa* (mvule), *Afzelia cuanzensis* (East African afzelia), *Dalbergia melanozylon* (African blackwood), *Khaya nyasica* (African mahogany) and so on.

Although over 800 tree species are reported to exist in the savanna areas, only 20 tree species out of them are utilized for forestry purposes.

The largest man-made forest in Tanzania, which was afforested for industrial use and designated as forest reserve, covers about 79,000 hectares of land. In addition, there are many afforested lands under management and control of rural administrations and Village Afforestations implemented throughout the country, but any reliable statistical figures thereof are not available.

The stand growth of forests in Tanzania is estimated as follows: 20 to 25 m^3/ha of annual increment for man-made coniferous forest, 5 to 10m ^{3}/ha for natural tropical rainforest, and only 0.5 to 2.0 m^3/ha for savanna which occupies the largest portion of the country's wooded area. Under such conditions, the annual forestry production of this country is estimated at 6.7 million m^3 for timber and 19.9 million m^3 for fuelwood with total production of 26.6 million m^3. (Note: The productivity for man-made forest is a forecasted value in the forestry production program of Tanzania.)

On the other hand, although any reliable statistical data for wood consumption is not obtainable in the country, the country's fuelwood consumption is about 40 million m^3 per year, when the fuelwood consumption per capita in the country is estimated at 2 m^3 per person per year. (Note: Some experts claim that 1 m^3 per capita per year shall be probable figure instead of 2 m^3.) The supply and demand balance of timber and fuelwood in Tanzania would be estimated as follows:

Table 3-3 Supply and Demand Balance of Timber and Fuelwood in Tanzania

(Unit: 1,000 m³)

Use	Natural Forest	Man-made Forest (H)*	Man-made Forest (S)*	Total
Total Supply	25,000	200	1,400	26,600
Timber wood	6,000	100	600	6,700
Fuelwood	19,000	100	800	19,900
Total demand	40,910	38	567	41,515
Lumber	300	4	204	508
Match	—	—	17	17
Plywood	10	—	—	10
Hardboard	—	3	20	23
Chipboard	—	—	5	5
Pulp	—	—	305	305
Pole	600	31	5	636
Other uses	—	—	11	11
Fuelwood	40,000	—	—	40,000

*H : Hardwood S : Softwood

Due to shortage of sawing capabilities throughout the country, the forestry resources of man-made forests are not effectively utilized.

The fuelwood supply provides 91% of the energy consumption in Tanzania, and also the 98% of energy consumption of household. It is very important for the national economy of Tanzania, to supply of fuelwood sufficiently and timely.

Although the major part of the territory is covered by the savanna vegetation, well-populated areas are concentrated on the mountain region, lake side region and coastal region where the land is densely wooded due to plenty of rainfall. So many of the inhabitants had been accustomed to easily obtain fuelwood in the neighboring natural forests. But an explosive increase of population in this country invited an enormous increase of fuelwood demand, an expanding clear cutting of wooded areas for food supply and over-grazing. Under such situations, the forestry resources of the country have rapidly diminished during recent years, and securing fuelwood requires heavier expense for urban people and much labor and time for rural inhabitants. At the same time, the decrease of forestry resources have invited a declined productivity of land leading to the shortage of food supply, deteriorated environmental conditions, an expansion of desert area and other unfavorable situations.

The forest policy of Tanzania was first launched stressing upon the designation and management of forest reserve and large-scale afforestation projects were carried out at some regions to increase production of forestry materials, but since the latter half of 1960's the promotion of social forestry became the major target for the country's forestry policy to improve against the shortage of fuelwood,

declined productivity of land and environmental deteriorations as stated before.

Although every possible effort has been made by the people concerned with forestry, the goals have not been attained mainly due to insufficiency of necessary resources. For example, although afforestation of over 200,000 hectares is needed annually to satisfy the domestic fuelwood demand, actual afforestation made ranges only between one-tenth to one-twentieth of the goals.

(2) Forest reserve

Forest area covering 13,491,000 hectares is designated as forest reserves in Tanzania, and this corresponds to 30% of the total forest area or 14% of the territory of the country.

Designation of forest reserves were started when the country was ruled by Germany, but many of the current forest reserves were designated during 1950's. The area of forest reserve has not substantially increased since 1963.

The number of forest reserves designated amounts to 540 and the area of a forest reserve ranges from 3 hectares up to 680,000 hectares with an average area of 25,000 hectares.

Considerable number of important broadleaf trees out of the forest reserves are also registered as reserved trees. In addition, forest with better forest type have been conserved at respective villages under their own rules and regulations.

The purposes of forest reserve system are: to secure stable and sustained production of timber, poles and fuelwood; and to preserve water conservation forests, soil conservation forests, water catchment forests and experimental forest. The area of production purposes reportedly amounted to 11,800,000 hectares in 1979 and 10,800,000 hectares in 1982 respectively. Therefore, the area of forest reserves for conservation and research purposes is understood to have increased from 1,600,000 hectares in 1979 to 2,600,000 hectares in 1982.

The decentralization policy adopted by the Tanzanian Government since 1972, transferred a large part of the forest reserves under administrative control of Forestry Division of the Central Government to the District Councils concerned, the industrial plantation areas and water conservation forests of 578,000 hectares are the only forests presently managed by the Forestry Division.

It is reported that the area of forest reserve has shown a sharp decline due to clearing for cultivation.

(3) Industrial afforestation

Afforestation of experiment forests was commenced at the begining of 1900's in Tanzania. The teak forest located at Longuza were first planted in 1906 and afforestation activities at Shume and Magamba started in 1920's.

In 1952, the Government's afforestation program aiming to increase production of timber, poles and fuelwood was established and since 1960 the area exceeding 1,000 hectares had been afforested annually and peaked in 1967/68 with 3,514 hectares planted. In 1977, the Government decided to establish a pulp mill at Mufindi

and the afforestation efforts after 1977 were concentrated on Sao Hill area for production of pulp and paper. The largest annual afforestation of 7,399 hectares was made in 1978/79. The newly afforested area has been remarkably decreased since 1982/83 and area of 1,000 to 3,000 hectares has been afforested during recent years mainly at Sao Hill area.

The area of man-made forest afforested up to 1986 is shown in the following table. The total area amounts to 79,300 hectares, while the afforested area at Sao Hill exceeds 50% thereof.

Table 3-4 Actual Condition of Man-made Forests

(ha)

Place	Coniferous trees	Broadleaf trees	Total
Sao-Hill area	37,400	2,600	40,000
Other 18 areas	31,300	8,000	39,300
Total	68,700	10,600	79,300

(Industrial Plantation Forestry in Tanzania 1986)

The above afforested area includes; 6,042 hectares where reforestation is needed: 978 hectares where clear cutting was made and 5,064 hectares where afforestation did not succeed.

Additional afforestation programs to be implemented include 56,000 hectares in total with 31,000 hectares at Sao Hill area and 25,000 hectares at other areas.

The 19 industrial plantation located places with elevations of 80 to 2,500 meters and annual rainfall from 750 mm to 2,100 mm, where higher precipitation is recorded in Tanzania.

The coniferous tree species count 22 in total (including domestics 2) and among them *Pinus patula* is planted dominantly in 36,620 hectares, while the broadleaf tree species count 30 (including domestics 9) and *Tectona grandis* has the largest area of 2,641 hectares. The juvenile forest with age less than 15 years old occupies approximately three-fourths of the total afforested area. The annual cutting volume has been limited to 330,000 m^3 level at present these years due to shortage of insufficient plant capacity at saw mills, but is expected to increase to 680,000 m^3 in 1990 and eventually to 1,600,000 m^3 under the current long-term forestry program. A half of the cutting volume will be utilized for lumber and remaining half for chips and other usages.

(4) Village afforestation

In addition to the large-scale afforestation program aiming to enhance timber production and water conservation as aforesaid, Village Afforestation Program for fuelwood production and soil conservation was launched in 1967 in several regions and the activities therefore have been extensively implemented since 1970.

The afforested areas under the Program are estimated as follows based upon

the number of planting stocks used (calculated under the assumption of 1,600 trees per hectares).

Table 3-5 Past Records of Village Afforestation (1975-1982)

(ha)

Year	1975/76	76/77	77/78	78/79	79/80	80/81	81/82	Total
Estimated area	3,280	3,678	5,776	7,161	7,946	9,490	12,050	49,381

(Trees for Village Forestry 1984)

As shown in the table, the afforested area under the Program are believed to have increased from 3,280 hectares in 1975/76 to 7,946 hectares in 1979/80 indicating almost 240% growth during the four year period.

In 1981, the Tanzanian Government formed Village Forestry Section under Forestry Division and, at the same time, established National Village Afforestation Plan. The 5-year plan aimed to add following afforested area for the period from 1982 through 1987.

Table 3-6 Annual Afforestation Plan (1982-1987)

(ha)

Year	1982/83	83/84	84/85	85/86	86/87	Total
Area	14,460	17,352	20,822	24,986	29,984	107,604

(Tanzania Five Year National Village Afforestation Plan 1983)

The Tanzanian Government carried out educational campaign under the slogan—"Forests are Wealth"—in 8 regions including Arusha Region from 1980 through 1984, as extension movement of promoting the plan.

The afforestation program under the 5-year plan is expected to be implemented by: a) village inhabitants, b) communities, c) schools and other organizations and d) Forestry Division (by way of afforestation for demonstration purpose).

The broadleaf trees consisting of domestic tree such as *Acacia albida* and exotic trees such as *Grevillea robusta, Leucaena sp., Cassia spp., Eucalyptus spp.* etc. were chosen as the most suitable species for agroforestry.

Although the village Afforestation Plan has been performed by the whole nation throughout the country, some observes admit that areas appreciating favorable results from this Plan are limited to almost half of the planting area and the annual afforested area under this Plan has been far below the country's annual expected target of planting area of 200,000 hectares.

In order to expand the afforested area by 200,000 hectares per year, every household of Tanzania must plant and breed 80 nursery seedlings (or 16 seedlings per person) every year. If 2 to 3 million hectares of land will be afforested within

10 to 15 years period through above mentioned household afforestation activities, the domestic demand for fuelwood will be completely satisfied and then natural forests will be maintained and conserved. In future the man-made forests newly afforested are usually cut in approximately ten years and after several regenerations by coppice, reforestation is to be carried out. Such reforested area is believed to amount to around 50,000 hectares every year.

(5) Legislation, policy and planning for forestry

① Legislation of Forestry

The legislation of forestry in Tanzania is based on "Forest Ordinance—Chapter 389 of the Forest Laws" enacted in 1957 and Forest Rules regulating the details and came into force in 1959. The legislation mainly stipulates on conservation and utilization of forest reserves and forest products.

② Policies for forestry

The first notification on forestry policy was made in 1953, stipulating designation, conservation and management of forest reserves. The principles stated in said notification remain unchanged and still valid.

Since 1963 when the country became independent as the Republic of Tanganyika, reasonable and proper utilization of woodland and reinforcement of water conservation by forest were taken up for main program of forestry policy of the country, and in addition, an extensive afforestation plan was executed in the areas where a dense population exists and the productivity of land had considerably deteriorated.

On top of those measures as stated above, major parts of the forestry industry in the country were nationalized and government-owned saw mills were organized under the socialist policies.

The second political reform to forestry (greatly affected the country's forestry) was the decentralization put into effect since 1972. Before the decentralization, all forestry activities in the country had been directly administered and managed by Forestry Division (or present Forestry and Beekeeping Division). But after the decentralization was instituted, Forestry Division concentrates its activities on nationwide forest projects and most of the forestry administration works have been transferred to the districts concerned.

One of the most remarkable events in terms of current forestry policy, specially of promotion of social forestry was the Afforestation Promotion Conference held in 1980 under leadership of President Nyerere. At the Conference, President Nyerere declared in his speech to the attendants "Cut a tree, Plant three trees. When we pay no attention to afforestation and planting, our country will soon confront a crisis and our children will be compelled to inherit waste lands. World-famous natural resources of this country including wildlife protection areas and Mt. Kilimanjaro are actually exposed to risk of deterioration. We have to hasten in afforestation. Any and all people at the central government, local governments, non-administrative organizations and bodies, schools, villages and even at every

household, afforestation efforts shall be exerted under mutual cooperation, and I declare that afforestation is one of the most important musts of our nation."

③ Planning for forestry

The National Economic Plan is prepared and established by Ministry of Finance and Economic Planning. The Ministry draws up three types of plans—long-term 20-year plan (the current plan covers the period from 1981 up to 2000), 5-year Development Plan and annual plan.

The first 5-year Development Plan was established in 1961 and the current fifth 5-year Development Plan covers the period from 1987 to 1992.

Although the forestry plan is prepared by Planning Division of Ministry of Lands, Natural Resources and Tourism, the established forestry plan shall be implemented by Forestry and Beekeeping Division and regional and district authorities.

④ Administrative structures of Forestry and Beekeeping Division

Forestry and Beekeeping Division, one of the five divisions of Ministry of Natural Resources and Tourism is in charge of the overall administration of forestry in the country. As shown in Fig. 3-4, Forestry and Beekeeping Division consists of five sections that 71 experts and 154 technical staff are attached and Village Forestry Section out of them is in charge of management of local social forestry.

Village Forestry Section consists of four sub-sections. The whole territory of the country is divided into 5 zones and a Zonal Community Forest Officer is stationed at the central town of each zone.

Forestry and Beekeeping Division adminsiters the following forest projects which are deemed to be essential for the country's national economy:

a. 19 Afforestation Projects (57,000 hectares in total)
b. 4 Catchment Projects (578,000 hectares in total)
c. 2 Soil Conservation Projects (20,000 hectares at Dodoma Region, and Shinyanga) Olmotoni ?
d. Zonal Forest Management Project (at Olmotonyi)—including Logging and Road Building.

Village Forestry Section performs following duties:

a. Collection and filing of information and data on energy policies, supply/demand of fuelwood and community forestry
b. Public informations through various media including radio broadcasting, newspapers, films, posters, stickers, and calendars etc.
c. Instruction and training of administrative staff, forestry workers and general public (seminars, field trips, preparation and distribution of manuals)
d. Assistance to municipalities, communities, schools and other non-governmental organizations in establishing afforestation programs
e. Promotion of forestry education in primary and lower secondary schools, and study of possible roles to be undertaken by housewives and children in community forestry

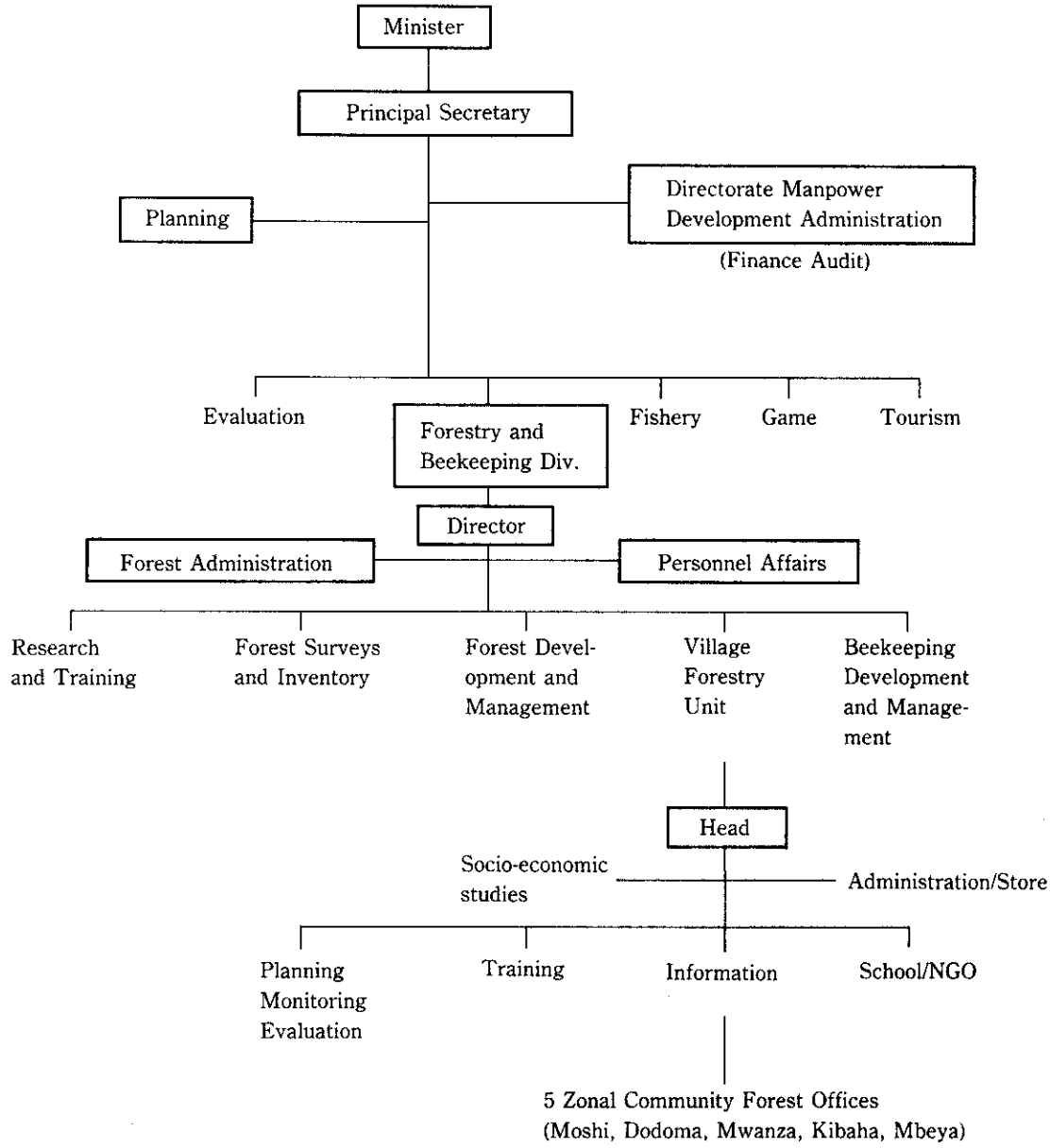


Fig. 3-4 Administrative Structure of Forestry in Tanzania

f. Large-scale afforestation of fuelwood forests to satisfy urban fuelwood demand and improvement of fuelwood usage

Forest administrative organization at district level and regional level will be discussed later in this study. (Note: Already mentioned, that the most of the forestry administration are implemented at district level. Regional level situates between the central government level and district level.)

⑤ Education system for forestry

Under the current education system of Tanzania, compulsory education is limited to primary school, where children of 7 years old enter for 7-year education period. The lower secondary schools in Tanzania have 4-year course and around 5% primary school pupils can go on to the lower secondary schools. Approximately 25% of the lower secondary school students go on to the 2-year higher secondary schools. Tanzania has two universities—Dar es Salaam University and Sokoine University of Agricultures—and the students will be given a degree of bachelor of science after 3-year study and a degree of master of science after additional 2 years of study.

For education and training of forestry specialist, the country has Olmotonyi Forestry Training School established in 1937, where 20 higher secondary school graduates and 50 lower secondary school graduates are received every year for 2-year education and training course. The graduates of the training school during the period from 1971 through 1983 consist of 858 people of certificate, 691 people of diploma and 150 people of degree undergraduate. In addition, the country has Moshi Forest Industries Training Institute and 3-month course Technical Training Centers at Rongi and Sao Hill for education of specialists and engineering in forestry products utilization technologies and on the job-training for lower cadre forest workers respectively.

3.2 Outline of Kilimanjaro Region

3.2.1 Geographical Features, Climate and Socio-economic Features

Kilimanjaro Region is one of 20 regions in Mainland Tanzania occupying the northeastern part of the country borders with the Republic of Kenya to the north. With a total area of 13,209 km^2 and a population of 1.08 million (estimation in 1983), the average population density is over 81 persons per km^2, being the second highest in the country, surpassed only by Dar es Salaam Region within which is situated Dar es Salaam City, the capital of Tanzania.

Kilimanjaro consists of two distinct areas which can be differentiated in terms of physiographic conditions such a topography, climate and also socio-economic development.

The highland covers 220,000 hectares including Mt. Kilimanjaro (5,895 meters) and Pare Mountain Range (with the highest peak of 2,462 meters) and most of the in-

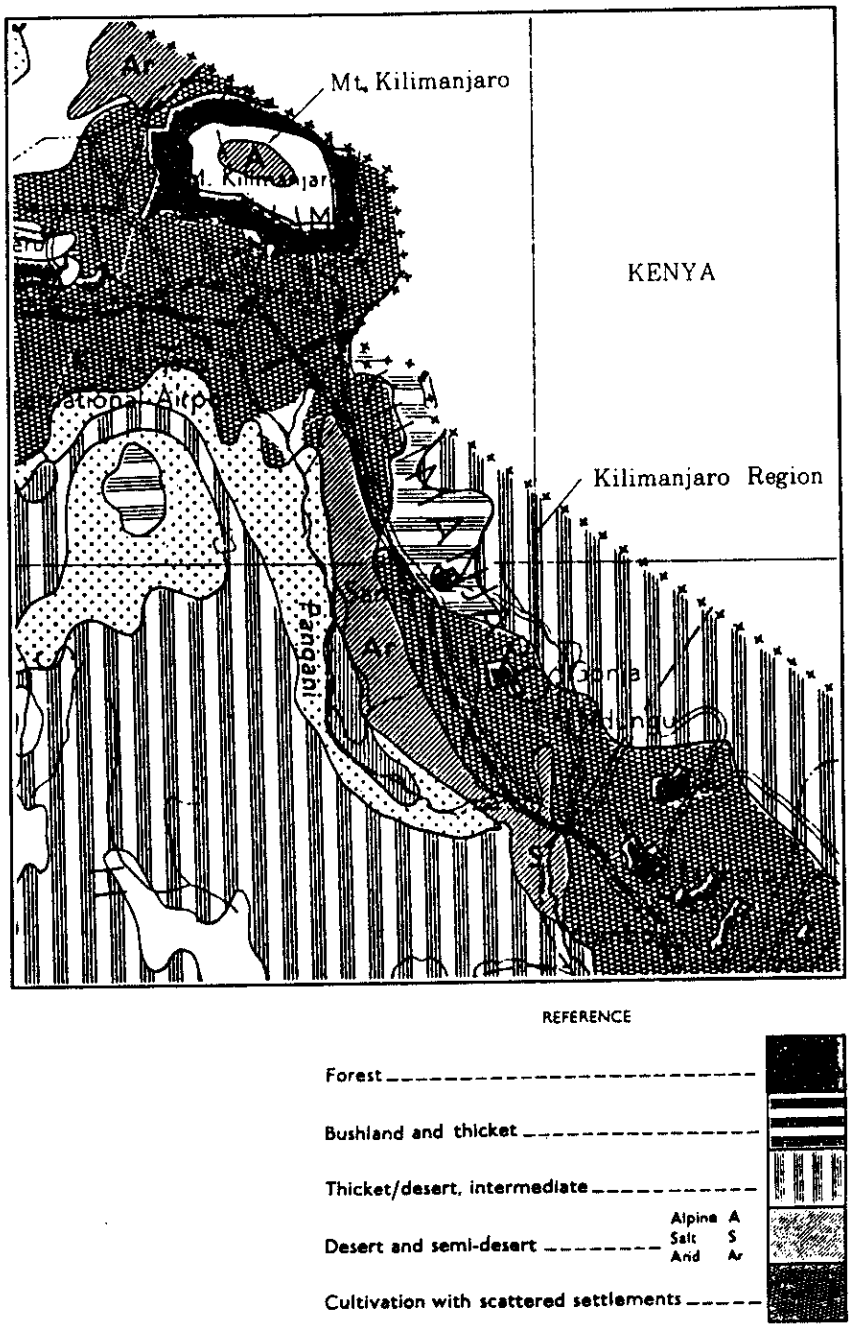


Fig. 3-5 Vegetation of Kilimanjaro Region
(Atlas of Tanzania 1976)

habitants reside at the zone with elevations of 1,000 to 1,800 meters. Thanks to plentiful rainfall and moderate temperature, most of this area except the Forest Reserves are cultivated. Most of the population in the region concentrates in the highland areas and the population density of the area exceeds 255 persons/km^2 in 1978.

Major agricultural products include coffee, bananas, beans, maize, eleusine, cassava, millet, vegetables and a variety of fruits. The highlands of Kilimanjaro Region are very famous for coffee production contributing almost half of the national coffee production. Traditionally, the highlands have for long been regarded as good for intensive agricultural farmlands with high productivity, however, for sometime now there has been a decline in farms-productivity which is becoming a serious agricultural problem today. It is estimated (1983) that about 120,000 hectares of farmlands have been rendered unproductive due to severe soil erosion.

On the other hand, the lowland area of 500 to 1,000 meters elevations extending over Arusha Chini Plain and the catchment areas of both the Pangani River and the Mkomadzi River is a semi-arid area including some places with annual rainfall below 400mm. The area is sparsely populated except the area along the trunk roads. And the census in 1978 shows that the area's population density is as small as 17 persons/km^2. Main cash crops grown in the lowlands include cotton, sunflowers, groundnuts, coconuts while food crops include maize, millet and paddy.

There exist a number of rather large-scale plantations of sisal, corn and other crops along the trunk roads and partly paddy fields are found in some places. But most of the lowland area is of savanna and is mainly utilized for extensive cattle grazing. It is reported that approximately 1,300,000 heads of cattle were kept in 1983.

Table 3-7 Land Use of Kilimanjaro Region

Item	Area(1,000ha)	Percentage(%)	Remarks
Grazing land	441	33	
National Park	305	23	
Cultivated Area	289	22	
Forest and Woodland	141	11	mostly covered by water conservation forests
Bushland and thicket area	115	9	
Rivers	30	2	
Total	1,321	100	

(Guideline for Compiling Regional and District Afforestation Plans in Tanzania 1985)

3.2.2 Forestry

Almost 95% of the total energy consumption and 98% of household energy consumption in Kilimanjaro Region are provided by fuelwood. Although electricity has been extensively distributed in the villages since 1983/84 with the aid of Japanese Government, most of it is used for lighting. In this case, therefore fuelwood will remain the most important source of energy for some decades in future.

The total fuelwood consumption in 1983 is estimated at 2,040,000 m^3, while the reasonable amount of possible maximum supply of fuelwood within Kilimanjaro Region is estimated at 620,000 m^3 in total, consisting of 510,000 m^3 from farm-residues and farm vicinities in the highland and 110,000 m^3 from savanna area in the lowlands. Therefore, the excess volume cut for fuelwood amounts to 1,420,000 m^3.

This excessive consumption of wood should be compensated by annual planting of 21,000,000 seedlings, but actually only 715,000 seedlings per year on an average have been planted.

Table 3-8 Past Records of Afforestation in Kilimanjaro Region

Year	1977/78	78/79	79/80	80/81	81/82	82/83	83/84	Total
Number of planted seedlings(thousands)	498	781	654	493	882	900	800	5,006

(Guideline for compiling Regional and District Afforestation Plans in Tanzania 1985)

The considerably low figure of actual planting activity (only 3% of the required number of seedlings to planted) is believed to have been caused by a small number of nurseries, lack of funds, and insufficiency of personnel and vehicles. Forest Division has set up the following annual seedling targets for each district within the region to promote afforestation.

Table 3-9 Annual Seedling Targets for Each District

District	Population(1983)	Average seedlings per individual	Total seedlings to be planted	Envisaged government support T.shs (millions)
Moshi	373,973	20	7.5	3.7
Hai	206,576	20	4.1	2.1
Rombo	189,100	20	3.8	1.9
Same	160,202	20	3.2	1.6
Mwanga	89,350	20	1.8	0.9
Total	1,019,201		20.4	10.2

(Guideline for Compiling Regional and District Afforestation Plans in Tanzania 1985)

3.2.3 Administrative Organization

Kilimanjaro Region is divided into five districts whereby the District Councils under the District Executive Directors execute the day to day development and implementation of projects within the Districts.

The Department of Natural Resources in the District sees to it that the development of forestry, beekeeping, fisheries and wildlife activities are conducted within the various respective ordinances at the District level on the day to day basis. The following chart will clearly show the organization concerning forestry. (See Fig. 3-6)

Kilimanjaro Region Development Directorate under the Regional Development Director, which is directly under the Central Government (Prime Minister's Office) has twelve Developmental Departments, Department of Natural Resources being one of them.

Ideally, the Regional Natural Resources Department in which forestry falls is charged with the administration and coordination of all the forestry activities in the region. All the foresters deployed throughout the region are charged with the administration of the Forest Ordinance Cap. 389 of 1957 and the implementation of the National Forest Policy. It is important to note that the duties of these foresters include management of local forest reserves, village forestry activities and collection and recording data concerning forestry, as different from those who manage the man-made forest plantations and water catchment forests, who are under the direct supervision of the Director of Forestry and Beekeeping.

Currently, the Regional Development Director's Office in Kilimanjaro Region in collaboration with the Director of Forestry and Beekeeping of the Ministry of Lands, Natural Resources and Tourism is contributing to the implementation of the national afforestation projects which are foreign aided such as "Intensifications of Village Afforestation in Kilimanjaro Region" financed by Sweden through FAO and "Wood for Rural Energy, Hai Afforestation Scheme" financed by the Government of Japan through FAO. Also is implementing agricultural and industrial projects namely Kilimanjaro Agricultural Development Centre (KADC) and Kilimanjaro Industrial Development Centre (KIDC) involved in paddy production in Lower Moshi and ceramics products in Same respectively.

Once the Same Expanded Afforestation Project is instituted, such a project will be implemented by the Kilimanjaro Regional Development Director under the auspices of KFDC or Kilimanjaro Forestry Development Centre Project. At the completion of the establishment of the Development Project, the training facilities within KFDC will be transferred to the management of the Village Forestry Unit under the Forestry and Beekeeping Department to be run in the same manner as Olmotonyi Forestry Training Institute and Forestry Industries Training Institute Moshi. Trial Forests that will be established under the project will be under the Forest Development and Management Section of the Forestry and Beekeeping Department.

Close relationship between the Forest Department, Regional and District Authorities will be greatly required for smooth implementation of the project.

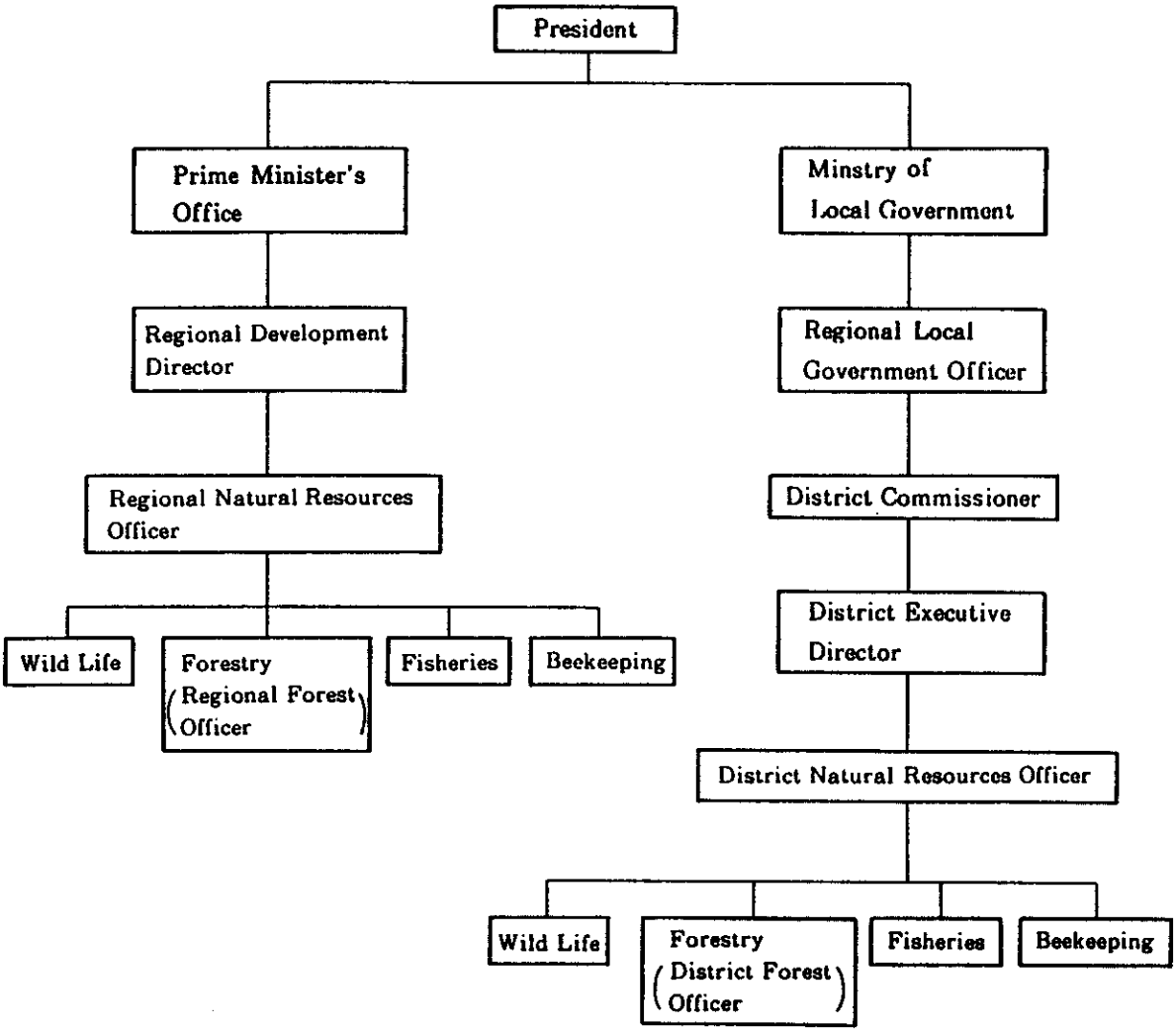


Fig. 3-6 District and Regional Forestry Administrative Organization in Tanzania

3.3 Outline of the Study Area

3.3.1 Outline of Same District

Same District, where the study area is located, is situated at the southernmost part of Kilimanjaro Region and covers 547,000 hectares. Pare Mountain Range, with the highest peak 2,462 meters above the sea-level, stretches from north to south in the central part of the district and the flat lands extend to the east and the west of the mountain range. The estimated population of the district is about 169,000 (in 1985) and 78% thereof is believed to reside in Pare Mountain Range. Therefore, the population density in the flat lands is considerably low. Same District is divided into 6 divisions, 24 wards and 65 villages administratively.

The District has the cultivated area of 43,000 hectares and about 10% thereof in the eastern part of the district is irrigated. Major cash crops include coffee, cotton, cardamon, sisal and sugarcane, while rice, maize, beans, bananas and fruits are grown

as subsistence crops. The deterioration of land productivity due to soil erosion has been observed also in this district and 50,000 hectares of eroded farmland are reported.

About 90% of the lowlands is utilized for grazing and the census in 1984 indicates that there are 112,737 of cattle, 79,319 of goats, 45,920 of sheep, 3,518 of donkeys, and 611 of pigs making 242,105 heads in total as well as 123,237 of chicken and ducks.

3.3.2 Outline of the Study Area

(1) Location

The study area is located at the central part of Same District and covers around 200,000 hectares with about 55 km length from north to south and about 40 km width east to west. Although the study area covers only one-third of the district, it includes Same Town, the center of the district, the mountainous areas and most of the district population is understood to reside in the study area.

A railway and a national highway extend side by side, from north to south across the central part of the study area, and the mountainous area to the east of the railway and the highway and the flat area to the west make a conspicuous contrast in topography.

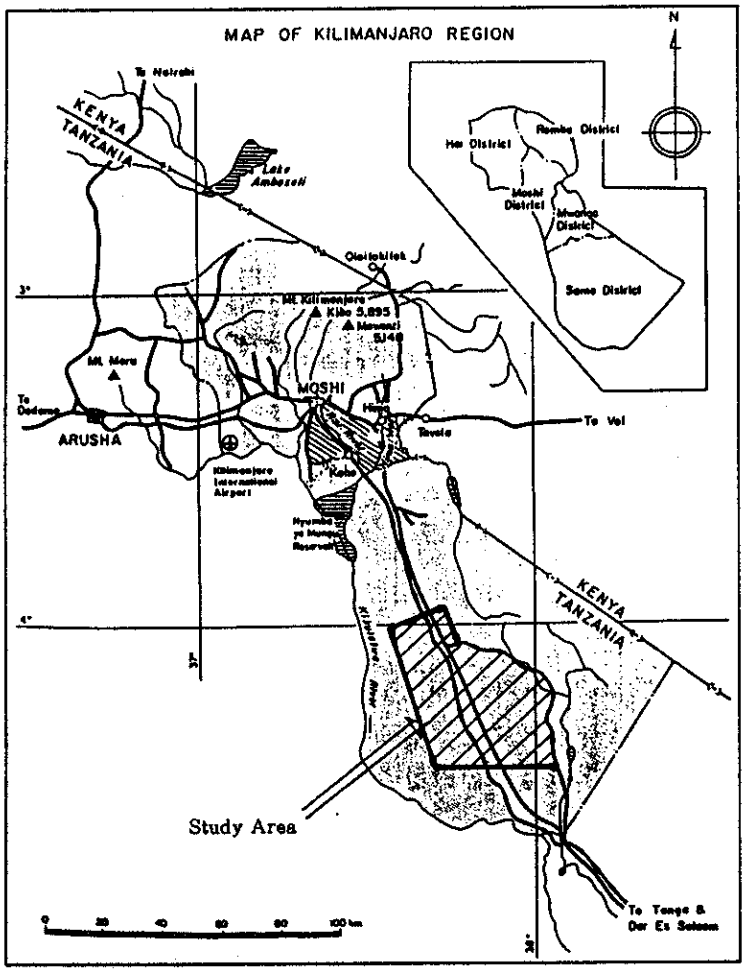


Fig. 3-7 Location of the Study Area

(2) Topographical and geological features

In the mountainous area in the east, Central Pare Mountain Range extending form north falls to the valley bottom at Same Town with elevation of 900 meters and South Pare Mountain Range immediately rises to form the chain of mountains of 2,000 meters level in the direction to south. The highest peak of the area is Mt. Shengena with elevation of 2,462 meters. There extend Kenya Steppe with an average elevation of about 600 meters to the east of the mountain range and Masai Steppe with an average elevation of about 800 meters to the west of the mountain range. Since the distance between the two steppes counts only 25 kilometers at maximum for about 2,000 meters difference between the ridge and the steppes in elevation, the mountainous area shall be recognized as being greatly steep in general.

Three rows of fault are observed in the mountainous area. The area consists of Pre-Cambrian metamorphic rocks. Since the eastern boundary of the study area is the old national highway running along the foot of Pare mountain range, only small part of Kenya Steppe is included in the study area.

On the other hand, the western half of the study area is occupied by Masai Steppe extending to the west of the mountainous area. Masai Steppe has the elevation of about 1,000 meters in the north and about 600 meters in the south, and then it is slightly inclined to the south, but can be said to be almost flat. Masai Steppe is a quite extensive plain with length of about 200 kilometers both from north to south and from east to west. Isolated monadnocks are found sporadically in the steppe and monadnocks of Kitamri, Kishaa and Makei are included in the study area. This area consists of Cenozoic limestone.

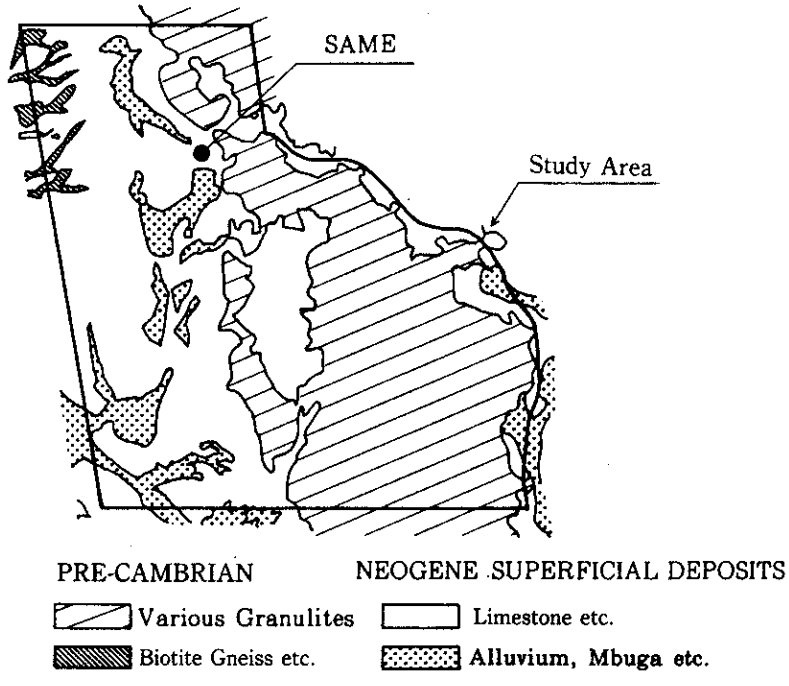


Fig. 3-8 Geological Map
(Kilimanjaro Region Integrated Development Plan 1977)

(3) Climate

① Temperature

The observed temperature data at Same are shown in Table 3-10.

Table 3-10 Temperature Data (1957-70), Same District

Month	Means			Extremes	
	Max.	Min.	Ranges	Highest	Lowest
	℃	℃	℃	℃	℃
1	31.5	19.2	12.3	36.6	16.4
2	32.2	19.2	13.0	37.8	16.4
3	31.6	19.5	12.1	35.5	16.0
4	29.3	19.0	10.3	34.1	16.4
5	26.9	17.5	9.4	32.4	13.6
6	26.4	15.8	10.6	30.5	11.6
7	25.8	15.1	10.7	30.0	10.8
8	26.7	14.9	11.8	31.2	11.2
9	28.5	15.6	12.9	33.2	10.1
10	30.0	17.1	12.9	34.4	13.0
11	30.6	18.5	12.1	35.4	13.9
12	30.5	19.2	11.3	35.1	14.0
Mean	29.2	17.5	11.7	37.8	10.1

Although the study area situated at around 4° of south latitude, belongs to the tropical zone, owing to the elevation (more than 900 meters above the sea-level even at Same Town) the temperature is generally lower and the range of the daily temperature fluctuation is larger than the coastal area. The data of temperature observed in the mountainous areas were not available, but it should be understood that the night time temperatures in the mountainous area stand considerably low.

② Precipitaion

The data of precipitation observed at Same and Makanya are shown in Table 3-11 and Table 3-12. It should be noted that the annual rainfall is generally small and the variation is quite large in annual and monthly rainfall from year to year. This fact should be taken into consideration in case of planting in the plains.

An unusually small rainfall was observed in 1987. This fact shall be well recognized and noted for planting programs to be implemented in the plain areas. Under the Hai afforestation project of FAO, 1,600,000 seedlings were planned to be planted in November 1987, but the seedlings are not planted yet as of February 1988 and grow to become epinasty seedlings at nurseries.

Table 3-11 Rainfall Data (1980-1986), Same

(mm)

Month / Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1980	9.3	17.6	59.6	114.7	37.3	—	1.9	37.1	3.6	13.0	66.5	31.5	392.1
1981	24.4	1.5	183.3	148.2	91.3	—	—	10.4	7.7	98.0	22.3	79.6	666.7
1982	30.6	—	3.7	48.6	48.9	156.4	29.0	24.0	11.1	34.2	137.5	230.0	754.0
1983	1.5	105.7	55.6	39.2	101.4	15.4	—	—	1.7	2.7	20.8	175.1	519.1
1984	30.0	1.2	81.3	162.8	30.2	30.5	8.9	—	6.2	41.8	51.1	24.8	468.8
1985	1.9	112.3	19.7	16.7	81.6	4.2	6.9	1.5	1.0	50.7	36.7	44.4	375.7
1986	128.7	0.0	19.4	102.4	115.3	18.9	0.0	1.1	0.0	5.5	73.7	116.9	581.9
Mean	32.3	34.0	60.3	90.3	72.2	32.2	6.6	10.5	4.4	35.1	58.3	100.0	536.9

Table 3-12 Rainfall Data (1983-1986), Makanya

(mm)

Month / Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1983	—	50.0	68.5	16.0	36.3	7.0	—	—	—	—	35.0	115.0	327.8
1984	11.0	4.0	18.0	105.5	8.0	11.0	—	—	—	22.4	61.0	98.0	338.9
1985	11.0	97.0	6.0	12.0	36.0	—	10.0	—	—	18.0	46.0	7.2	243.2
1986	139.0	—	21.6	25.0	51.3	12.0	—	—	—	71.6	72.0	59.2	451.7
Mean	40.3	37.8	28.5	39.6	32.9	7.5	2.5	—	—	28.0	53.5	69.9	340.4

Although the observed precipitation data in the mountainous areas were not available, rainfall distribution is estimated on the basis of elevations as shown in the following rainfall map of the study area.

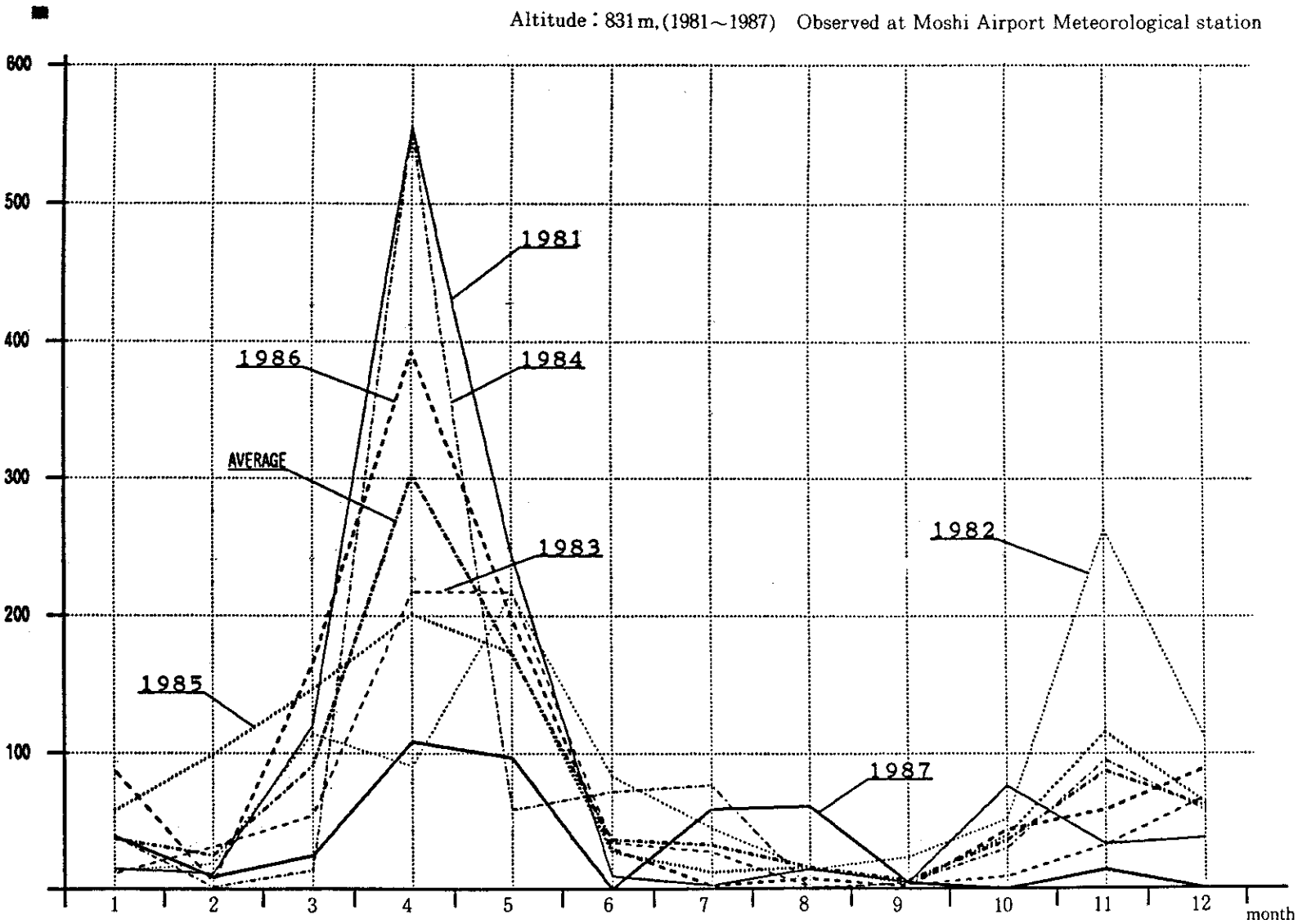


Fig. 3-9 Monthly Rainfall

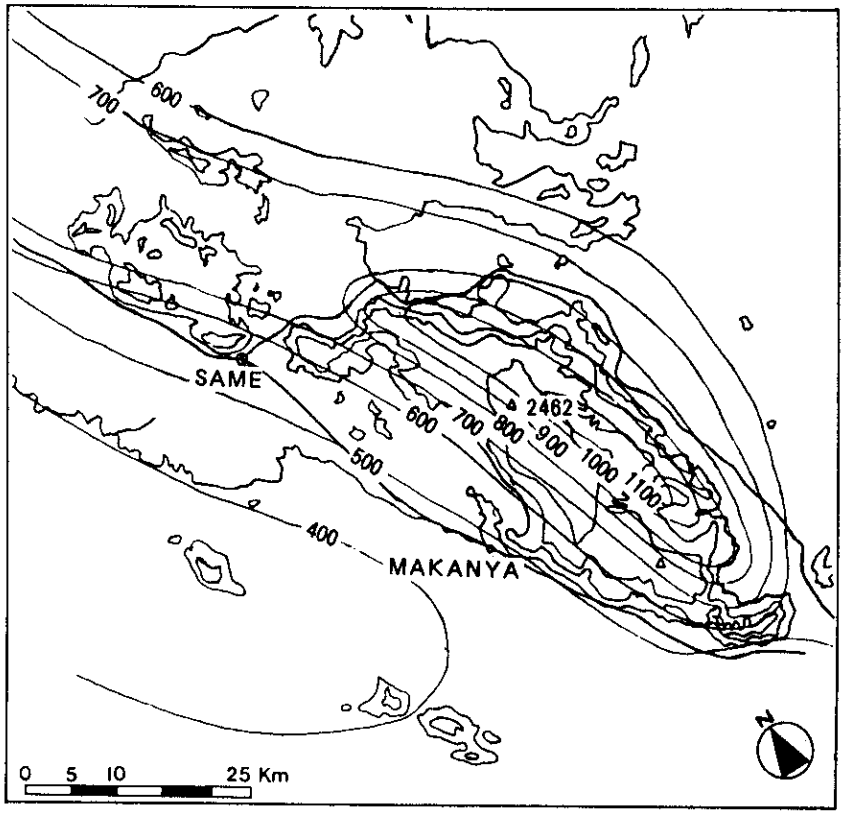


Fig. 3-10 Annual Rainfall Map
(Kilimanjaro Regional Integrated Development Plan 1977)

The eastern slopes of Pare Mountain Range receive plenty of rainfall as shown in the figure when easterly winds and southerly winds, the area's prevailing winds in summer and winter respectively, hit against the mountain range, while at the western slope, the winds crossing over the mountain range cause a foehn phenomenon and make the slope rather dry with small rainfall. Further westward, the more interior in Masai steppe, the more severe the dryness becomes. The average annual precipitation of 240 to 450 mm at Makanya is understood to be near the lowest limit for planting.

③ Wind direction and wind speed

The wind direction and wind speed observed at Same are as follows:

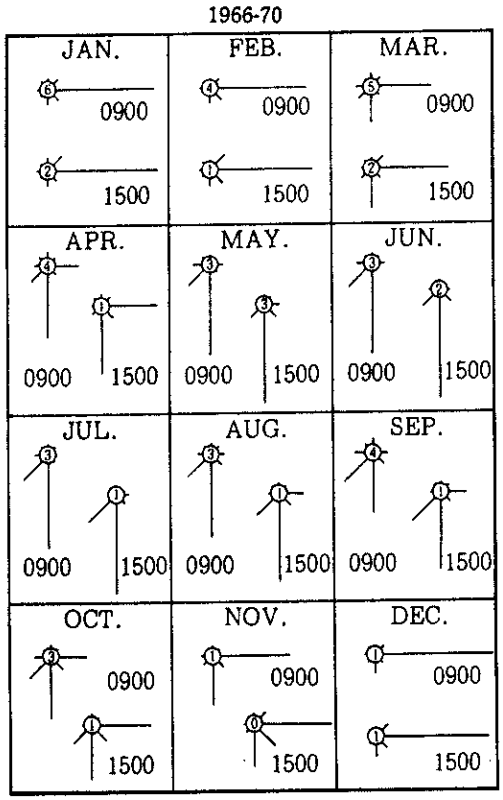


Fig. 3-11 Wind Direction, Same District

Table 3-13 Wind Speed, Same District

Month	Wind speed (1957–70)	
	9 : 00 A.M.	3 : 00 P.M.
	knot per sec.	knot per sec.
Jan.	7	9
Feb.	5	9
Mar.	4	7
Apr.	3	5
May.	3	5
Jun.	3	6
Jul.	3	7
Aug.	3	7
Sept.	3	7
Oct.	4	7
Nov.	6	8
Dec.	8	10
Ave.	4	7

As Same stands directly against the wind passing through the valley between Central Pare Mountain Range and South Pare Mountain Range, it is a particular place where strong winds blow usually. The field survey conducted in January and February in both 1987 and 1988 revealed that the wind speed at night went up considerably to indicate that effective measures to counter strong winds at the time of planting should be carefully elaborated.

(4) Land use

Forests, woodlands and savannas cover about 160,000 hectares, or 77% of the area. Most of the forests and woodlands except Forest Reserves are used for grazing.

In the highlands and the piedmonts, crop fields cover approximately 39,000 hectares or 19% of the area, and sisal estates cover 3,000 hectares or 2% of the area. In addition, there exists some small area of paddy fields and palm plantations.

On the other hand, Forest Reserves in the study area are located at Chome, Chambogo, Kwizu, Vumari and some other places covering approximately 26,000 hectares or 13% of the total area. Moreover, Mkomazi Game Reserve of 1,500 hectares and Ruvu River Game Controlled Area of about 81,000 hectares are designated by the Government as controlled areas. Therefore, the rest of land area, where any legal control is not applied, occupies 48% of the total area.

A schematic presentation of the land use of the area from east to west is shown in the following figure:

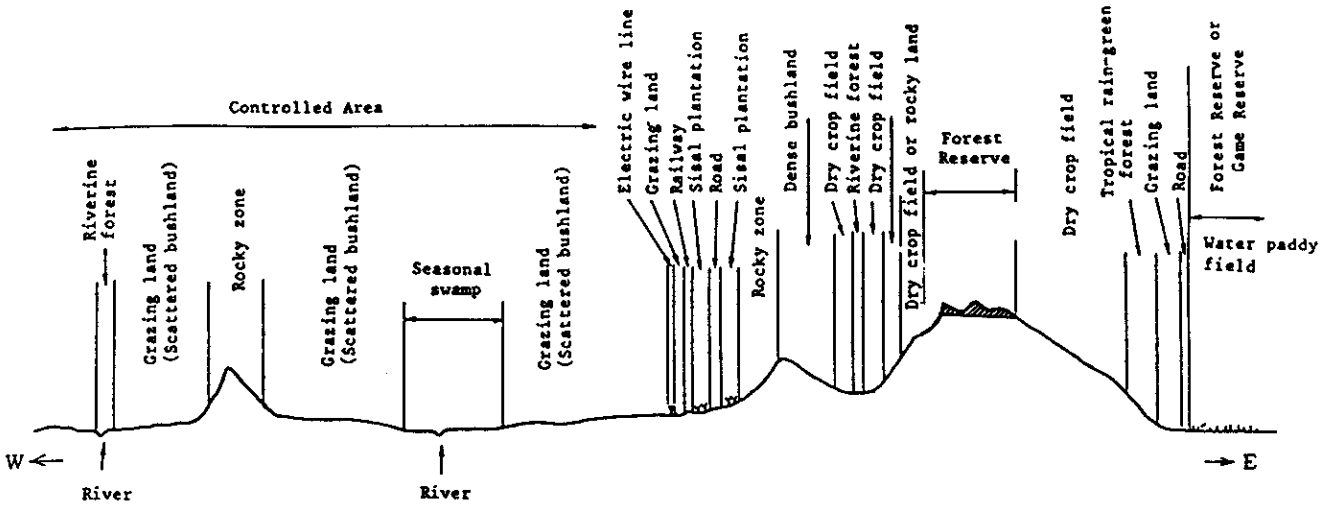


Fig. 3-12 Typical Schematic Section of Land Use

(5) Vegetation

The vegetation of the study area can be classified as hereunder according to Schmidt- Husen's classification:

a. Eastern lowland ··· Wet-dry savanna

In the vast grassland of eastern lowland, wet "High grass-low tree savanna" and dry "Acacia-high gramineous plant savanna" are mixed in proportion to the topography.

b. Lowland at the eastern piedmont of highland--Tropical evergreen lowland-rain forest

Mainly utilized for paddy field and palm plantation, the Gonja Forest Reserve still retains its natural vegetation.

c. Piedmont and hilly areas--Tropical deciduous dry forest (tropical rain-green forest)

The seasonal variation of humidity is quite large, and high and middle trees which shed leaves in dry season and semi-deciduous low trees are mixed. Succulent are scattered in the rocky area.

d. Highland (mountainous area)--Tropical evergreen mountain forest (Alpine rain forest)

Although most of the highland is cultivated, natural vegetation is still conserved in the forest reserves maintained at the mountaintop areas. The climate in the Forest Reserves is highly humid and many kinds of tree species and lianas species are observed therein.

e. Lowlands and the western foot of the highlands--Thornbush savanna

Dry savanna with thornbushes, stem succulents, low grasses and herbs extend from the foot of western slopes to the lowland.

f. Western swampy lowlands--Seasonally waterlogged savanna

This area extends north to south in belt-like form along the river. In the

rainy season these areas are waterlogged and changed in dry season to low grassland with scattered low shrubs. Southwards it can be seen drier conditions and appear the saline soils.

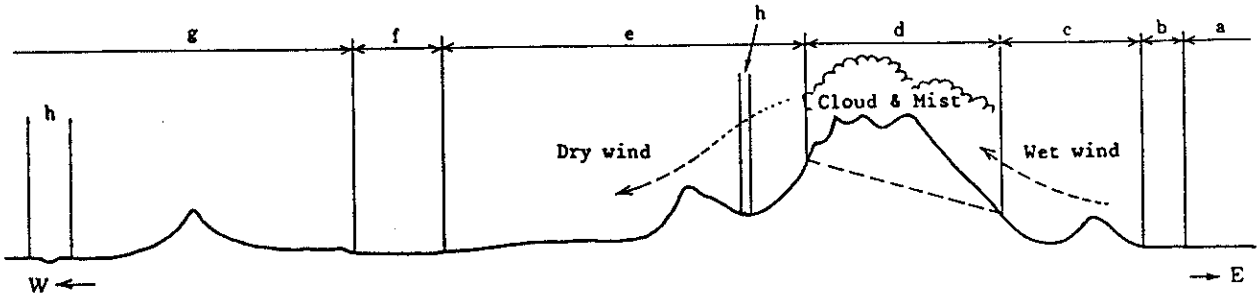
g. Western low hills and monadnock (Inserberg)··Thornbush savanna and rocky savanna

The western lowlands become drier toward the west. In the gently-sloped hills with some rocky monadnock, thornbush savanna prevails but the bush density of this vegetation becomes less. Stem succulents grow densely on monadnock rock.

h. Riverbanks···Riverine forests

Along the rivers which keep their waterflow almost throughout the year, deciduous or semi-deciduous medium-high forests are distributed in belt-like forms.

The vegetation distribution as above can be shown schematically as follows: In the figure, the marks; a～h mean those vegetation types.



(Note) a-h: Vegetation cover types (agree with the foregoing symbols)

Fig. 3-13 Typical Schematic Section of the Vegetation and Forest Types

The largest part (51%) of the study area is covered by thornbush savanna followed by tropical deciduous dry forest (23%), tropical evergreen mountain forest (10%), mountainous grassland with heath (a variation of tropical evergreen mountain forest) (7%), seasonally waterlogged savanna (6%), wet-dry savanna (2%) and secondary growth, afforested area and rocky zone (1%).

(6) Forestry

The fuelwood supply and demand in Same District is also very strained as any other districts in this country. 3,200,000 seedlings shall be annually planted to satisfy the district's demand for fuelwood. But actual number of seedlings planted as shown in the following table has been far below such requirements.

Table 3-14 Actual Number of Seedlings Planted

(In thousand seedlings)

Year	1979/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	Mean
Number of Seedlings	50	64	110	91	104	100	100	84	(Planned) 150	95

Nursery facilities located at Gonja Maore, Suji and Mwenbe, but all of these three facilities are small-sized. Seeds are collected in the forests near these facilities and some portion of seeds are supplied by Silvicultural Research Station at Lushoto.

The district's administrative organization for forestry is as follows:

District Natural Resources Officer	Same	1
District Forest Officer	〃	1
Assistant 〃 〃	〃	1
〃 〃 〃	Suji	1
	Hedaru	1
	Mwembe	1
Forest Assistant	Mamba Myamba	1
	Vunta	1
Forest Attendant	Kwizu Forest Reserve	1
	Suji	2
	Bwambo	1
	Gonja Maore	3
	Mwembe	3
	Kisiwani	1

Fig. 3-14 Forestry Administrative Organization in Same District

(7) Administrative organization of village and ownership system of land

Each village has its village Chairman and a village Secretary elected among the village inhabitants, and at some villages a village manager is stationed for coordination of development programs. Among most of the villages, planning of village development programs and management thereof are undertaken by the political committee, security committee, agricultural committee, planning and economical committee and financial and commercial committee of the village respectively. Any development program shall be discussed and approved at the General Assembly of the village. Each committee consists of six members including the committee Chairman and Secretary.

All of the land in Tanzania is publicly owned and managed by Ministry of Lands, Natural Resources and Tourism. But, in this area, there exists a particular kind of land called KISAKA or KIHAMBA, "the land continuously cultivated exclusively by a family under the custom of Pare tribe" which is even now, legally inheritted by a male/males of the family. This right of inheritance is stipulated under the Customary Land Tribunal Rule No. 47 of 1968, and any dispute on such a land shall be dealt with at the District Land Tribunal Court consisting of six members including the Chairman and the Deputy Chairman. It shall be noted that the sale of land is strictly prohibited, but any property thereon including farm crops, wood and buildings may be transferred to a third party by sale.

Grazing land is a common property of community for its common use.

Pare tribe has an traditional understanding that cooperative and communal ventures are essential for community life, and Monday is designated as Day of Msaragambo, when all males and females above 18 years old and less than 50 years old participate in the community's common work.

Under this common working system, building and repairing of roads, schools, churches, clinics and even houses are carried out as well as attendance to sick persons, and funeral services. It is noteworthy that grazing and farm works are also included in the community's common ventures, but planting of tree seedlings has rarely been counted as one of Msaragambo's items, presumably because ① the first priority has been given to agriculture rather than forestry, ② people have usually desired to plant tree seedlings within their own Kisaka and ③ land for planting has not been available.

But, it is expected that cooperative planting of tree seedlings under Msaragambo will be certainly realized when distribution of seedlings, facilities for transportation and funds for planting will be supported by the Government.

At schools, remarkable progress has been made recently in afforestation through pupils' participation in collection, planting and tending of seedlings under teachers' instructions.

4. Basic Surveys

4.1 Aerial Photography and Preparation of Basic Maps

4.1.1 Aerial Photography

(1) Flight planning

Considering the geographical conditions of the study area that is rather flat in the western part and is hilly and mountainous, with large relative height differences, in the eastern part the flight runs were planned to north-south direction. This produced overlap of 60% for the flat area and 80% for the mountainous area.

Flight altitudes were also varied based on three steps which are the heights of the flat area, mid-slope and top of the mountains.

The major technical specifications are as follows:

— Photographic Area:	200,000 ha.	
— Photographic Scale:	1/20,000	
— Flight Run;	17 runs in total	
— Flight Height:	Falt area,	11,500 ft.
	Mid slope of mountains,	13,500 ft.
	Top of mountains,	15,200 ft.
— Overlap:	Flat area,	60%
	Mountainous area,	80%
— Aerial Camera:	f = 151.88 mm	

(2) Photo shooting

The airplane which was used for aerial photography was based at Arusha airport. From there it flew along runs (courses) 1 to 17, and in the process a total of 754 sheets of photographs were taken.

(3) Photo Inspection

Upon the completion of photography overlap, sidelap, scale, and appearance of cloud were checked on proof print of each photograph.

(4) Preparation of Contact Prints and Enlargements

After photo shooting, contact prints and two times enlarged photographs were prepared.

(5) Preparation of Photo Index Map

After checking the results of aerial photography, photo index map was prepared by showing principal points of contact prints as shown on Fig. 4.1

Table 4-1 List of Contact Prints

Run No.	Quantity	Run No.	Quantity
C 1	53	C 10 A	19
C 2	45	C 10 B	40
C 3	55	C 11	41
C 4	53	C 11 A	26
C 5	54	C 12	35
C 6	53	C 13	33
C 7	47	C 14	39
C 8 A	15	C 15	29
C 8 B	39	C 16	20
C 9 A	16	C 17	5
C 9 B	37	Total	754

4.1.2 Control Point Survey

(1) Horizontal control points survey

In order to meet with the accuracy required for aerial triangulation, ten horizontal control points were planned to be newly established because of the insufficient number of existing control points to be used within the study area. (See Fig. 4-1)

① Reconnaissance & Point selection

Existing control points were reconnaissanced and new control points were selected based on the work plan.

Twelve new control points were finally established by traversing and triangulation survey methods.

② Pre-signalization

Aerial signals were established for the following points prior to the commencement of aerial photography:

— Existing control point: 6 points

— New control point: 12 points

③ Observation & Computation

Two times of traversing, three times of triangulation observation and two times of distance measuring were carried out to avoid careless mistakes of the observation. The checking calculation at the job site found that existing control points of 89×1 and 73×1 had the closing error of more than 6 m. Accordingly these points were newly observed. Final calculations was carried out in Japan by using a computer.

(2) Levelling

Levelling survey was conducted for a total of 310.6 km. Three national bench marks of A26/3, A26/25 and A26/37 were used and pricking was carried out at each 300 m interval. (See Fig. 4—1)

(3) Other field surveys (Field Verification)

Names of wards, villages, settlements, rivers, mountains, etc. and locations of schools, churches, etc. necessary for mapping were confirmed by field inspection.

4.1.3 Preparation of Basic Maps (Topographic Map)

(1) Aerial triangulation

① Outline of aerial triangulation

Using pricked diapositives of 1: 20,000 aerial photographs on which aerial signals were photographed, coordinates of pass points, control points, etc. necessary for stereo plotting are measured by stereo-comparator.

Adding the results of ground control point survey, adjustment computation was executed.

Coordinates of pass points and orientation elements of aerial photographs were calculated.

Aerial triangulation was done analytically by the block adjustment method by means of independent models.

584 models of aerial triangulation work was carried out, and the quantity of models for each flight run was as follows:

Table 4-2 The Quantity of Models for Each Flight Run

Course	Models	Course	Models
C 1	43	C10A	11
C 2	37	C11B	35
C 3	42	C 11	28
C 4	39	C11A	24
C 5	41	C 12	28
C 6	42	C 13	27
C 7	36	C 14	28
C 8 A	12	C 15	24
C 8 B	29	C 16	11
C 9 A	11	C 17	4
C 9 B	32	Total	584

② Equipment used

Pricking Device ; PUG4 (WILD)

Stereo Comparator ; Stecometer (ZEISS JENA)

Computer ; FACOM—M340 (FUJITSU)

③ Adjustment computation and precision

PAT—M43 program was used for block adjustment computation. Residuals of ground control points used for transformation from model coordinates to geo-

detic coordinates were planned to be less than 0.8 per mil of the flight height for both planimetry and altitude, and the maximum error to be less than 1.6 per mil of the flight height.

The precision was as given below:

Table 4-3 The Precision of Land Survey

Number of models	Control Points		Residuals (Horizontal)		Residuals (Vertical)	
	Horizontal	Vertical	Standard deviation	Maximum error	Standard deviation	Maximum error
models	pts.	pts.	m	m	m	m
584	29	157	0.84	2.14	0.15	0.15

(2) Stereo plotting

① Outline of stereo plotting

Using the results of aerial triangulation and field verification, necessary items for representing on the map were measured and plotted by stereo plotting machine, and plotted manuscript of the topographic map was prepared for study area. Work specifications and equipments used are as follows.

- Work specifications

  Plotting Scale ; 1/20,000

  Plotting Area ; 200,000 ha.

  Contour Interval ; Intermediate contour-10 m
  Index contour-50 m
  (half interval contour lines of 5 m were supplemented according to topography.)

  Projection ; UTM

  Number of Sheets ; 11 sheets

- Equipment used

  Plotter; Autograph A8 (WILD)
  Metrograph (ZEISS)

(3) Compilation.

Compilation work was carried out based on the prepared plotted manuscript.

- Detailed compilation

On the basis of the plotted manuscript, compilation was carried out using the results of field verification and ground control data. The work was executed as follows:

a. Both planimetric features and contour lines were compiled on the same sheets using overlay compilation method.

b. Stable synthesized polyester sheets (#500) were used.

c. Generalization on villages was carried out in conformity with map symbols.

d. Buildings were sketched according to topography.

○ Inspection

Correlation with field verification data, between contour lines and spot heights, and conformity to specifications of map symbols were inspected.

Doubtful points arising during compilation were noted on compiled sheets in order to clarify at the time of field compilation.

(4) Field compilation

① outline

Field compilation work was carried out in order to prepare original manuscript by checking and filling up the compiled manuscript in the field.

In field compilation, important items to be represented on the maptopography, ground features and place names and doubtful points arisen in compilation, and administrative boundaries, legal boundaries (forest reserves and game reserves) was clarified in the field.

Also, since this field compilation work was to be the last opportunity for discussing the matters related to basic maps with Tanzanian counterparts, the final discussion on map legends and marginal information were conducted and confirmation thereof was made.

② Preparatory work

The following preparatory office work was carried out.

a. Reproduction of compiled manuscript for field compilation work,

b. Listing items and places to be identified in the field,

c. Filing other materials to be brought for use in the field.

③ Field compilation

a. Checking, identification and correction of manuscript

Checking of the compiled manuscript was made in the field. The results not only were recorded in field notebooks, but identified and corrected items were put on blue copies of compiled manuscript.

b. Consultation with Tanzanian counterpart

With regard to drafting of basic maps scheduled after field compilation work, marginal information had been prepared and sent in advance to Tanzanian counterpart's office.

The marginal information was approved and the contents of topographic map was also confirmed during this work by the counterpart.

④ Adjustment

Results of field compilation were adjusted on compiled manuscript and annotation maps.

Upon compilation of these adjustment work, original manuscript of 1 : 20,000 topographic maps was completed.

(5) Drafting

Using original manuscript, basic maps at a scale of 1 : 20,000 were prepared in conformity with specifications of map symbols by fair final drafting methods.

After inspection, duplicate maps and blue copies of each basic map were prepared on a polyester base (#500).

(6) Mosaic photomap

On the basis of aerial triangulation results, correcting the scale and inclination of photographs by rectifying instruments, aerial photographs at a controlled scale of 1 : 20,000 were prepared.

Posting controlled photographs onto sheets where pass points had been plotted, while correcting prominent planimetric features of photographs—roads and cultivated land boundaries—so as not to give rise to remarkable discontinuity of photographic images, color tones and unevenness, original photomaps were prepared.

The original photomaps were cut in line with neat line of topographic maps, and having been printed with marginal information, two sets of mosaic photomaps of scale 1 : 20,000 were prepared.

4.2 Vegetation and Forest Type Survey

4.2.1 Survey Methods

This vegetation and forest type survey was conducted for the purpose of acquiring a grasp of the existing condition of vegetation and forest types in the survey area and obtaining basic information necessary for studying the ideal way of social forestry in the area and the direction of forest management in semi-arid area. Broadly speaking, the contents of survey consist of collection of information on vegetation and forest types, basic field survey, preparation of vegetation and forest type maps, and a full-scale field survey. The survey methods and results are described below.

(1) Basic field survey

① Field reconnaissance

In order to grasp the outline of conditions of vegetation and forest types in the study area, field reconnaissance was conducted along the major roads.

② Preliminary photo interpretation

Through preliminary interpretation of aerial photographs (on the scale of 1 : 20,000) which were taken this time, 16 representative plots were sampled from the entire study area based on crown diameter, crown density and color tone of vegetation, in order to establish the plans for plot survey and field observation which are described later.

③ Plot survey and observation

Vegetation profile diagram (vertical-structure) and special distribution detail map (structure of 8 m × 50 m) were prepared for 10 plots horizontal of the 16 sam-

pled plots. The timber cruise has been done in two plots of 50 m × 25 m at two locations, namely the test plot and the high forest. On the other (six) plots, tree species were checked. The locations of these approximate survey plots are as shown on Fig. 4-2 (shown along with the locations of plots of the full-scale field survey which is described later).

(2) Preparation of vegetation and forest type maps

① Vegetation and forest type classification criteria

The vegetation and forest type maps of this area were prepared from the results of preliminary field survey and preliminary interpretation of aerial photographs. The available criteria of vegetation and forest type classification for the planned social forestry and forest management of semi-arid area has been decided as shown in Table 3-3-1 and also the legend of vegetation and forest type were decided.

② Photo-interpretation

By stereoscopy of 754 aerial photographs of a scale of 1 : 20,000 pictured during 1987 (January-February), photo-interpretation and demarcation were performed in accordance with the aforementioned vegetation and forest type classification criteria.

③ Preparation of skeleton maps of vegetation and forest type

The vegetation and forest type skeleton maps on the scale of 1 : 20,000 to be used for planning of full-scale plots of the main field survey to be described later and for the full-scale field survey during itself were prepared by transcribing the vegetation and forest type classifications and their symbols shown on the photographs onto original drawings of basic maps and coloring each of the classified vegetation and forest cover types in different colors.

④ Field check of distribution of vegetation and forest type

The demarcation lines and map legends on the vegetation and forest type skeleton maps were checked by the main vegetation and forest type survey results and modified in part (such as secondary growths and mountainous grasslands).

⑤ Final execution of vegetation and forest type maps

Based on the checking skeleton map, the final vegetation and forest type map on the scale 1 : 20,000 were prepared by tracing on the duplicate (polyester base) of base maps.

(3) Full-scale field survey

① Sampling design

The sample test plots for vegetation and forest type survey were set up as per Table 4-5 and Fig. 4-2 with due regard to the distribution status of each classified vegetation and forest type, contents of survey and required time, survey period, local road conditions and other.

Table 4-4 Vegetation and Forest Type Classification

I	II	III	IV	Symbol	Remarks
Tropical evergreen forest (Wet-high forest)	Lowland forest			E_f	Consists mainly of the Gonja Maore Forest Reserve.
	Mountain forest (Alpine forest)			E_m	Consists of forest reserves located at the top and ridge areas of mountainous areas.
	Riverine forest & gallery forest			E_r	Remnant forest along streams in mountainous districts, sized 20 m in width and 500 m in length or more.
Tropical deciduous dry forest (Tropical raingreen forest)	Middle-height forest	Dense forest		Dd (h_1)	Tree height 10 m or more, density 70% or more.
		Scattered forest		Dd (h_2)	Tree height 10 m or more, density under 70%
	Low forest and bush	Dense forest		Dd (ℓ_1)	Tree height under 10 m, density 70% or more.
		Middle density forest		Dd (ℓ_2)	Tree height under 10 m, density from 40% through 69%.
		Scattered forest		Dd (ℓ_3)	Tree height under 10 m, density from 10% through 39%
	Riverine forest & gallery forest			Dd (r)	Sized 20 m in width and 500 m in length or more.
Tropical savanna (Tropical steppe)	Wet-dry savanna	High-stem grassland	Wooded grassland	Sd (g_1)	Dry grassland dotted with woods with tree height 5 m or more.
			Swampy grassland	Sd (g_2)	Wet grassland and marshland with rare occurrence of aforementioned woods.
		Riverine forest & Gallery forest		Sd (r)	Sized 20 m in width and 500 m in length or more.
	Thornbush savanna (Thornbush steppe)	Dense thornbush savanna (Density 70% or more)	Dense bush and shrub	St (d_1)	Dotted distribution of dense bush and shrub formations.
			Dense thicket	St (d_2)	Densely covered with shrubs and fleshy plants (in thickets).
		Middle density thornbush savanna (Density 40% through 69%)	As dots	St (m_1)	Shrubs distributed in dots.
			As groups	St (m_2)	Shrubs and fleshy vegetation distributed in lumps.
		Scattered thornbush savanna (Density 10% through 39%)	As dots	St (S_1)	
			As groups	ST (S_2)	
		Dry grassland		St (g)	Shrubs with density under 10%.
		Rocky Savanna		St (r)	
	Seasonally water-logged savanna			Sw	Savanna flooded after the rain and scattered with shrubs in the dry season.
Forest plantation				Fp	Man-made forest, nursery.
Secondary growth				Sg	Bushland with tree height 5 m or more on felled and burnt blanks, consisting mainly of Em.
Mountainous grassland				Mg	Grassland and bushland on felled and burnt blanks, consisting mainly of Em and Dd (Tree height under 5 m).
Rocky zone				Rc	

Table 4-5 Number of Plots for Vegetation and Forest Type Survey

Symbol	Number of plots	Symbol	Number of plots	Symbol	Number of plots
El	1	$Sd(g_1)$	1	St(g)	1
Em	2	$Sd(g_2)$	1	St(r)	1
Er	1	Sd(r)	1	Sw	1
$Dd(h_1)$	2	$St(d_1)$	3	Fp	4
$Dd(h_2)$	1	$St(d_2)$	3	Sg	—
$Dd(\ell_1)$	2	$St(m_1)$	3	Mg	2
$Dd(\ell_2)$	2	$St(m_2)$	3	Rc	—
$Dd(\ell_3)$	2	$St(s_1)$	2		
Dd(r)	2	$St(s_2)$	3	Total	43

② Contents and methods of survey

As for the contents and methods of field survey, the following plan was developed and implemented based on the results of the basic field survey, the purpose being to provide information and data necessary for contemplating social forestry and forest management of semi-arid areas.

a. Site conditions of survey plots

Location, elevation, land form, aspect, inclination and soil.

b. Vegetation research in the field

- o Species quantities in each stratum, judgement of dominant species.
- o Judgement of mean tree height, mean d.b.h., values of cover and abundance of each species by strata.
- o Observation of the survey plot's history of utilization, etc.

The community strata were defined in four layers such as, high tree layer (T1), subordinate tree layer (T2), shrub layer (S), and herb layer (H). The species names of plants were checked by Latin names, and their local names were obtained from the local inhabitants as far as possible.

c. Preparation of diagrams of vegetation profiles and plans of vegetation structure.

Diagrams of vegetation profiles and planes of vegetation structure were prepared particularly for representative types of tropical deciduous dry forest and tropical savanna distributed widely in this area in order to be able to grasp the differences in community formation of each types at a glance. The sizes of the plots were prepared in 8 m × 50 m, in the case of dense forest and steep slope the plots were prepared in 8 m × 25 m.

d. Timber cruise of test plots

- o Plot size

The basic plot size is 50 m × 25 m (0.125 ha), and the plot size of dense forest and steep slope 25 m × 25 m (0.0625 ha). A pocket compass and meter tapes were used in setting up the plots.

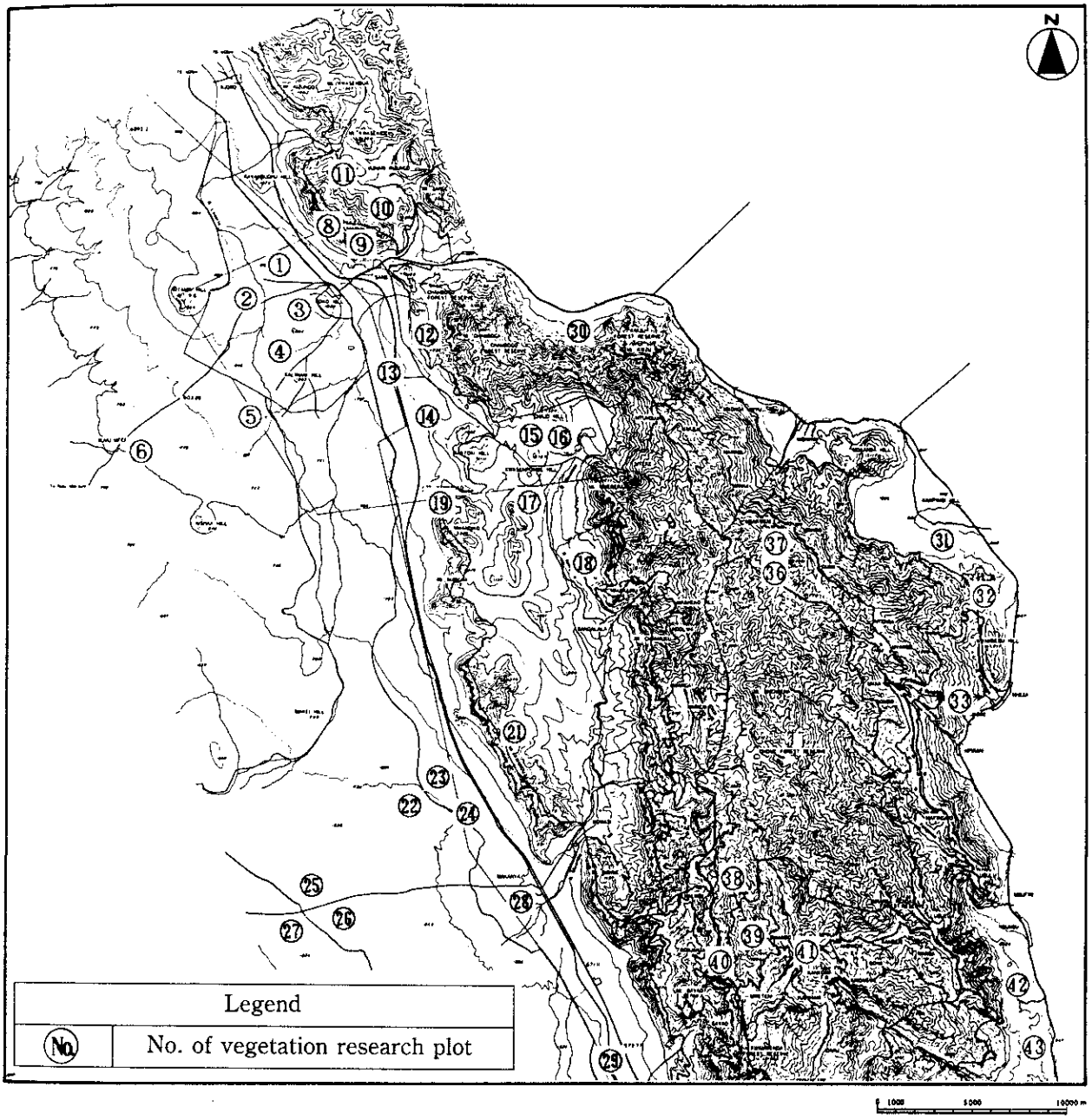


Fig. 4-2 Location of Vegetation Research Plot

○ Trees measured

In high tropical evergreen forest and high tropical deciduous dry forest, every standing tree of 10 cm or more in d.b.h., and in other forests, every standing tree of 4 cm or more in d.b.h., within each plot was measured.

○ Items investigated

- Diameter breast height (d.b.h.) ... measured with a calliper by rounding fractions of 2 cm.
- Height to the first main branch ...measured with a hypsometer by rounding fractions of 1 m (on high trees only).
- Total tree height ...same as above.
- Stem volume ...Since Tanzania has no stem volume table for natural broad leaved trees and particularly for shrubs, the stem volume was estimated according to the following formula by using the breast height form factor of 0.4 as an expedient mainly for the purpose of comparing the stumpage volume among different categories of vegetation and forest type in this area.

$$V = 0.4\pi \left(\frac{D}{200}\right)^2 H$$

Wherein V : stem volume with bark (m^3),
D : d.b.h. (cm),
H : total tree height (m)

- Use of trees ...divided into next classification by the interviews with local inhabitants.

Firewood, crude wood for charcoal making, pole material, for medicinal use, fruit trees, crude wood for furniture and building material, fodder trees, other uses.

③ Compilation of field survey findings

The results of field survey of each survey plot area as per "the field notes on the vegetation and forest type survey" attached in a separate cover, which are summarized in Table 4-6, "A List of Vegetation and Forest Type Survey Findings." in Appendix shows major plants species, in the 43 survey plots. There were 165 species of major trees and shrubs and 42 species of herbs, totalling 207 species.

4.2.2 Survey Results

The following is an analysis and examination of the foregoing vegetation and forest type survey, especially of vegetation and forest types in this area, their site conditions, distribution status, community structure, stand volume, and of the guidelines for managing of forest land in accordance with each vegetation and forest type.

(1) Vegetation and forest type and site condition

① Tropical evergreen forest. ... Eℓ, Em, Er

Among tropical evergreen forests, lowland forests Eℓ survive only at elevations

between 500 m to 600 m on the piedmont of the eastern side of the highland, and a part of it reserved as the Gonja Forest Reserve. Mountain forests Em and tropical evergreen riverine forests Er are distributed on highlands about 1,200 m-1,300 m or higher in elevation. Em constitues the important parts of Vumari, Chambogo, Kwizu, Chome and other forest reserves, while Er is distributed in narrow belt on both banks of relatively large rivers that flow through the cultivated land on the highland. Soils of these forests almost entirely consist of Cambisols.

② Tropical deciduous dry forest...Dd(h_1), Dd(h_2), Dd(ℓ_1), Dd(ℓ_2), Dd(ℓ_3), Dd(r)

Tropical deciduous dry forest is distributed on the western piedmont of the highland at about 1,000 m or more in elevation and on slope and spur piedmonts of the eastern side of the highland at about 500 m to 1,300 m in elevation, and comprises the transitory zone between tropical evergreen forest and tropical savanna. In other words, this vegetation and forest type is primarily distributed on the foothills with slope inclination of around 5° to 15° on the periphery of the highland.

The soils are mostly Cambisols and partially Lithosols and rocky land are contained in part. Ndungu and its neighborhood located on the southeast of the highland and elevation of the 500 m mark, and the area constitutes a rain-shadow of Usambara mountain area on its east so that dryness seems to have increased somewhat, so the soils are Nitosols and Cambisols, and vegetation is very similar to tropical savanna.

③ Tropical savanna

a. Wet-dry savanna...Sd(g_1), Sd(g_2), Sd(r)

This type is the wooded grassland mainly distributed in the lowland plain area on the northeast of the highland between 500 m and 900 m in elevation, and most of it comprises the Mkomazi Game Reserve. Riverine forest Sd(r) of this type, however, also occurs, although small in area, in the westside piedmont of the highland and on the western lowland on both banks of major rivers where soils are fairly wet. Accordingly, both Nitosols and Vertisols occur due to differences in soil water conditions.

b. Thornbush savanna...St(d_1), St(d_2), St(m_1), St(m_2), St(s_1), St(s_2), St(g), St(r)

Thornbush savanna is a typical type of vegetation in this area, being widely distributed from about 600 m to about 1,000 m in elevation mainly on the east side piedmont of the highland through the whole stretch of the western lowland. Shrub density of thornbush savanna varies depending on the intensity of grazing and cutting for fuelwood.

In the surroundings of settlements, low density savanna of St(s_1), St(s_2), St(m_1), St(m_2) are distributed more frequently, while in areas distant from settlements, and along national highways, railway beds and former sisal plantations where the tresspassing of people and animals are more strictly regulated than in other areas, high density savanna of St(d_1), St(d_2) are distributed more frequently. Dry grassland St(g) is mainly distributed in small areas around seasonally waterlogged

savanna Sw which will be discussed later.

Rocky savanna St(r) can be seen on the fault line scarp on the westside of the highland and also on (the slopes of about 15° or more in inclination) of the monadonocks (inselbergs) that stand on the western lowland like islands.

c. Seasonally waterlogged savanna...Sw

The area along the rivers that run down the western lowland from north to south becomes flooded during the rainy season and turns into grassland with scatterings of shrubs, during the dry season. Herbs are not as tall and dense as in high stem grassland Sd(g_1) and Sd(g_2) of wet dry savanna, and trees are also very few. Soils of almost the entire area consist of Vertisols.

④ Forest plantation...Fp

Aside from residential forests and roadside trees, the major forest plantations in this area are the man-made plantations of *Cassia siamea* in the area of neighborhood of the Same Hospital and on the premises of the Makanya Primary School, and planting of *Eucalyptus saligna* on the boundaries of the Chome Forest Reserve, plantation of *Acacia mearnsii* and their secondary growths on the highland (particularly in the vicinity of Bwambo and Mamba-Miamba in the south). Nurseries at Mwembe and Gonja are also included in this category. Although planting of *Azadirachta indica, Grevillea robusta, Eucalyptus spp., Cupressus lusitanica,* etc. as shade trees for coffee, planting and cultivation of fruit trees like *Psidium guajava, Tamarindus indica,* etc. are active on the highland, they are not sizable enough to be called forest plantation and are therefore classified as a part of cultivated land (land use classification symbol C). Soils are mostly Cambisols suitable for planting, but man-made school forest land at Makanya comprises Fluvisols.

⑤ Secondary growth ... Sg

Mainly secondary natural growths of tropical evergreen forest were classified here as the secondary growth. Its distribution is seen scattered along the streams in the northeastern part of the highland. In other words, on the felled and burnt blanks of mountain forest Em and along the streams and on the lower part of slopes which escaped the fire damage. Mountain forests on the ridge and middle to upper portion of slopes, it seems become heath which is described later when prescribed burning has been repeated.

⑥ Mountains grassland...Mg

Grassland and bushland (of less than 5 m in tree height), and heath on the felled and burnt blanks of mountain forests Em and tropical deciduous dry forest Dd are called mountain grasslands here in order to distinguish them from grassland and wooded grassland in lowlands. They are mainly distributed on highlands of about 1,500 m or more in elevation, and their soils consist of Cambisols.

⑦ Rocky zone...Rc

A number of fault lines run approximately in the north-south direction on the east and west sides and at the center of the highland of this area, and rocky cliffs

Table 4-6 Vegetation and Forest Types and Their Distribution Area

Vegetation and Forest types					Area (ha)	Distribution area (%)	Research plot No.
I	II	III	IV	Symbol			
Tropical evergreen forest (Wet-high Forest)	Lowland forest			Eℓ	175	0.1	33
	Mountain forest			Em	15,925	10.0	35, 38
	Riverine forest & gallery forest			Er	50	0.0	41
	Sum total				((16,150))	((10.1))	
Tropical deciduous forest (Tropical raingreen forest)	Middle-height forest	Dense forest		$Dd(h_1)$	1,975	1.2	8, 10
		Scattered forest		$Dd(h_2)$	850	0.5	32
		Total			(2,825)	(1.7)	
	Low forest and bush	Dense forest		$Dd(\ell_1)$	20,750	13.0	16, 42
		Middle density forest		$Dd(\ell_2)$	6,150	3.9	17, 43
		Scattered forest		$Dd(\ell_3)$	7,150	4.5	11, 15
		Total			(34,050)	(21.4)	
		Riverine forest & gallery forest		Dd(r)	375	0.2	34
	Sum total				((37,250))	((23.3))	
Tropical savanna (Tropical steppe)	Wet-dry savanna	High-stem grassland	Wooded grassland	$Sd(g_1)$	1,575	1.0	30
			Swampy grassland	$Sd(g_2)$	750	0.5	31
		Riverine forest & gallery forest		Sd(r)	225	0.1	26
		Total			(2,550)	(1.6)	
	Thornbush savanna (Thornbush steppe)	Dense thornbush savanna (Density 70% or more)	Dense bush & shrub	$St(d_1)$	13,325	8.3	6, 18, 20
			Dense thicket	$St(d_2)$	9,475	5.9	7, 14, 24
		Middle density thornbush savanna (Density 40% through 69%)	As dots	$St(m_1)$	7,350	4.6	3, 23, 29
			As groups	$St(m_2)$	7,150	4.5	1, 5, 21
		Scattered thornbush savanna (Density 10% through 39%)	As dots	$St(s_1)$	29,875	18.8	4, 22
			As groups	$St(s_2)$	10,950	6.9	2, 12, 27
		Dry grassland		St(g)	2,775	1.7	25
		Rocky savanna		St(r)	525	0.3	19
		Total			(81,425)	(51.0)	
	Seasonally water-logged savanna			Sw	10,000	6.3	13, (25)
	Sum total				((93,975))	((58.9))	
Forest plantation				Fp	325	0.2	9, 28, 36, 39
Secondary growth				Sg	725	0.5	
Mountainous grassland				Mg	10,375	6.5	37, 40
Rocky zone				Rc	775	0.5	
TOTAL					159,625	100.0	

Note : Area is summed by each mesh (25 ha) in which represented the most distributed type on vegetation maps.

Newtonia, and the southern part of the Chome Forest Reserve a community of *Ocotea, Podocarpus* and *Macaranga*, which suggest that mountain forests are composed of many tree species of which the dominant one differs considerably depending on the place.

Riverine forest is considered to have the same tendency as mountain forest, but because considered its proximity to settlements and cultivated lands, its subordinate trees and shrubs are frequently felled so that the cover degree of those layers are low at 5% and 50%, respectively. (Plot No. 41 is where shrubs are still to be found more than other plots among riverine forests.) As far as the plots surveyed are concerned, *Parinari, Albizia*, and *Syzygium* were the dominant species of the high tree layer.

② Tropical deciduous dry forest ...Dd(h_1), Dd(h_2), Dd(ℓ_1), Dd(ℓ_2), Dd(ℓ_3), Dd(r)

Both middle height forest Dd(h_1) and Dd(h_2) in the category of tropical deciduous dry forest indicate a cover degree of around 50% for the middle height tree layer around 10 m tall, but the former dense forest Dd(h_1) has a considerably large number of standing trees. The herb layer in both forests thrives with a cover degree of 60% to 70%. Plot No. 8 and 10 of Dd(h_1) are located in the west and east piedmont of the Vumari Forest Reserve. In the west piedmont, the plot forms a community of *Acacia, Combretum*, and *Grewia*, while in the east piedmont, the plot forms a community of *Brachylaena* and *Manilkara*; the shrub layer of the former consists of dense *Acacia brevispica* while that of the latter consists of dense *Croton* sp. Plot No. 32 of Dd(h_2) forms a community of *Acacia, Commiphora* and *Terminalia*. Although it is located in the western piedmont of highland (near Gonja), it is slightly similar to Plot No. 8, and also has the tendency of a tropical savanna.

The tree height of low forest of tropical deciduous forest is around 5 m. It forms a community of *Acacia* and *Commiphora*, with intrusion of *Euphorbia nyikae* and *Euphorbia dawei* where rocky, which on the whole seen to indicate a transition into tropical savanna. However, it is different from tropical savanna in that it has a mixture of various dominant species like *Dalbergia, Boscia, Boswellia, Ozoroa* and *Combretum* and that its d.b.h., number of standing trees and stem volume are slightly much higher than tropical savannas.

Although tropical deciduous dry forests consisting of low and dwarf trees are divided to Dd(ℓ_1), Dd(ℓ_2), and Dd(ℓ_3) depending on the cover density of larger tree layer and to small tree layer, by the field observation we recognized Dd(ℓ_1) to be above 50% of cover density, Dd(ℓ_2) between 30% to 49%, Dd(ℓ_3) to be less than 30% (Plot No. 15 being an exception) for Dd(ℓ_3). The herb layer consists of *Panicum, Barleria, Arestida, Cynodon, Heteropogan*, etc., and its cover degree is greatly influenced by the degree of disturbance by grazing.

Riverine forest in the category of tropical deciduous dry forest is a community of *Ficus, Acacia*, and *Manilkara* in Plot No. 34, where intensively influenced by man and animals, and another riverine deciduous forest have the shrub layer of

Tabernaemontana and the heavy layer of *Acalypha* and *Asparagus*.

③ Tropical savanna

a. Wet dry savanna...Sd(g_1), Sd(g_2), Sd(r)

It is a typical type of so-called wooded grassland, having scattered middle height trees and shrubs, their cover degree being generally less than 10%, while the herb layer thrives densely with a cover degree of above 90%. However, the ratio of low trees and bushes slightly increases in its riverine forest to around 30% to 40%. The dominant species is basically *Acacia*, with a mixture of *Commiphora, Salvadora*, etc.

Herbs are mostly high stemmed such as *Chloris* and *Seteria*. Plot No. 26 is located on the periphery of seasonally waterlogged savanna in the western lowland, and dominated by *Acacia etbaica* instead of *Acacia tortilis* which is frequently seen in wet-dry savanna, while herbs are dominated by *Barleria*.

b. Thornbush savanna...St(d_1), St(d_2), St(m_1), St(m_2), St(s_1), St(s_2), St(g), St(r)

The upper story trees of this type are basically *Acacia* and *Commiphora*, generally around 5 m in mean tree height, and in some places, mixed with *Euphorbia, Baswellia, Boscia, Bolanites*, etc. In *Acacia* genus, *A.nilotica, A.mellifera, A.etbaica*, and *A. brevispica* are more common than *A.tortilis*. The shrub layer is generally dominated by *Grewia*, with a mixutre of *Maerua, Salvadora, Boscia*, etc. In the herb layer, *Sansevieria, Euphorbia, Barleria*, and *Sida* are most common. Vegetations of this type are damaged severely by cutting for fuelwood and grazing, the cover degree of middle height tree layer of these forests are generally less than 20% except that of St(d_1) and St(d_2) which is 30 to 40% or more. The cover degree of the shrub layer is also 20% to 30% or less, that of the herb layer, except Plot No. 24 of St(d_2), are 30% to 40% or less, and in St(m_2), St(s_1) and St(s_2), below 10%, meaning that most places are almost denuded.

Dry grassland St(g) is the grassland of *Barleria* and *Panicum* scattered with *Acacia* and *Salvadora*, where the cover degree of the herb layer is around 40%. Rocky savanna St(r) forms a community of *Euphorbia, Boswellia* and *Commiphora*, and its vegetation cover is small even with the shrub layer mainly consisting of *Indigofera* included.

c. Seasonally waterlogged savanna...Sw

Almost entirely consists of the herb layer with hardly any middle height trees, but only slightly dotted with shrubs of *Acacia* and *Balanites*. The dominant species of the herb layer are dense *Sansevieria* and *Euphorbia* at places which are wet even during the dry season; at dry places, *Bareria* seems to occur more frequently.

④ Forest plantation...Fp

Invasion of shrubs and herbs is generally very small in man-made forests of *Cassia siamea* at Same and Makanya, where the forest canopy is almost closed. The man-made forest of *Acacia mearnsii* on the highland can be seen the vigorous vegetation of *Acacia*, and regenerated trees attain 30% cover density of shrub layer.

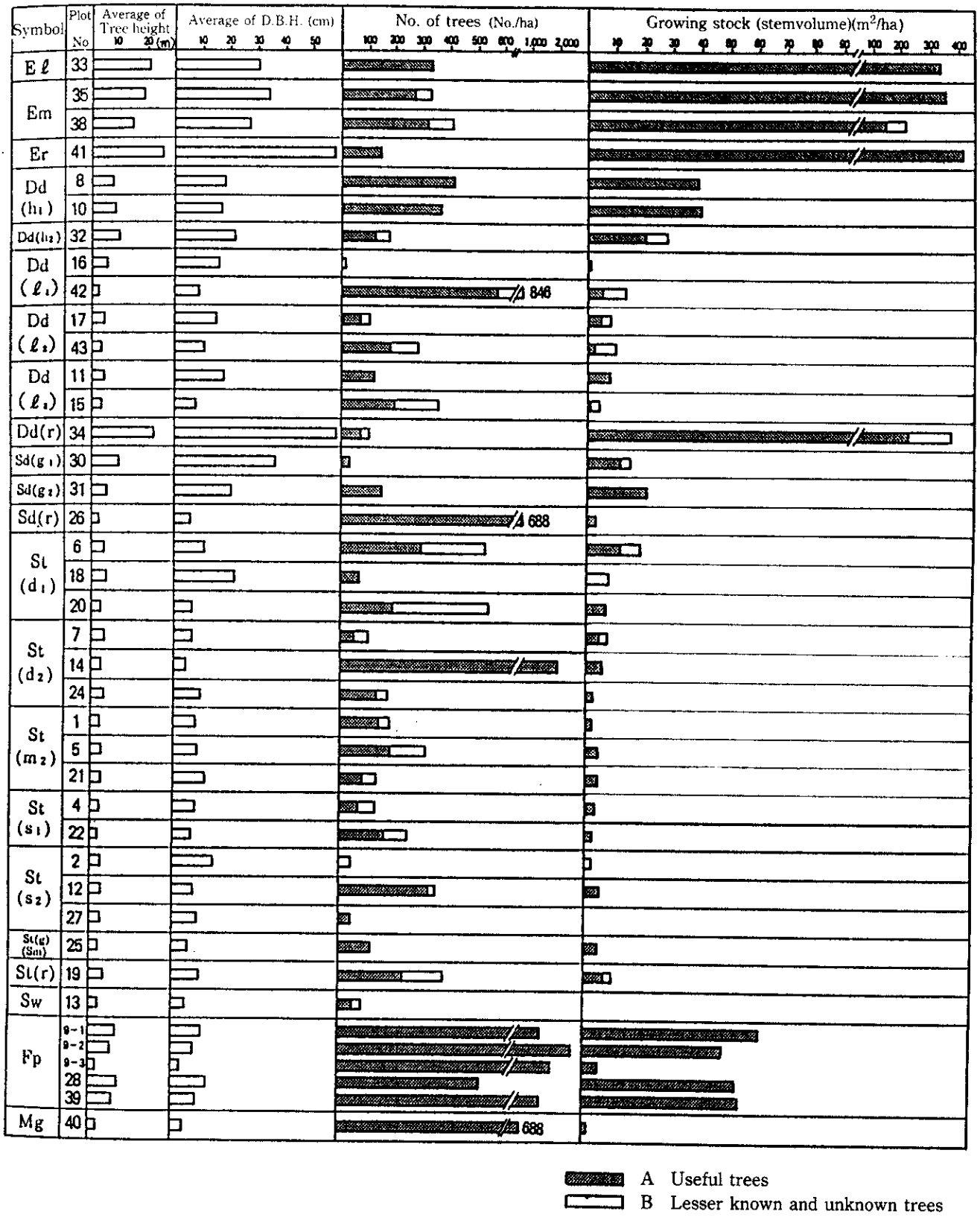


Fig. 4-3 Result of Plot Survey

⑤ Mountainous grassland...Mg

Mountainous grassland consists only of the shrub layer of one to two meters in height and the herb layer of less than one meter high and has not the medium height trees.

Especially the mountain grasslands located on the peripheral of the Chome Forest Reserve is occupied by dense growing of *Myrica, Aguria* and *Kotscha*, and around area of plantation of *Acacia mearnsii* are dominanted by dense *Philippia* mixed with naturally regenerated *Acacia*. The herb layer of these grassland almost consists of *Pteridium* and *Eragrostis*, and these cover density of these species are 70% in northern area of the highland and 30% in southern area. On the mountain ridge and upper slope of southwestern area of the highland (west of Suji), these vegetations (Mg) are dominated by *Tarcnonthus comphratus* above 1 m in height.

The mountain grasslands which are dominated by tall grass of Gramineae can be seen on the ridges and northern slopes of the Kwizu and Chambogo Forest Reserve which are located around the northern part of highland as result of repeated fires.

(4) Vegetation and forest type and stand volume

The stand volume (stem volume) of each vegetation and forest type is shown in Fig. 4-3 by the timber cruise of each plot. It will be said perhaps that the estimated numerical value of stem values are not so accurate because of the 43 plots (0.125 ha and 0.02 ha) and lacking of accurate stem volume table.

But these result data are very worth to compare the numerical values of each vegetation type in surveyed area.

① Tropical evergreen forest...Eℓ, Em, Er

This type of forest is composed of trees which are around 20 m in height, around 30 cm in d.b.h. (except in riverine forest Er), 300-400 trees/ha and around 300 m^3/ha of growing stock. Riverine forest Er cannot be estimated in general, because these forests are affected by the different invasion of man and animals depending on each place, but its tree height and d.b.h. are larger than Eℓ and Em its growing stock exceeds 400 m^3 ha in some places. However, felling of medium-height and low trees seems to have advanced considerably, and the number of standing trees with d.b.h. of 10 cm or more is less than 150 trees/ha. Almost all medium and large diameter trees in forests of this type are useful for many purposes.

② Tropical deciduous dry forest...Dd(h_1), Dd(h_2), Dd(ℓ_1), Dd(ℓ_2), Dd(ℓ_3), Dd(r)

The dense forests of medium height trees Dd(h_1) are around 10 m in height and around 20 cm in d.b.h. and stand volume are 40 m^3/ha, which are 1/8 ~ 1/10 of the tropical evergreen forest.

The scattered forests of medium height trees Dd(h_2) are somewhat larger in tree height and d.b.h. than Dd(h_1), but the number of standing trees is almost half as much, and the growing stock is a little less than 30 m^3/ha, mixed with still unexploited.

The low forest estimated by the standing stock of over 4 cm in d.b.h. are around 5 m in height and number of standing stock are vary considerably from place to place.

The growing stock of this forest is less than some 10 m^3/ ha, and the ratio of still unexploited trees is rather higher than in the medium height forest because of the larger ratio of *Commiphora, Euphobia* species.

The stand conditions of riverine forests Dd(r) are similar to that of the riverine forests of tropical evergreen trees, even though the dominant species are different. The number of standing trees with d.b.h. of 10 cm or more is about 100 trees/ha, and the growing stock about 400 m^3 /ha with a considerable mixture of still unexploited trees.

③ Tropical savanna

a. Wet dry savanna...Sd(g_1), Sd(g_2), Sd(r)

The riverine forest Sd(r) surveyed this time happens to be located in the thornbush savanna zone of western lowland. Wooded grassland which accounts for most of the area of this type is estimated to be around 10 m in height, 20 to 30 cm in d.b.h., the number of standing trees in the neighborhood of 100 trees/ha, and the growing stock in the range of around 20 m^3/ha. Since the dominant species belong to the *Acacia* genus, the ratio of useful trees is high.

b. Thornbush savanna...St(d_1), St(d_2), St(m_1), St(m_2), St(s_1), St(s_2), St(g), St(r)

The mean tree height of standing trees with d.b.h. of 4 cm or more in thornbush savanna is, on the whole, around 5 m. Their d.b.h. is generally around 10 cm although around 20 cm in some places, and the growing stock is mostly around 5 m^3/ha. *Commiphora* spp. occurs frequently, and the ratio between *Acacia* and other useful trees and unexploited trees varies considerably from place to place but, on the whole, it is 1:1.

Among thornbush savanna, dense thornbush savanna St(d_1) and St(d_2) has nearly 10 m^3/ha of growing stock, with a high ratio of useful trees in some places.

c. Seasonally waterlogged savanna...Sw

Trees in seasonally waterlogged savanna are even smaller than the trees in thornbush savanna, and the number of standing trees is also fewer. Growing stock is less than 1 m^3/ha.

④ Forest plantation...Fp

Plot No. 9-1 is the former cultivated land adjacent to Same Hospital on which *Cassia* siamea was planted at a rate of some 680 trees/acre (= 1,680 trees/ha, at intervals of about 2.5 m) during March-April, 1978. The forest of nine years old consists of the trees of 10 m in height and 11 cm in mean d.b.h., and the current number of standing trees is 1,450 trees/ha. The growing stock is estimated to be 61 m^3/ha.

The forest of *Cassia siamea* of Plot No. 9-2 was planted more densely than Plot No. 9-1 in the same period on the same site at the rate of 1,200 trees/acre (about

2,970 trees/ha, at intervals of about 1.5 m to 2.0 m) mainly for the purpose of soil conservation. At presents, the mean tree height is 8 m, mean d.b.h. 8 cm, number of standing trees about 2,530 trees, and the growing stock was estimated 48 m^3/ha.

At some distance from Plot No. 9-1 and 9-2, a four year old stand of *Cassia siamea* planted during March-April 1983 remains only on a very small area. Its theoretically calculated mean tree height would have been 3 m, mean d.b.h. 3 cm, stand density 1,800 trees/ha and the growing stock 5 m^3/ha, but due to inadequate management which permitted grazing to be done in the stand, tree growth is poor. The areas of these afforestation sites adjacent to Same Hospital is said to be about 5 ha in all.

Forest of *Cassia siamea* on Plot No. 28 was originally planted by the pupils of Makanya Primary School during February- March of 1980, but its original image is retained only in very small area due to repeated cutting. (Planting is still being carried out, though at a small scale, on the adjacent land.) When the condition of the seven year old stand is conjectured from the residual trees and stumps, some 0.2 ha of stand with mean tree height of 11 m, mean d.b.h. of 13 cm, stand density of 520 trees/ha (at intervals of about 4.5 m) and a growing stock of 53 m^3/ha would have been there.

Next is the planted area of *Acacia mearnsii* on the high-land. According to the local inhabitants, the stretch of tropical evergreen forests (mountain forest) of whole districts felled down until the 1950's, and since the middle of the 1960's, *Acacia mearnsii* began to be planted in its place. Since then selective cutting for fuelwood seems to have been repeated.

The forest stand of Plot No. 39 is composed of planted *Acacia mearnsii* of 15 m in height and 10 ~ 20 cm in d.b.h. and mixed with natural regenerated trees of *Acacia*. These forests rather can be considered as secondary forests of *Acacia mearnsii*. This forest is composed by stocks of 9 m in height, 9 cm in d.b.h. and 54 m^3/ha of growing stock.

⑤ Mountain grassland...Mg

Plot No. 40 is the heath of *Philippia* and *Myrica*. The standing trees of this site are 3 cm in mean height, 4 cm in mean d.b.h. and 690 trees/ha of stand density and only 1 m^3/ha of growing stock. Although the volume of this vegetation is very poor, the trees are usable as fuelwood and also for medicine.

(5) Forest management considering vegetation

Broadly judging from the results of soil survey, field vegetation research, timber cruise and observation of sample plots and interpretation of aerial photographs described heretofore, the following may be stated in contemplating the semi-arid area forest management plan and social forestry for this area.

① Water catchment conservation and soil conservation

As shown in table 4-7, the types of vegetation and forest located in survey area can be arranged conclusively according to the intensity of the function of water

conservation and soil conservation (prevention of soil erosion). In other words, forests of more densely covered trees with taller and having larger crown are more effective in these functions.

Based on such a viewpoint, forest lands with larger functional effectiveness must be the first to be protected and maintained, while forest lands with smaller functional effectiveness must be improved by afforestation to cover the surface soil more densely. Most of the tropical evergreen forests such as Eℓ and Em types in this area have been designated as forest reserves and are fairly well protected, but deciduous dry forests (Dd(h), Dd(ℓ)) which locate at peripheries, of evergreen forests have been damaged by cultivation and grazing. Therefore, not only deciduous forests but also riverine forests Dd(r) and riverine savanna Sd(r) must be conserved intensively.

Table 4-7 Comparison of Vegetation Type Based on Function of Water Conservation and Soil Conservation

Larger function ← → Smaller function			
Larger function ↕ Smaller function			
Eℓ, Em, Er	Dd(h_1)	Dd(h_1)	St(m_1), St(m_2)
Dd(r), Fp	Dd(h_2)	Dd(h_2), Dd(ℓ_3)	St(s_1), St(s_2)
	(Sg)	St(d_1), St(d_2)	St(g)
	Sd(r)	Sd(g_1)	St(r)
		Sd(g_2)	Sw
		Mg	Rc

② Utilization of useful trees

In the point of stock volume of useful trees for fuelwood and building material, each type of forest and vegetation can be arranged as shown in Table 4-8.

Table 4-8 Comparison by the Growing Stock of Useful Trees

Larger Stock ← → Smaller Stock			
Larger Stock ↕ Smaller Stock			
Er	Fp	Dd (h_2)	St (d_2)
El	Dd (h_1)	Sd (g_2)	St (m_1), St (m_2)
Em	(Sg)	Sd (g_1)	Sd (r)
Dd (r)		St (d_1)	St (s_1), St (s_2)
		Dd (l_1)	St (g), St (r)
		Dd (l_2)	Mg
		Dd (l_3)	Sw, Rc

From the viewpoint of utilization of useful trees, at first tropical evergreen forest, then artificial forest, deciduous dry forest, wet dry savanna, and thornbush savanna, can be used effectively and continuously in order of stock volume. In fact the tropical evergreen forest can not be used economically, because of designation as forest reserve and under regulation of cutting.

And also the forest of this type is expected the important role of the water and soil conservation. As almost of dry-wet savanna, belongs to the Mkomazi Game Reserve, the forest of this type is limited for many kinds of uses. The urgent task in this area is therefore the systematic utilization of deciduous dry forest such as Dd(h_1), Dd(h_2) and then thornbush savanna such as St(d_1), St(d_2) and increase of forest plantations such as those existing now.

Almost of thornbush savanna has very poor functions of soil and water conservation and also very poor stock volumes of trees, so the uncontrolled cutting for fuelwood of these vegetation is not only the little gain but also promotes the devastation of natural forest lands.

③ Utilization of forest land for grazing

The correlations of the intensity of character of vegetation types and the intensity of grazing (including of fuelwood cutting) are shown in Table 4-9, judging from the field observation and photo interpretation.

Overgrazing not only accelerates soil erosion and invites devastation of national land but also disturbs the growth of useful trees for neccessary fuelwood, and invites depletion of forest resources. Accordingly, it is an urgent task to protect the tropical evergreen forests, deciduous dry forests, dense thornbush savanna and others which are still relatively less affected from excessive utilization for grazing, and also to consider ways for soil conservation in dense thornbush savanna, development of fuelwood stand and a rational way of grazing that harmonizes with those two.

Table 4-9 Comparison between Vegetation and Forest Type and Degree of Their Utilization

Classification	Vegetation and forest type	Remark
Degree of utilization -- small	El, Em, Dd (h_1), Dd (l_1) St (d_2), Fp, Rc	Middle-height forest of 70% or larger crown density, etc.
Degree of utilization intermediate	Dd (h_2), Dd (l_2), Dd (r) Sd (r), St (d_1), St (r) Sg, Mg, Er	Middle-height forest of 40-69% crown density and thornbush savanna of 70% or larger crown density
Degree of utilization -- large	Dd (l_3), St (m_1), St (m_2) St (s_1), St (s_2), S (g) Sd (g_1), Sd (g_2), Sw	Middle-height forest of 39% or smaller

(Note) **Grassland near settlement which is considered to be permanent grazing land is classified as pure grazing land G in terms of land use. (Excluded from this Table.)**

4.3 Soil Survey

4.3.1 Survey Methods

The survey was undertaken for the purpose of preparing a soil map based on the results of investigations of the soil properties and soil distribution. The soil map drawn on a scale of 1:20,000 is to be used as basic data for drafting the Kilimanjaro Region forestry development program.

At the basic survey carried out during January and February 1987 and at the full scale survey undertaken from August to October 1987, 23 pits were selected in the flatland area of the surveyed area, 11 pits in the piedmont area and 18 pits in the mountainous area to make a total of 52 pits (see Fig. 4-4).

At the pits, a soil profile was made 70 cm wide and 100 cm deep the morphological examination has been done about next items: 1) soil horizon depth 2) feature of boundary of horizon 3) nomenclature of each horizon 4) colors 5) texture 6) gravels 7) structure 8) consistency 9) moisture condition 10) voids 11) mottle and concretion 12) leaching and accumulation 13) roots condition.

At the same time soil materials were sampled from each horizon and measured soil pH by pH meter using a glass electrode.

Soil classification was made on the basis of the result of this survey, and then the expanses of the various classified soil were grasped by using about 100 simple pits. The results of the soil examination in each pit are in the Appendix.

4.3.2 Survey Results

(1) Types of soil and their distribution

With respect to soil classification in the tropical regions the U.S. Department of Agriculture system of classification is followed in Asian and the American continents, but in the African Continent, French and Belgian classification systems are followed. On the other hand FAO/Unesco system of Soil Map of the World has been established by the pedologists of many countries for the unifing the nomenclature of soils of the world and published the soil maps of the world and their descriptions. In this report of soil survey, the nomenclature of soils was taken the soil units of FAO/Unesco system. However, in view of the nature of areas surveyed and the survey period available, graphic indication of classifications within the groups were undertaken.

Types of soil found in the surveyed areas included the following six:

The typical profiles in each soil type are described in Appendix.

a. Fluvisols

These soils are found on the river basins, alluvial fans where alluvial deposits have been left. It consists of deposits of weathering materials carried by stream and deposited in layers comprising different soil texture, such as clay, sand and gravels. Plot 27 represents the clay soil of alluvial fan with sandwiching three lay-

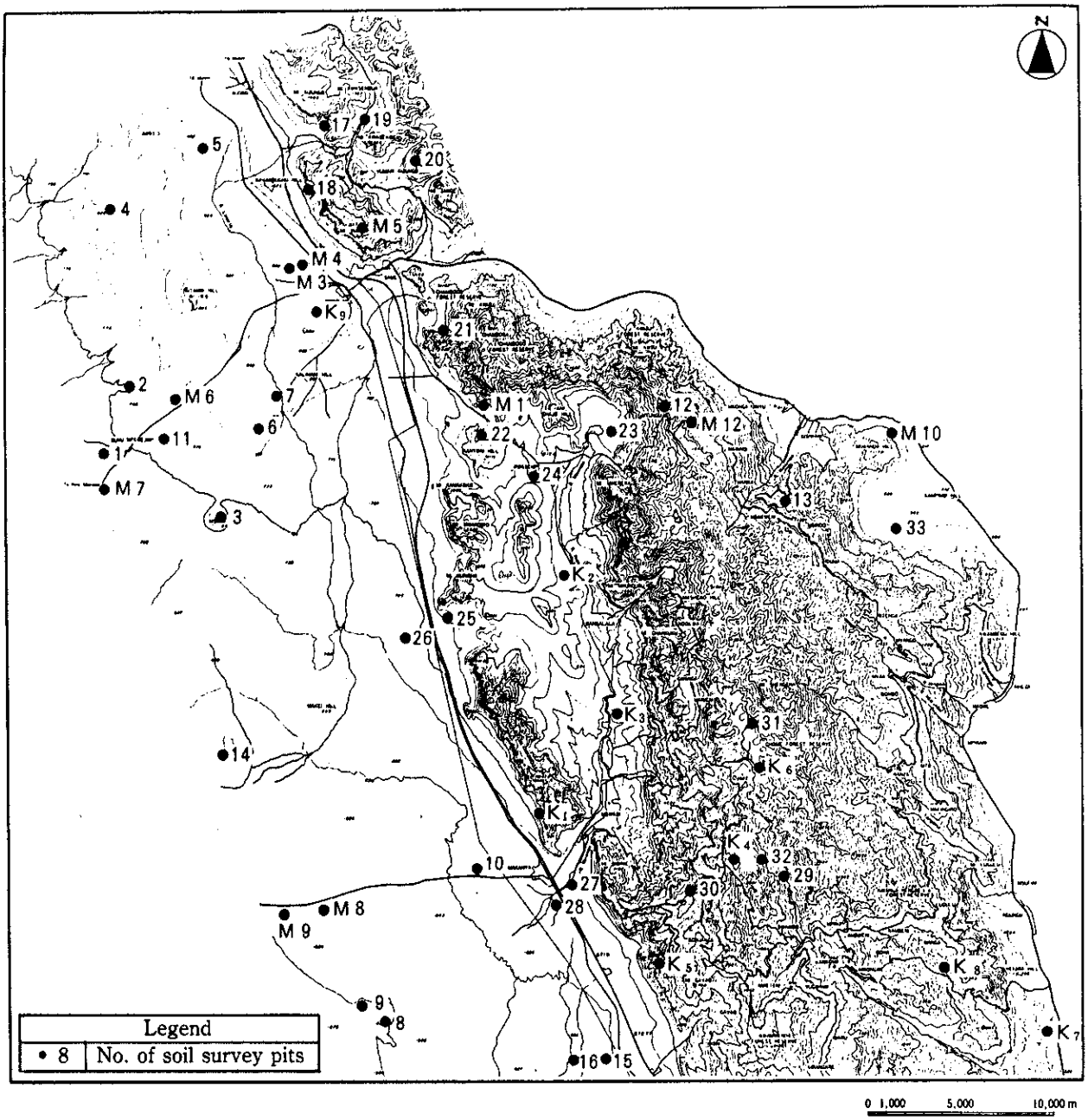


Fig. 4-4 Location of the Soil Survey Pits

ers of brownish gray and grayish brown fine sand. The pH value of this soil is over 8.0. Its distribution, excepting a part thereof, is localized and its area is small; it is used mostly for cultivating purposes.

b. Lithosols

These soils are a very thin immature soil found in places adjacent to rocky areas, or on the tableland and the concave slopes of hilly lands. Plot K2 has only no more than 10 cm of reddish brown A-B horizon on the base rock. Since it is an extremely thin soil, it is at present used merely for grazing.

c. Rendzinas

These soils are found on small hills of the lime stone or upper part of the dissected slope of the north-western region. The distribution areas of this soil are small. This type of soil has only A-horizon formed on the lime stone. Plot 1 is the soil found on the top of low hills in the flatland; the brown colored A horizon is less than 30 cm deep. The pH value of this soil is high at more than 8.0 caused by parent material. The Renzinas area is very poor land of thornbush savanna and not suitable arable land, and used only grazing.

d. Vertisols

These soils are found on the gentle slope of the river side where the land is submerged under water during the rainy season but during the dry season, these soils shrink and have large cracks in black heavy clayish. A horizon and small soil aggregate of the surface layer fall in the cracks, so the soil surface form uneven relief. Plot M-8 is the soil of Vertisols on the flatland that submerged into rivers during the rainy season. The clay any horizon more than 70 cm in depth cracks in block forms and deep fissures run through it. The pH value is high at 9.1 in some parts. Vertisols are distributed all over the plains area but they appear widely towards the south. For land utilization there are many restricting factors, such as submersion during the rainy season, heavy clay, deep fissures and so forth. At present the area is used for crop cultivation and for domestic animal grazing. Some parts of this soil have shallow cracks, and in the southern part, some Vertisol can be seen in the mottling of salt accumulation horizon.

e. Cambisols

These soils are distributed from the foothills to mountain tops widely. They have an umbric A horizon (blackish brown) and cambic B horizon (brown). These soils are mainly soils with transitional properties which the other soils will develop. In the B horizon illuviation of clay, calcium, sodium or iron etc. can not be seen. Plot 17 shows the soil found on the gently sloping foothills on the western mountain slopes. They have a dark brown A horizon and a reddish brown B horizon in which special deposits are not visible. Generally the soil has a developed A horizon (with some local differences). This kind of soil is found on mountain tops rather than on the foothills and on eastern slopes rather than on the western slopes. These soils are highly productive and most of them are used for cultivation or as forest reserves.

f. Nitosols

These soils are distributed widely over the plain areas, except on the monadmocks and the concaved area that are submerged during the rainy season. The rate of destribution is especially high in the central portion of the plains.

Nitosols are formed under the good environmental conditions permitting adequate draining of water. These soils have some weatherable primary minerals and without abrupt textural change and with the gradual degrees of clay content to deep depths.

Plot 11 is the soil appearing on the flat surface and clay deposit layer is not evident. Root threads are found down to the depth of 60 cm, medium roots and rootlets have penetrated down to the depth of 70 cm, suggesting favorable physical conditions. Nitosols have the deep, uniform profiles that are porous and well drained so have good potentialities for agriculture. But on the hilly area the soils have rather shallow horizon in the southern area some soils have salt deposits apparently. At present this soil is used as farmland or as thornbush savanna. No problems are posed in the land utilization, except in the southern part where salt deposits are seen.

Incidentally, talus areas depositted rock with some soil materials have been classified as rocky outcrop.

(2) Soil distribution of the surveyed area

The surveyed area of about 200,000 ha is divided into eastern and western parts by the center line on the basis of topography, geological features, meteorological conditions and vegetations. The western half forms the plains of thornbush savanna at an elevation of 600 to 800 meters. The base rocks here consist of lime stones of the Tertiary period and the alluvial deposits. The eastern half consists of mountainous region named the Pare mountains, with the elevation ranging from 600 meters to 2,462 meters. The bedrocks are the metamorphic rocks of the Pre-Cambrian period. The regions are covered with tropical evergreen forests. To outline the distribution situation of soil of various types in the surveyed areas, in the plains, while leaving spots of rocky monadnocks, Nitosols and Vertisols are prevalent, but in parts of the northern dissected area, Lithosols and Rendzinas are found. The mountainous areas are widely covered with Cambisols, excepting the rock outcrop area on the fault line scarp and the Lithosols thereon. Fig. 4-5 shows the typical distribution.

Table 4-10 Area and Rate of Each Soil Type in the Study Area

Type of Soil	Fluvisols	Lithosols or Rock Zone	Rendzinas	Vertisols	Cambisols	Nitosols	Total
Area (ha)	325	21,300	2,750	14,975	87,375	81,425	208,150
Persentage	0.2	10.2	1.3	7.2	42.0	39.1	100.0

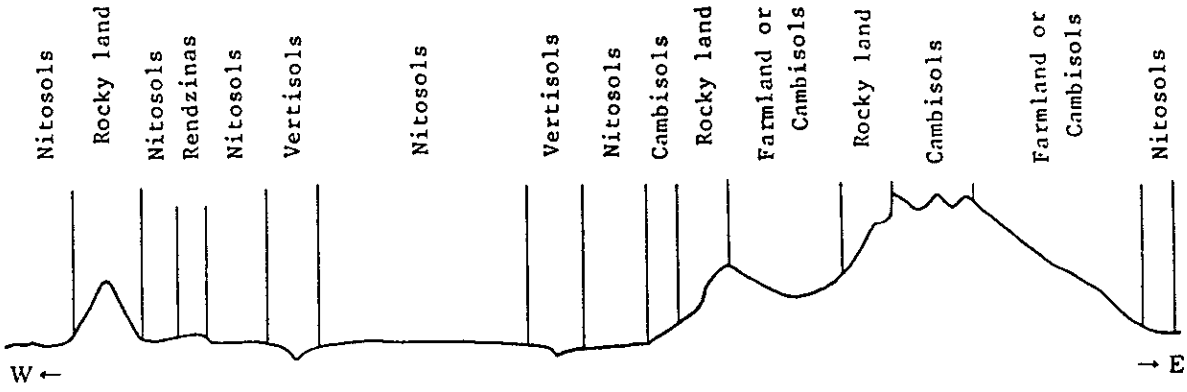


Fig. 4-5 Typified Schematic Soil Zone

(1) Northern area of the western plain

This is the area that lies northward between the Same and Ruvu Mferejini in the western plains.

It comprises the dissected area of Ruvu Mferejini, which is being eroded by the numerous tributaries of the River Ruvu, and plains of the upper reaches of River Leserta, which is located between Ruvu Mferejini Area and the northern mountainous area. Rocks spread over the dissected slope along the many tributaries, and on the Renzinas distribute upper convex ridge. While Nitosols are widely distribute on the plains, the monadnock is covered with rocks but Rendzinas distributed on low hills. Also, Vertisols distributed over the depressed areas along the River Leserta.

(2) Central area of western plains

The central area is composed of the gentle slopes of the plains, where monadnocks, such as Kishaa Hill and Kalimani Hill are found in parts, and the lowland along River Leserta that flows through the central plains. Nitosols are distribute over the wide slopes, and the hills rising here and there in this area are covered with rocks. Also, on the hillside of Kinyangusl, Renzinas are recognized. The submerged areas along the River Leserta are covered with Vertisols but their distribution area decreases towards south.

(3) Western plains and southern areas

This area is composed largely by the confluence of the River Leserta and River

Mwembe south of Makanya. Vertisols are distributed widely over the stream basin of the two rivers, where is waterlogged in rainy season and the area expands towards south. Nitosols are distributed on the upper slope of concave area. Where the River Mwembe flows out into the plains, Fluvisols sandwiching fine sand layers that have been carried down and depositted, but the distributed area is small.

(4) Northern mountain region

This area is positioned at the southern tip of the Central Pare Mountains and consists of hilly tableland adjoining the northern area of the western plains with the fault line scarp. On the fault scarp and the ascending slopes of the tableland rocky areas and Lithosols are found, but Cambisols are distributed over the gentle slope of the foothills and the lower part of the midslopes. In general Cambisols with poor A horizon are predominant, but soils with well-developed A horizon are found on the slopes in the Mt. Vumari Forest Reserve.

(5) Western slopes of southern mountains

This area includes the western slopes of the South Pare Mountains, and it consists of three stages of fault line scarp and two terraces. Cambisols are distributed over this area excepting the rocky portions of the fault scarp ridge. The first terrace (the lower terrace) is subjected to erosion by the River Mwembe flowing in parallel with the fault scarp, resulting the formation of the flatland and hillyland of Mwembe and Bangalala. On the hillyland, rocky areas and Lithosols of thin layer are found. However, Cambisols with well-developed A horizon are distributed on the flat and river side. Cambisols are widely distributed on the second terrace which is Chome and Suji flatlands. Here Cambisols have better developed A horizon than the soils of the first terrace.

(6) Southern mountains and mountain top areas

This area is positioned on the ridge lines of the South Pare Mountains. It forms a tableland on which hilly mountains appear in a range. Cambisols having thin blackish brown A horizon are distributed in this area. However, on the sharp mountain top, rocks and Lithosols are distributed.

(7) Southern mountains and eastern slopes of southern mountain regions

This area is the eastern slope of South Pare Mountains containing river valleys of the River Hingilili, River Yongoma and River Saseni, which flow in southeastern direction. The mountain slopes contain scattered rocky parts are adjacent to the eastern plains by the fault line scarp. Cambisols are distributed widely over the area, except the rocky parts and Lithosols partially exist. The Cambisols generaly have well-developed A horizon, except those on the dissected terrain area of the foothills of the southern part of Ndungu.

(8) Eastern plains

The surveyed area of eastern plains of Ndung are demarcated by the national highway, so its area is very narrow, except the outflow part of the River Kambogo. Nitosols are distributed over the gentle slopes, but Vertisols appear on the out-

lets of the rivers that flow as if cutting across the area of Nitosols. These soils occupy especially wide area around the outlet of River Kambogo.

4.4 Land Use Survey

This survey of land use was implemented in order to grasp the existing conditions of land use in the Study Area which is a basic information indispensable to examine how the social forestry should be and planning of the semi-arid forest management in this area. The contents of the survey are roughly divided into preliminary field survey, preparation of the land use maps and full-scale field survey, and the outline of study methods and study results of each of the above is described below.

4.4.1 Survey Methods

(1) Preliminary field survey

The existing condition of the land use were grasped through field exploration and interpretation of aerial photographs. The items for land use which are distributed (detected) in the study area are listed as follows:

- ○ Village ... Houses, Government offices, markets, bus stations, petrol stations, substations, schools, churches, warehouses and other vacant lands (including these sites and open spaces).
- ○ Roads ... Trunk roads, regional roads etc. (including roadbeds)
- ○ Railway ... Railway-bed
- ○ Site for high-tension wire
- ○ Paddy field ... Mostly along Kisiwani-Ndungu route (mainly on the east side)
- ○ Dry Crop field ...
  - • Around villages in the lowlands
    Maize, sisal, cotton, cassava, etc.
  - • Highlands
    Maize, banana, coffee, tomato, cabbage, cassava, onion, sugar-cane, sorgham, millet, kidney beans, and fruit trees such as mango, guava, papaya, orange, etc.
  - * In highlands, two-storey cultivation is practiced under shade trees in the highlands.
- ○ Sisal plantation ... There are large-sized plantations along new and old trunk roads.
- ○ Grazing land ...
  - • Permanent grassland
  - * In rainy season the grassland is water-logged or swampy. (around Same, etc.)
  - • Scattered bushland
  - * Overlapped with thornbush savanna in vegetation and forest type.

- Forest reserves ... Mainly tropical rain mountain forest (high forest) and a part of tropical rain lowland forests are designated as forest reserves.

  Forest reserves in Chome, Chambogo, Koko Hill (the above are national), Kamkoma, Kiranga, Hengae, Chongweni, Kisiwani, Kwizu, Maganda, Vumari and Gonja (the above are regional) are included in the Study Area.
- Game reserves ... Mkomazi Game Reserve extends on the east side of the old trunk road, a part of which is included in the Study Area.
- Game controlled areas ... Ruvu River Game Controlled Area extends, overlapped with grazing land and bush land, all over the western lowland.
- Others ...
  - Dense bushland, riverine forest and tropical rain green forest, etc. which do not belong to the forest reserves, game reserves and grazing land.
  - Rock outcrop
  - Swamps (desert-like in dry season. Thornbush savanna, seasonally waterlogged savanna.)
  - Rivers (riverbeds) ... Rivers with distinct riverbeds.

(2) Preparation of land use maps

① Criteria for land use classification

The land use classification for preparation of land use maps, which will be most effective in considering the prospective social forestry and semi-arid forest management in this area, was examined on the basis of the results of the preliminary field survey and the preliminary interpretation of aerial photographs. As the result, the criteria for classification were set up as shown on Table 4-11.

② Aerial photo interpretation

By stereoscopic observation of about 750 sheets of aerial photographs on the scale of 1 : 20,000 taken in fiscal year 1986 (January to February 1987), the aerial photo interpretation and classification was implemented in accordance with the above-mentioned criteria for land use classification.

③ Preparation of approximate land use maps

By transferring boundery line and classification symbol of each land use item on the base maps by instrument original sheets and coloring by the land use classification, approximate land use maps (Scale 1 : 20,000, including the approximate classification of vegetation and forest type) for full-scale field survey were prepared.

④ Field inspection for land use classification

In the full-scale field survey, the boundary lines and symbols of classified land use on the approximate land use maps were inspected and partially amended. Also the boundary lines of legally regulated areas were confirmed as far as possible in accordance with the existing data.

⑤ Preparation of land use maps

On the basis of the approximate land use maps which had been inspected and amended in the field, boundary line and classification symbol of each land use item,

As for Mkomazi Game Reserve and Ruvu River Game Controlled Area, no boundary survey maps have prepared the boundaries of these areas are found only in a small-scale map (Scale 1 : 2,000,000, 1965) by the Ministry of Lands, Natural Resources and Tourism and a map (Scale 1 : 250,000, 1969) of Pare District (the former name of Same District). It was decided for the sake of convenience that these maps would be enlarged to scale of 1 : 20,000 for use in this new land use map.

③ Observation of forest lands utilized for grazing

While the vegetation and forest type was investigated, the relationship between the vegetation and forest type and the degree of utilization for grazing was determined, by observing the grazing conditions around the survey spots. The result is as shown in the item for Vegetation and Forest Type Survey and also the classification of the forest lands by the degree of utilization for grazing was included in the new land use map.

4.4.2 Survey Results

According to the results of the preliminary field surveys and basic field surveys, the land use maps newly prepared, and analysis of the present land use through grid cell data, the following may be pointed out concerning the present land use of this area.

(1) Land Use Classification and Distribution

As can be seen on Table 4-12, approximately 77% of the Study area, approx. 160,000 ha is forest land, and its greater part (approx. 70% of the forest land) is considered to be used for extensive grazing. With the highlands and its east and west piedmonts as the center of distribution, approximately 19% of the entire area is crop fields and in addition, approx. 2% is large-sized sisal plantations, which is of conspicuous peculiarity. Though sizable villages are only 0.3%, the great majority of villages are scattered in perfect harmony with crop fields on the highland.

The distribution of classified land use is expressed in a grid cell map shown as in Appendix.

As for the legally regulated areas, the Study Area includes forest reserves such as Chome, Chambogo, Kwizu and Vumari, which count approx. 13%, 27,000 ha, and Mkomazi Game Reserve covering approx. 1%, 1,300 ha. In addition, there is Ruvu River Game Controlled Area, approx. 39%, approx. 80,000 ha. After all, it is 48% of the entire area, a little more than 100,000 ha where such legal regulations are not applied.

(2) Land use classification and locational conditions

① Village

As shown in Table 4-13, densely settled areas (where over 51 houses in the unit 25 hectares are found) cover around 950 hectares within the study area, 79% of this area are concentrated on the lower area than 1,000 meters in their altitude. Such areas include Same Town, Makanya, Kisiwani, Gonja and Maore sizable village. Around 60 to 70% of the monderately settled areas (where 11 to 30 houses

Table 4-12 Area by Each Land Use

Classification		Symbol	Area(ha)	Area ratio
Grazing intensity	low	F	48,525	23.3
	middle	F(g)	34,075	16.4
	high	F(G)	77,025	37.0
	Total		159,625	76.7
Grazing land		G	5,825	2.8
Dry crop field		C	38,625	18.6
Sisal plantation		S	3,275	1.6
Paddy field		PF	—	—
Palm planation		PP	—	—
Village		V	725	0.3
Roadbed		T	—	—
Railway-bed		R	—	—
Site for High-tension wire		E	—	—
Water bodies		W	25	—
Other land		O	50	—
Total			208,150	100.0

Note: The area of classified land use was estimated by observing the prevailing land use in each cell on the land use maps devided into square (2.5cm × 2.5cm) cells and summing up the area (25 ha/cell) of the cells which have the same prevailing land use.

and 31 to 50 houses in the unit 25 hectares are found) are at altitude of 1,251 to 1,500 meters and 1,501 to 1,750 meters respectively. This indicates that both cultivated land and villages mainly co-exist in highlands. While, almost 70% of the low densely settled areas where less than 10 houses are found in the unit 25 hectares area, they extend in the western hilly areas and lowlands of the altitude below 1,250 meters.

The relationship between distribution of houses and inclination of their lands as shown in Table 4-14, reflects the facts as mentioned above; densely settled areas concentrate on the area of inclination below 5° ; and moderately settled areas are mainly found in the highland area of inclination between 21° and 30°. In the highland areas, even heavily steep slopes of inclination from 31° upto 40° are considerably settled, probably because most of gentle slopes have already developed.

2 Cultivated lands

Farmlands except sisal estates are almost uniformly distributed in the areas of altitudes between 750 meters to 1,750 meters, as indicated in Table 4-16, and are most densely distributed in the areas of altitudes between 1,000 meters to 1,500 meters. Including sisal estates the percentage of cultivated lands in the lowland areas becomes fairly large.

According to the analysis of farmland distribution by inclination of lands it may

be characterized of the study area that approximately 64% of cultivated lands are located in the areas of inclination over 21°. Especially much of the cultivated lands are found on the heavily steep areas of inclination over 31° than on the moderately steep area of inclination between 6° and 20°.

These features are expected to result from the following conditions (of the study area):

- the spacious lowland plains are not suitable for farming due to semi-arid climate or seasonal swamps:
- Since in the area between the lowland and the highland there exist so many fault scarps, the areas of moderate gradient are rather small and rocky; and

Because of these features, they have been obliged to cultivate steep slopes under moderate humidity.

Table 4-15 Cultivated Land Areas by Inclination and Altitude *

Cultivated land areas by their Altitudes			Cultivated land areas by their inclination		
Altitude class (m)	Area (ha)	Ratio (%)	Inclination class (°; degrees)	Area (ha)	Ratio (%)
– 750	3,825	9.9	0–5	6,450	16.7
751–1000	8,150	21.1	6–10	1,975	5.1
1001–1250	8,925	23.1	11–20	2,825	7.3
1251–1500	8,750	22.6	21–30	11,550	29.9
1501–1750	7,200	18.6	31–40	13,250	34.3
1751–	1,800	4.7	41–	2,600	6.7
Total	38,650	100.0	Total	38,650	100.0

* The areas of sisal estates, paddy fields and palm trees are excluded from these above.

③ Grazing lands

The grazing lands herein shall be defined as semipermanent pastures (grasslands) around settlements and thornbush savanna areas affected by grazing.

Of the study area grazing has been practiced mainly in the lowlands due to their history and natural conditions. 55% of grazing lands are located in the area of altitudes below 750 meters followed by areas of altitudes between 751 and 1,000 meters (ratio of 34%) and the ratio of grazing lands in the highland areas higher than 1,000 meters is remarkably small.

Therefore, almost (80% of) grazing lands are located in flatland of inclination below 5° and 13% of them are found in the piedmont and hilly areas with inclination from 6° up to 20°

Table 4-16 Grazing Land Areas by Inclination and Altitude

Grazing land areas by their Altitudes			Cultivated land areas by their inclination		
Altitude class (m)	Area (ha)	Ratio (%)	Inclination class (° ; degrees)	Area (ha)	Ratio (%)
− 750	45,825	55.3	0−5	66,625	80.3
751−1000	27,925	33.7	6−10	4,975	6.0
1001−1250	7,375	8.9	11−20	5,875	7.1
1251−1500	1,725	2.1	21−30	3,275	4.0
1501−1750	0	0	31−40	1,475	1.8
1751−	0	0	41−	625	0.8
Total	82,850	100.0	Total	82,850	100.0

4.5 Survey of Socio-economic Conditions

4.5.1 Survey Methods

(1) Objective and methods

The present survey was implemented in order to grasp the socio-economic conditions and the inhabitants' views on forestry which are the basic data for studying how the social forestry in this area should be.

Questionnaire forms applied to the village authorities and the inhabitants were prepared separately on the basis of the results of the preliminary survey conducted during January and February in 1987. The village chairmen or village secretaries and heads of families were separately interviewed.

(2) Survey items

The survey items are as follows:

① For village authorities

- Population and the number of households by occupation

On agriculture

- Farmland area and possession rights
- Grassland area and possession rights
- Land made arable by the slash-and-burn system
- Principal crop planting areas and harvest
- Fertility of fields
- Fertilizers

On livestock rearing

- Number of domestic animals and raising methods
- Utilization of Water (sources of water, experience in water shortage, etc.)

On forestry

- Utilization of trees (uses of trees, desired species of trees, etc.)

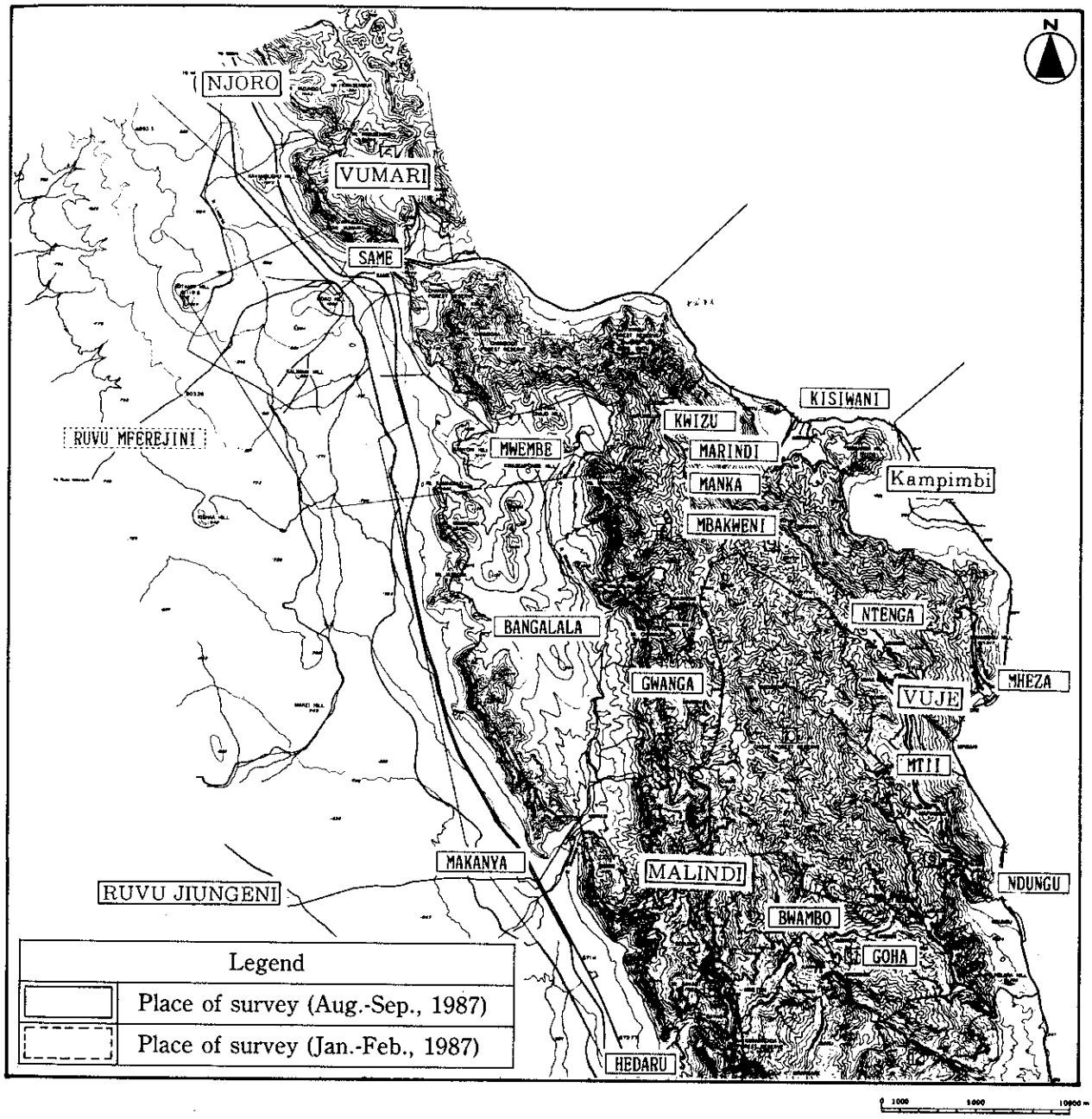


Fig. 4-6 Village Location of Socio-economic Conditions Survey

- Firewood gathering (distance, time required, etc.)
- Prospect for securing fuelwood
- Results and plans of tree planting
- Quantities of charcoal used and produced
- Protection for planted trees
- Government aid or coopperation for tree planting
- Development themes of the villages

② For inhabitants

- Occupations, etc
- Family
- Land in possession

On agriculture,

- Cultivated land and fallow land
- Land made arable by the slash-and-burn method
- Farmland soil
- Fertilizers
- Crops

On livestock rearing

- Domestic animals

On forestry

- Daily fuel (kinds, quantities used)
- Firewood gathering
- Utilization of trees
- Cultivation of tree seedlings (will to purchase tree seedlings)

(3) Survey sites

Interview survey of village authorities was conducted in a total of 21 places by selecting 20 villages and 1 town out of 50 villages and 1 town existing within the Study Area.

Individual interviews of inhabitants were conducted in a total of 22 places, including the 20 villages and 1 town cited above and the Masai people at Kampibi, Kisiwani Village. Fig. 4-6 shows the survey sites.

While the results of survey are described in below, for the sake of convenience of description, the Study Area are divided into the highland area, the western lowland area and the eastern lowland area.

The highland area includes 11 villages, consisting of Vumari, Gwanga, Malindi, Kwizu, Manka, Mbakweni, Ntenga, Vuje, Mtii, Goha and Bwambo.

The western lowland area includes 1 town and 6 villages, consisting of Same, Ruvu Jiungeni, Njoro, Makanya, Hedaru, Mwembe, and Bangalala.

The eastern lowland includes 3 villages, consisting of Kisiwani, Mheza and Ndungu.

While the Masai tribe making their living on livestock rearing alone inhabits

the lowland areas, data could be obtained only at the Mheza Village and Kampimbi, because of the tribe has no fixed residence.

4.5.2 Survey Results

(1) Population and number of households

The population per village ranged between 1,240 and 10,704, averaging 2,946. In the lowland area, the population per village ranged between 1,590 and 10,704, averaging 4,178. In the highland area, however, the population per village ranged between 1,240 and 2,972, averaging 1,938, which is only about half the average population in the lowland villages.

In 16 places out of the 21 places the adult female population topped the adult male population. This is caused by the fact that young males tend to go out of villages in search of jobs in the cities and larger towns. In the present study area, population increase in Same town has been striking, as the population of 6,000 in 1974 had increased to 10,704 by 1986, marking about 4% increase per year. Per-household membership in the 21 surveyed places averaged 6.2, showing little difference between the highland and lowland areas. Most heads of families are engaged in farming, with livestock rearing as side business. Some families are running retail stores and restaurants are found in densely inhabited places.

(2) Utilization of water

The source of water for daily use is river water in most cases, followed by well water (underground water) in the lowland and by spring water and well water in the highland areas.

Waterworks are provided for 13 places out of the 21 survey places, but the supply is by no means enough to meet the needs of the inhabitants. In many places, water carrying work is left to women and children. This, together with gathering of fuel wood, constitutes very heavy work. Experience in water shortage is almost universal, as only the Village of Ndungu out of the 21 survey places has had no such experience.

(3) Agriculture

① Farmland

Average per-household farmland area in the lowland villages ranging between 1.63 and 10.00 acres, the average being 4.59 acres. In the highland villages, the average area was 6.47 acres as the areas ranging between 3.64 and 16.17 acres. The per-household farming scale is larger in the highland area. However, these figures are suspected to be somewhat exaggerated, since they were obtained merely from interviews.

The rate of the acquisition of Kisaka (see 3.3.2.(7)), which may be considered private land possessions was found to be 100% in the highland villages and in the eastern lowland villages in the present survey, but the rate were as low as 27% and 30% in the Village of Makanya and the Village of Ruva Jiungeni, which began

forming communities only about 20 years ago.

Shifting cultivation has not been undertaken in the surveyed places.

② Crops

Among improtant crops, maize and beans have the largest planted areas. In most cases, these are cultivated under mixed cropping or under the double-crop a year system. These are followed by cassavas, bananas and sweet potatoes.

The areas of cultivation of the following crops are limited. In the lowland areas, sorghum, cotton and millet are raised. In the eastern lowland area and along the River Ruvu in the western lowland area, rice is raised. In the highland area, coffee and Irish potatoes are raised. Also cultivated are sugar canes, castor beans, cardamons, sunflowers, wheat and vegetables such as onions, tomatoes and the like and also fruits such as mangoes, papayas and citrus.

While the crops cited above fill the household needs, they are also widely sold. Entire yields of coffee, cotton, sunflowers and cardamons in particular, are converted into cash. In addition, some sisal fields of considerable area are existing, but cultivation is not active because of recent business slump.

③ Fertility of land

The fertility of land is gradually declining in all the areas. The decline of fertility took place from 5 to 30 years ago; responses in 12 out of the 21 surveyed places indicated that the decline commenced some 20 years ago. Fertilizing efforts are made in 20 out of the 21 surveyed places. Barnyard manure is used in 20 surveyed places, compost is used in 18 surveyed places and chemical fertilizers are used in 17 surveyed places.

(4) Livestock rearing

Domestic animals and domestic fowls are kept everywhere, but number of domestic animals per-village is generally larger in the lowland areas than in the highland area. The numbers of principal domestic animals, i.e., cattle, goats and sheep, in terms of total heads per village and per household count, on an average, 21, 781 heads and 28 heads respetively in the lowland areas, and 2,798 and 8 respectively in the highland area. Incidentally, as these figures do not include holdings of the Masai tribe, the number of domestic animals in the lowland areas where they inhabit is likely to be larger.

Cattle, goats and sheep are kept in all the surveyed places. Donkeys were found in 9 out of the 21 surveyed places mostly in the lowland areas, while pigs were kept in 12 out of the 21 surveyed places, mostly in the highland area.

In the western and eastern lowland areas domestic animals are left in the grazing land for the most part, but in the highland area, they are largely kept in the pens, although some are allowed to graze. In the lowland areas, too, some dairy cows (improved breed) are kept in the pens.

When the animals are allowed to graze, the distance to move in a day ranges from 5 km to 14 km or an average of 7.8 km, in the lowland areas. In the highland

Table 4-17 Livestock

	VILLAGE	Main Types and Number of Animals							Raising Method		
		Cows	Goats	Sheep	Donkeys	Pigs	Chickens	Others	Housing	Grazing	In case of grazing how far take
Lowland area	SAME-Ward	15,160	11,130	4,257	1,300	80	21,000		–	v	8 (km)
	RUVU JIUNGENI	11,680	7,800	5,600	4,500	600	50		–	v	7
	NJORO	45,226 (1,496)	43,914	21,718	417	–	5,220	Ducks 259			
	MAKANYA	4,569	5,370	3,180	133	–	3,224		v	v	14
	HEDARU No records available	(10)	–	–	–	–	–		v	v	–
	MWEMBE	2,464	7,063	1,631	54	–	8,549	Rabbit 39	–	v	8
	BANGALALA	4,200	8,800	2,510	120	–	5,880		–	v	8
	KISIWANI	71 (3)	919	491	–	–	3,255	Ducks 575 Rabbit 31	v	v	5
	MHEZA Pares	2,829	2,085	920	90	6	2,900	Ducks 120	v	v	10
	MHEZA Masai	21,849	2,043	1,180	450	–	1,000			v	5
	NDUNGU	1,693	1,333	1,198	23	–	2,986	Ducks 448	–	v	5
	VUMARI	4,000	6,000	4,000	–	–	2,500	Rabbit 20	–	v	3
Highland area	GWANGA	900	150	180	–	80	1,500		v	–	–
	MALINDI	638 (118)	700	120	–	2	900	Ducks 150		v	–
	KWIZU	540	30	1,210	–	95	2,720		v	–	–
	MANKA	428 (148)	170	290	–	36	2,725	Ducks 25 Rabbit 45	v	v	5
	MBAKWENI	620	50	350	–	30	3,100		v	–	–
	NTENGA	1,140 (10)	720	450	–	200	5,200		v	v	8
	VUJE	1,172 (70)	848	557	–	152	3,000		v	–	–
	MTII	93	168	51	–	133	6,218	Rabbit 129	–	v	6
	GOHA	714 (15)	450	430	5	–	3,530	Ducks 250	v	–	–
	BWAMBO	610 (93)	60	150	–	15	1,800		v	–	–

Note : The figures in parentheses shows the number of dairy cows.

villages however, the distance ranges from 5 km to 8 km for an average of 6.3 km.

Chickens are the most popular domestic fowl in all the surveyed places, and they are usually left to move about around the houses freely. Table 4-17 shows the numbers of domestic animals and fowls and the methods of keeping them.

(5) Forestry

① Fuelwood

The inhabitants of the surveyed places normally use wood for daily fuel. In some parts, charcoal is used, but the quantity used in the general household is very small. Use of cow dungs for fuel was not found in any surveyed place.

Fuelwood gathering is normally the work of women and children. Fuelwood

is cut into sticks 15 to 20 cm in length and tied up in bundles 20 to 40 cm in diameter, and each bundle is carried balance on the head. This is a very heavy work for them. A bundle of firewood has an average volume of 0.042 ~ 0.056 m^3. (1 bundle [1.5 ~ 2 cubic feet] 0.042 ~ 0.056 m^3).

The distance they have to travel for gathering fuelwood ranges from 0 km to 10 km or an average of 4.9 km. Time required for the purpose ranges from 2 to 9 hours or an average of 5.5 hours.

Comparison of the lowland areas and the highland areas with respect to fuelwood gathering gives the figures below. In the lowland villages, people have to walk 1 km to 10 km for an average of 6.8 km to gather firewood. Time required for this work range from 3 to 9 hours, or an average of 7.1 hours. In the highland area, the distance ranges from 0 km to 4 km or an average of 3.1 km, and the time needed ranges from 2 to 6 hours for an average of 4 hours. The highland people thus have to work half as much as the lowland people in fuelwood gathering.

In Malindi in the highland areas people sometimes buy fuelwood from the lowland areas and the price is about Shs. 2,000 for a medium-sized truck load. But such incidents do not seem to take place so often.

The fuelwood consumption per household ranges from 2 to 5 bundles per week, which means an average of 3.3 bundles are needed. While the lowland people consume 2 to 4 bundles or an average of 2.7 bundles of fuelwood per week, the highland people consume from 3 to 5 bundles a week for an average of 3.8 bundles, because of the lower temperature.

② Charcoal

Charcoal is used in 13 places out of the 21 places surveyed. Charcoal is used largely in the hotels and restaurants; few private households use it. The Town of Same consume the largest quantity of charcoal at 270 bags per week. The consumption in 12 other places ranged from 2 bags to 65 bags per week.

A bag of charcoal weighs about 30 kg and is priced at about Shs. 150 to 200. Charcoal production is managed in 13 places out of the 21 places surveyed. In the lowland areas 9 places out of the 10 places surveyed are producing 240 to 3,600 bags per year, while in the highlands, 4 out of 11 surveyed places are producing 100 to 1,320 bags per year.

Larger quantities of charcoal are produced in the lowland areas because there is more demand for charcoal in these areas and also because of more readily available transportation facilities. While charcoal production is thus practiced, it is only in the Town of Same that charcoal production is encouraged reflecting shortage of wood for making charcoal.

③ Uses of trees

In the areas surveyed, trees are also used for various purposes other than fuel. The uses include building of houses, providing shades for the crops and houses, feeding domestic animals, preventing soil erosion, producing fruits and medicinal

application.

Trees used as firewood include largely *Acacia spp.*, *Cassia spp.* and *Grevillea spp.* followed by *Eucalyptus spp.* and *Albizia spp.* As material for making charcoal, species of *Acacia* such as *Acacia mearnsii* are used most widely, and *Cassia siamea* is also used.

As fodder for domestic animals, *Acacia spp.*, *Ficus spp.* and *Leucaena sp.* are leading trees for goats allowed to graze. For animals kept in the barns, leaves of *Persea americana* (avocado trees), *Eriobotrya japonica* (loquats trees) and *Psidium guajava* (guava trees) are given in addition to the above mentioned species.

For making poles, *Eucalyptus spp.* and *Acacia spp.*, such as *Acacia mearnsii*, are used most widely, followed by *Grevilles robusta, Widdringtonia whytei* and so forth.

As fruit-bearing trees, *Carica papaya* (pawpaw trees), *Mangifera indica* (mango trees), *Persea americana* (avocado trees) and *Citrus spp.* are predominant. Other fruit-bearing trees grown include *Psidium guajava* (guava trees) and *Malus spp.* (apple trees).

For medicinal purposes, *Ocotea usambarensis* seems to be used as well as *Cassia siames, Azadirachta indica* and *Rauvolfia caffra.*

For providing shades, *Azadirachta indica, Cassia siamea,* and *Albizia spp.* and *Grevillea sp.* have been mentioned at nearly half the total places surveyed at this time. In addition, fruit-bearing trees such as *Mangifera indica* (mango), *Persea americana* (avocado) and *Citrus spp.* (citrous trees) are also used for providing shades.

For preventing soil erosion, *Azadirachta indica, Cassia siamea, Albizia spp.* and *Ficus spp.* are used most widely. *Pennisetum purpureum* (elephant grass) and *Agave sisalana* (sisal), which are not trees, are also used for preventing soil erosion.

④ Species of trees desired for planting

The lowland and highland areas show some differences in the species of trees desired for planting. For fuelwood, in the lowland people prefer *Azadirachta indica* and *Cassia siamea* rather than other species, and *Acacia albida* and *Chlorophora excelsa* are next popular. In the highland area *Grevillea robusta* is preferred in all the surveyed places and *Cedrela odorata, Widdringtonia whytei* and *Acacia mearnsii* were mentioned as the next best.

As material for making charcoal, *Cassia siamea* and *Acacia albida* are prefered in the lowland areas, while *Acacia mearnsii* is popular in the highland areas.

Incidentally, responses citing only *Acacia mearnsii* (local name is Miwati) as the desired species counted 6 out of the 11 village authorities surveyed, while inhabitants in 4 out of the 11 surveyed places gave similar responses.

As pole materials, *Cassia siamea* and *Eucalyptus spp.* were desired most widely in the whole area, and in addition, *Acacia albida, Azadirachta indica* and *Cedrella odorata* in lowland areas and *Acacia mearnsii* and *Grevillea robusta* in the highland area were also desired.

As fruit-bearing trees, *Citrus spp.* was desired in all the places surveyed, and in the lowland areas, *Mangifera indica* (mango) and *Carica papaya* (pawpaw trees) were also desired, while in the highland areas, *Persea americana* (avocado trees), *Prunus spp.* (plums and peaches) and *Pyrus spp.* (pear trees) found wide popularity. Mention of *Malus spp.* (apple trees) was also found.

As trees for medicinal application, mention of *Cassia siamea* and *Azadirachta indica* were found more frequently in the responses of villages authorities, but the inhabitants showed preferences of Mkwinini, Mijohoro, Vidongadwa, Miangwi, Muarobini and Mdaria.

As shade-providing trees, the lowland people prefered *Azadirachta indica, Cassia siamea* and *Delonix regia,* while the highland people prefered *Grevillea spp.* and *Albizia spp.,* Some responses also mentioned *Leucaena sp.*.

As trees that can be used for fodder, *Leucaena sp.* was prefered in all the areas, and in the lowland areas, *Acacia albida, Azadirachta indica* and *Ficus spp.* were also desired, while in the highland areas preferences of *Mangifera indica* (mango) and *Eriobotrya japonica* (loquat trees) were also found.

As trees for preventing soil erosion, *Azadirachta indica, Cassia siamea* and *Ficus spp.* are popular in the lowland areas but in the highland areas, preferences of *Ficus spp.* and *Albizia spp.* are predominant.

⑤ Wood supply and demand

Most places surveyed indicated shortage of wood supply. Shortage of firewood were complained in all the places other than the places having access to the riverine forests along the Ruvu River. In the lowland areas, in particular, considerable distances seem to lie between the villages and places where firewood is available. Shortage of wood for making charcoal is likely to be more acute, as tree species suited to making charcoal are more limited than fuelwood.

Trees usable for fodder are in shortage in 19 places out of the 21 places surveyed. Animals allowed to graze in the lowland areas seem to travel considerable distances to find edible tree leaves.

Shortage of pole material was mentioned in all the places surveyed. Pole materials do not seem to be available near the villages in any of the areas.

Fruit-bearing trees were indicated to be short of supply in 20 places out of the 21 surveyed. In 8 out of 21 village authorities surveyed shortage of medicinal trees was indicated in the responses, and out of 22 individuals inteviewed 13 indicated the shortage.

In all the responses of authorities of the town and villages, shortage of shade-giving trees was indicated, and all the individuals interviewed except one, confirmed the shortage. Shortage of shade-giving trees not only for farm crops such as coffee but also for providing comfortable shades around the houses has become general.

Soil erosion preventing trees are short of supply also in most places surveyed.

⑥ Outlook for securing of firewood

Complaints about shortage of fuelwood are even now frequently made in all the surveyed places except the places haivng access to the riverine forest along the Ruvu River. To anticipate the conditions ten years hence, shortage is likely to prevail in all the places surveyed, and in 19 out of the 21 surveyed places, the shortage is likely to become quite acute.

⑦ Realities of afforestation

The leading role in actual tree planting practice has been played firstly by individuals in most cases and in most places surveyed; and secondly by schools and churches. Only in 5 out of the 21 surveyed places, the government was found to have played the leading role.

In the western lowland areas *Azadirachta indica, Cassia siamea, Delonix regia* and *Casuarina spp.* are the species predominantly planted, and tree planting commenced only after 1965. Some responses say the growth of planted trees are wholly satisfactory, but the fact seems to be that the survival of planted trees ranges from 20 to 80% for an average of 62%.

In the eastern lowland areas *Azadirachta indica, Cassia siamea* and *Cedrela odorata* have been planted, and in Kisiwani *Cassia siamea* has been planted since as early as 1910. In this area, also, large numbers of fruit-bearing trees, such as *Mangifera indica* (mangoes), *Psidium guajava* (guavas), *Carica papaya* (pawpaw) and *Citrus spp.* (citrous trees) are grown, and the responses say their growth is wholly satisfactory in all cases.

In the highlands areas *Azadirachta indica, Cassia siamea, Cedrela odrata, Widdringtonia whytei, Albizia spp., Eucalyptus spp., Grevillea spp.*, and *Pinus spp.* are grown, some of them since as early as 1920's. As coffee was introduced into this area in 1922, *Grevillea spp.* began to be planted from 1925 as shade-providing trees.

Fruit-bearing trees, such as *Persea americana* (avocadoes), *Psidium guajava* (guavas), *Eriobotrya japonica* (loquats), *Mangifera indica* (mangoes) and *Pyrus spp.* (pears)—some them since 1930's—are also grown in the highland areas. Responses indicate that the growth of these trees is entirely satisfactory.

⑧ Tree-planting plans

Twenty out of the 21 surveyed places have tree-planting plans, and in all the places, the schedule calls of planting during 1988/1989.

As species of trees to be planted, *Acacia albida, Albizia lebbeck, Azadirachta indica, Cassia siamea, Cedrela odrata, Chlorophorea excelsa, Delonix regia, Grevillea robusta, Markhamia plativalix* and *Widdringtonia whytei* are expected to be planted in large numbers in most places, but some places they expect to plant *Acacia mearnsii, Casuarina spp., Melia azedarach* and *Trichilia roka.*

Fruit bearing trees expected to be planted include *Malus spp.* (apple), *Persea americana* (avocado), *Mangifera indica* (mango), *Prunus spp.* (peach and plum), *Pyrus spp.* (pear) and *Citrus spp.* (citrous trees).

⑨ Protection of planted site

It is expected that by strict regulation of grazing the sites of tree planted coupled with severe penalty to the violators will be protected from damage by domestic animals. This system is at present applied to farm crops as well.

⑨ Government aid or cooperation for tree planting

What the town and villages wish to have the central government do is concerned with distribution of seedlings for the most part. Among the 21 surveyed places, 17 places have had some experience in obtaining free distribution of seedlings, and these places hope for continuation of such aid into the future.

This point was similary brought up in the interviews of individual inhabitants. With regard to seedlings of fruit-bearing trees, 21 out of 22 responses indicated willingness to buy the seedlings at Shs. 1 to 10 each, but only 4 out of 22 respondents indicated willingness to purchase seedlings of other species of tree, and the desired price, if they should buy, was Shs. 1 to 5. Many of the responses also hoped to have seedlings distributed during the best planting season and complained that the number distributed was small.

⑩ On the development of villages

To the question "what is now needed most for the development of your village?" the largest number of answers concerned with tree planting, as it was mentioned in 20 places out of the 21 surveyed places. This was followed by matters connected with water, such as establishment of waterworks and irrigation facilities. This was mentioned in 19 places. Then matters related to medical service and health were mentioned in 19 places. Road improvements, extension and maintenance were mentioned in 11 places. Improvement of domestic animals was mentioned in 8 places, matters related to agriculture, such as building of warehouses for harvested crops and introduction of modern farming, were mentioned in 3 places (13 places if matters connected with irrigation were included), matters connected with education were mentioned in 2 places and introduction of electricity was mentioned in 2 places.

Judging from the responses, it is evident that planting of trees is considered to be necessary matter for making their villages better places to live in.