JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
FOREST MANAGEMENT CENTER (FMC)
MINISTRY OF NATURE AND THE ENVIRONMENT, GOVERNMENT OF MONGOLIA

THE FOREST RESOURCES MANAGEMENT STUDY

IN

SELENGE AIMAK, MONGOLIA

FINAL REPORT

FEBRUARY, 1998

JAPAN FOREST TECHNICAL ASSOCIATION (JAFTA)
ASIA AIR SURVEY CO., LTD.

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PREFACE

In response to the request from the Government of Mongolia, the Government of Japan decided to conduct the Forest Resources Management Survey in Selenge Aimak, Mongolia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team headed by Mr. Ikuo SUZUKI, Japan Forest Technical Association six times during the period from May 1994 to December 1997.

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

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

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

February, 1998

Kimio FUJITA
President
Japan International Coopperation Agency

LETTER OF SUBMITTAL

Mr. Kimio FUJITA
President
Japan International Cooperation Agency

It is my great pleasure to inform you that the Forest Resources Management Study in Selenge Aimak, Mongolia has been successfully completed and that the Final Report has also been completed for submittal to your agency.

The present Report compiles the results of the surveys and analyses conducted and the plans, etc. formulated by the joint venture in the period from May, 1994 to December, 1998 in accordance with the contract made with the Japan International Cooperation Agency. The Study Team visited Mongolia six times during the period to conduct field surveys in the Study Area.

The forest management plan guidelines were prepared by the Study Team through discussions conducted with the officials concerned of the Government of Mongolia and by using the results of surveys conducted on natural conditions, socioeconomic conditions and forest resources of the Study Area after incorporating the countermeasures against forest fire. Based on the guidelines, the forest management plan was formulated.

I really hope that the present plan will be appropriately implemented with the efforts of Mongolian Government and the assistance of the related persons and contribute to the Mongolia by fostering its forest resources after all.

I would like to take this opportunity to express my utmost gratitude for the considerable understanding and assistance afforded to the Study Team by JICA, as well as the Ministry of Foreign Affairs and the Ministry of Agriculture, Forestry and Fisheries. I would also like to draw your attention to the facts that the Study Team was provided with useful advice and assistance in Mongolia by the JICA Mongolia Office, the Embassy of Japan, the Ministry of Nature and the Environment of Mongolia, the Forest Management Center under the said Ministry and many other organizations involved in this Study.

It is sincerely hoped that the Report submitted here to your organization will prove useful for the further promotion of the plan.

February, 1998

Ikuo SUZUKI
Team Leader
Study Team for Forest Resources Management
in Selenge Aimak, Mongolia

CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

1. OUTLINE OF THE STUDY

1.1 Background

The Government of Mongolia envisages the sustainable utilisation of its forests which account for some 10% (15 million ha) of the total national land area. Forests with such commercially valuable trees as scotch pine and siberian larch cover some 11 million ha and Selenge Aimak is specially rich in forest resources.

The extremely severe natural conditions and a felling cycle of more than 100 years make the smooth progress of reforestation work difficult to achieve. To make matters worse, concern has been expressed in regard to the declining forest area due to forest fires and the process of industrialisation.

Against this background, the Government of Mongolia made a request to the Government of Japan in November, 1992 to conduct a land use survey in Selenge Aimak and to prepare guidelines for a forest resources management master plan as well as a forest management plan for the Model Areas. In response to this request, the Government of Japan sent the Fact-Finding Mission to Mongolia in August, 1993 to confirm the contents of the request and to discuss the contents of the required assistance and proposed study area. In January, 1994, the Preliminary Study Team was sent to Mongolia and the Scope of Work was signed.

1.2 Objective

The ultimate objective of the Study is the preparation of a forest management plan for the Model Areas of some 30,000 ha based on land cover maps to be prepared through analysis of Landsat data for some 4.28 million ha of Selenge Aimak in Mongolia and also based on the forest management plan guidelines to be formulated for the Intensive Area of some 160,000 ha.

2. OUTLINE OF STUDY AREA

2.1 Natural Conditions

The Study Area is located in the transitional area where the mountainous zone around Lake Baykal in Russia changes to the Mongolian highlands and is part of the northern mountain range. Most of the area is situated between EL 800 m and EL 2,000 m and the highest point is Mt. Songol (EL 2,226 m) in the southeastern part while the lowest elevation is around 600 m along the northern border.

The Study Area and its surroundings belong to an orogenic zone of the Late Precambrian and Early Cambrian Era and is situated between the Siberian Platform and Mongolian Geosyncline. The area is one of Mongolia's richest in vegetation and the local vegetation can be classified based on the climatic zone and elevation (between 1,000 m and 2,000 m) as shown in Table 1.

Table 1 Vegetation Classification of Selenge Aimak Based on Climatic Zone and Elevation

Climatic Zone	Elevation (m)	Vegetation Category	Main Species
Boreal ↑	1,400 or more	• Mountainous Taiga Forest	Siberian larch, Siberian fir, Siberian spruce, Siberian pine
	upto 1,400	• Taiga Forest (forest with rich grass growth)	Iris, Cowberry, Rhododendron, Sedge, Siberian larch, Scotch pine
↓ Steppe	upto 1,400	• Grassland (mountainous)	Birch, Feather-grass
	upto 1,200	• Grassland (dry land)	Cottonweed, Feather-grass
		• Riverside Vegetation	Willow, Sedge

2.2 Socioeconomic Conditions

Selenge Aimak has an area of 41,119 km^2 and is divided into 20 administrative districts with its administrative center located in Sukhbaatar. Sukhbaatar and Ulaanbaatar are linked by a state road having a length of some 340 km which can be travelled by car in approximately 5 hours.

The land use in Mongolia mainly consisted of forests (8.8%), grassland (79.8%) and farmland (0.9%). In the case of Selenge Aimak, forest, grassland and farmland occupy

49.7%, 42.6% and 7.3%, respectively which shows relatively high ratio of forests and farmland.

As of 1993, Mongolia's population stood at 2.25 million (population density 1.4 persons/km^2). The population of Selenge Aimak as of 1994 was 90,220, corresponding to 4.0% of the national population and a population density of 2.2 persons/km^2.

Selenge Aimak accounts for 29% of the total amount of grain produced in the country (510,000 tons), underlining its status as the base supplying vegetables and grain to the cities, such as Ulaanbaatar, Darhan, and Erdenet. Some 1.8% of the total 25,694,000 heads livestock of Mongolia are raised in the province.

2.3 Landsat Data Analysis and Land Cover Map Preparation

Landsat data analysis was conducted to clarify the conditions of land cover in the whole of Selenge Aimak and to prepare land cover maps with a scale of 1/250,000.

In terms of vegetation category, forest accounts for 40% of the entire Study Area (about 4.28 million ha) with *Pinus sibirica* forest, *Larix sibirica* forest, *Pinus sylvestris* forest and broad-leaved forest each accounting from 9 to 11%. Meanwhile, grassland and farmland account for 51% and 9% of the study area, respectively. While 83% of forest and 57% of grassland are located in mountains and hills, 41% of farmland is located in plateau and terrace and 33% on colluvial slope.

3. AERIAL PHOTOGRAPHY AND PREPARATION OF TOPOGRAPHIC MAPS

The aerial photography (scale: 1/25,000) was conducted between June 11th and July 1st, 1994. A private Mongolian company was subcontracted to conduct the works of selection of ground control points and stone marker. The ground control point surveying was conducted by closed traversing using the static positioning method of the Global Positioning System (GPS) to determine the coordinates of the newly established GCPs. Part of this ground control point surveying was entrusted to the State Administration of Geodesy and Cartography of Mongolia.

Following selection of the Model Areas of 300 km^2 in the Intensive Area of 1,600 km^2, the topographical maps of the scale 1/50,000 were prepared for the Intensive Area by using SPOT imagery data and by superimposing the contour maps and orthophotos.

4. Surveys in Intensive Area

4.1 Natural Conditions Survey

The Intensive Area is situated around Lat. 50°N and on the climatic boundary of the steppe zone and boreal zone. The mean annual temperature is 0.7℃. The mean maximum monthly temperature ranges from -22.1 ℃ in January to 19.0℃ in July. Highest temperature is 36.4℃ in June and lowest temperature is -40.1℃ in January. The annual rainfall is 276 mm, most of which is recorded in summer between May and September. Most parts of the Intensive Area are in the altitude range of between 650 m and 1,500 m with Mt. Delgilhaan, located at its western boundary, being the highest point at 1,553 m.

Geologically, the mountains contain andesite, schist, tuff, rhyolite, porphyry of Triassic Period, as well as granite, granodiorite and gabbro, etc.

Three watersheds, i.e. Herane River watershed in the central area, Chikey River watershed in the east which extends into Russian territory and Uroo River watershed in the southwest, cover most of the Intensive Area.

The soils in the area are largely classified into Cambisols and Leptosols which are mainly distributed at steep mountains, Kastanozems at pediments, Arenosols at terraces and Fluvisols at valley bottom lowlands.

Vegetation of the area and its neighborhood consists of forest communities commonly called taiga which are a kind of coniferous forest, having developed as zonal vegetation under the subpolar climate. The species growing in these taiga are capable of withstanding extremely low temperatures of below -30℃ in winter and consist of coniferous trees belonging to the *Abies*, *Picea*, *Larix* and *Pinus* genera and broad-leaved trees belonging to the *Betula* and *Populus* genera.

The main wild mammals and birds which are said to inhabit the Intensive Area and its surroundings are 32 mammalian species and 45 bird species.

4.2 Socioeconomic Conditions Survey

Administratively, the Intensive Area mainly belongs to the Altanbulag District the total population of which was some 3,283 and its population density, as of December, 1994, was 1.2 persons/km^2. The farming area in Altanbulag District is some 12,128 ha,

accounting for 4.6% of the total land area of 264,357 ha of the district which is lower than 7.3% for Selenge Aimak. The method of cultivation is crop rotation of cultivating one year and fallow the following year. The total number of stock raised in the Altanbulag District is estimated at 14,833 heads of sheep, cattle and horses. The horses amount to some 1,724 heads.

No asphalt paved road or gravel paved road exist in the Intensive Area. All existing roads are dirt roads.

4.3 Forest and Forestry Survey

4.3.1 Forest and Forestry Related Laws

The basic law regarding forest and forestry in Mongolia is the Forest Law which was enacted in 1974. Following the shift towards democracy, however, a new Forest Law which divides the country's forest into strict zone forests, protected zone forests and utilization zone forests went into force in June 1995.

The Mongolian Law on Special Protected Areas, which went into effect in 1994, was enacted for the purpose of protecting the nature in Mongolia. The Forest and Grassland Fire Prevention Law was promulgated in May 1996 to prevent fires that are frequently occurring in Mongolia, and was enforced immediately.

4.3.2 Timber Production and Use

(1) Forest Resources

Forest land in Mongolia occupies some 15,219,000 ha (9.7% of the total land area of the country), of which some 13,924,000 ha are classified as stocked land, accounting for 8.9% of the country's total land area.

Within Selenge Aimak, *Pinus sylvestris* occupies the largest forest area (31.8%), followed by *Larix sibirica* (27.2%), *Betula* spp. (24.2%) and *Pinus sibirica* (15.7%). These top four species account for 99% of the forest land area of Selenge Aimak, particularly *Pinus sylvestris* accounting for 50.5% of the whole country.

(2) Cutting

The State Central Administrative Organization determines the upper limit of annual harvest of utilization zone forest by province and capital. The council of representatives in the capital and provincial representatives determines the allowable cut volume in the forests under their jurisdiction within the range decided by the State Central Administrative Organization. The council of district representatives determines the allowable cut volume in the area under its jurisdiction based on the yield decided by the provincial representatives council. The number of permits issued for cutting of standing trees in 1995 in Altanbulag District was 1,767, involving some 3,270 ha forest and some 92,500 m^3 of logs.

(3) Timber Supply and Demand

The 10 year statistics cited from the FAO Forest Products 1993 show that the annual log production volume for timber and veneer in Mongolia upto 1988 was 1,040,000 m^3 (990,000 m^3 from coniferous trees and 50,000 m^3 from broad-leaved trees). Since 1991, however, the production volume from coniferous trees has gradually declined while there has been no production from broad-leaved trees.

By 1988, the production volume of timber from coniferous trees was constant at 470,000 m^3/year and increased at one time from 1989 to 1990, followed by a period of a significant decline from 1991 onward. In 1993, the timber production volume from coniferous trees was equivalent to 23% of the 1989 level.

In 1987, 18,000 m^3 of timber was exported for China. Timber has since been exported intermittently with the volume totalling 91,000 m^3 in 1993. Some 70 to 80% of all timber-related businesses in Mongolia are concentrated in Selenge Aimak.

4.3.3 Afforestation

(1) Current Conditions

Afforestation commenced in Mongolia in 1968 and *Pinus sylvestris*, *Larix sibirica*, *Populus suaveolens* and *Haloxylon ammodendron*, etc. have been systematically planted since 1972. The total afforestation area was some 51,990 ha for 20 years from 1975 to 1994. Based on aerial photo interpretation areas

recently afforested by Forestry Office of Selenge Aimak were found to be 837 ha for the Intensive Area and 97 ha for the Model Areas.

(2) Method

Land preparation for afforestation purposes uses a plough-mounted tractor which digs inverse triangular-shaped grooves of 70 cm in width and 30 - 40 cm in depth at 3 - 5 m intervals. The dug soil is then replaced in the grooves to achieve a groove depth of 15 - 25 cm. The grooves are, in principle, dug parallel to the contour lines. Planting season is from late April to mid May, planting 3,000 to 3,500 trees/ha (3 to 6 seeds/hole when sowing the seeds directly). However, this planting method, including the land preparation process, must be reviewed because of its poor survival rate attributable to removal of the surface soil that deteriorates the moisture environment, poor quality of seedlings and deep planting.

(3) Present State of Nursing

Currently in Selenge Aimak there are 3 nurseries producing some 2,900,000 seedlings annually. *Pinus sylvestris* seedlings are grown at the nursery of the Forestry Office of Selenge Aimak located in Hond in the Intensive Area which was established in 1981 and at the nursery of Vocant Lumber Company, while *Larix sibirica* seedlings are grown at the nursery of Dzuunharaa Branch of the Forestry Office.

4.3.4 Forest Roads

While there are some recreational facilities and large farms in the Intensive Area and its surroundings, there are no official roads except for the provincial road located along the southern boundary of the Intensive Area. All of the roads in the Intensive Area are dirt roads which are also used as forest roads.

4.3.5 Forest Protection

(1) Forest Fires

The area damaged by fire throughout the country reached 4.34 million ha during the 23 year period from 1973 to 1995 with average annual damage of just over 189,000 ha, accounting for 1.4% of the forest area. The average of damaged area

per fire is large at 29,000 ha, indicating that the fire becomes large in scale once it occurs. In addition, more than 200,000 ha of forests are damaged in recent years.

Selenge Aimak is frequently hit by forest fires. A total of 88 fires that occurred in the 10 year period from 1966 to 1975 burnt 1.06 million ha, accounting for 56% of all areas damaged by fire in the country. As many as 20 to 40 forest fires are recorded every year. Most forest fires are caused by human carelessness such as throwing away of still burning cigarette tips or matches and open air fires by passengers.

Forest fire prevention measures adopted by some districts in Selenge Aimak are the requirements to notify of entry into a forest and to obtain a permit to enter a forest and public relations activities to prevent forest fires. In addition, the Tushig and Dzelter District Offices have established the Forest Fire Prevention Council while the Altanbulag District Office has established the Disaster Committee to implement fire prevention measures.

(2) Biological Damage

Along with insect damage to naturally regenerated *Pinus sylvestris* trees, damage to new tree summits by shoot borers was observed. Insect damage by borers was also observed among trees damaged by forest fires and overmatured trees although the damage was rather insignificant. Afforestation sites containing trees damaged by frost and drought were seen here and there.

4.4 Volume Table Survey

Through consultations with the RIFW, it was decided to examine the volume tables for the following 4 tree species which grow in the Intensive Area.

- *Larix sibirica*
- *Pinus sylvestris*
- *Pinus sibirica*
- *Populus tremula*

The volume formula shown in Table 2 for the tree species growing in the Study Area was used to estimate the forest resources volume.

Table 2 Volume Equation Used to Estimate Forest Resources Volume

Item	*Larix sibirica*	*Pinus sylvestris*	*Betula platyphylla*	*Populus tremula*
Volume Formula	$V = a \times d^b \times h^c$			
a	0.5640205	0.356149	0.8418616	0.2082071
b	1.8059458	1.91061797	1.7245579	1.7954576
c	0.8242713	0.96807707	0.6177921	1.0807193
Source	Newly formulated	Existing formula	Newly formulated	Inferred based on existing volume table

4.5 Land Use and Vegetation Survey

Land use and vegetation survey of the Intensive Areas was conducted by means of aerial photo interpretation, field survey and field verification and land use and vegetation maps (scale: 1/50,000) were prepared.

5. FOREST SURVEY OF MODEL AREAS

5.1 Soil Survey

A soil survey was conducted to examine morphological features of the forest soil profiles in the Model Areas. The soil profiles were described in accordance with the FAO Guidelines and soil maps (scale: 1/25,000) were prepared.

The 2 types of Cambisols comprising mapping unit "C" are both suitable for tree growth and their productivity is next to that of Haplic Kastanozems. Haplic Kastanozems, the main components of mapping unit "K", have the best soil productivity in the Model Areas due to their weak acidity and rich nutrients and provide good growth prospects for *Pinus sylvestris* and *Larix sibirica.* As Haplic Arenosols comprise excessively drained soil with a poor presence of organic matter and clay, they have low capacity to hold nutrients and moisture, making *Pinus sylvestris* the only suitable species for the mapping unit "A". The land productivity is extremely low in the case of those areas classified as "L·C". Umbric Fluvisols, the main components of mapping unit "F", are relatively rich in nutrients. However, their poor drainage makes them unsuitable for the growth of such useful trees as *Pinus sylvestris* and *Larix sibirica.*

5.2 Forest Physiognomy Survey

A forest physiognomy survey was conducted in the Model Areas on the basis of the forest type interpretation categories, interpretation items of land use and vegetation, and tree height and crown density given as in Table 3.

Table 3 Forest Type Interpretation Categories and Symbols

Category Type	Category	Range	Symbol
Height Class	Low	- 12 m	H3
	Medium	13 m - 20 m	H2
	High	21 m -	H1
Crown Density	Very Sparse	- 30%	D4
	Sparse	31% - 60%	D3
	Medium	61% - 90%	D2
	Dense	91% -	D1

Forest type maps of the Model Areas (scale: 1/25,000) were prepared through interpretation of aerial photos and field inspection.

5.3 Volume Survey

(1) Estimation of Volume

Volume survey was conducted through the sample plot survey in the Model Areas. The volume/ha was calculated for each forest physiognomy category as shown in Table 4.

Table 4 Volume/Ha by Forest Physiognomy Category

(Unit: m^3)

Secondary Category	Tertiary Category	Symbol	Average	Largest	Smallest
Coniferous Forest	Pine Forest	NP	190.797	303.352	77.978
	Larch Forest	NL	279.390	339.188	238.324
	Pine/Larch Forest	N	271.221	341.914	216.158
Mixed Forest		M	194.125	298.584	102.262
Broad-Leaved Forest		L	125.741	182.188	71.096
All Forest Land			194.479	341.914	71.096

By adding the volume of each forest physiognomy category based on the sample plot survey and aerial photo interpretation, the volume by each forest physiognomy category was estimated as shown in Table 5.

Table 5 Estimation of Gross Volume by Forest Physiognomy Category

(Unit: m^3)

Secondary Category	Tertiary Category	Symbol	Model Area 1	Model Area 2	Total
Coniferous Forest	Pine Forest	NP	680,140	308,170	988,310
	Larch Forest	NL		335,480	335,480
	Pine/Larch Forest	N		356,020	356,020
Mixed Forest		M	212,990	1,311,930	1,524,920
Broad-Leaved Forest		L	147,480	798,180	945,660
All Forest Land			1,040,610	3,109,780	4,150,390

(2) Preparation of Stand Volume Table

In order to prepare the forest inventory book, the volume/ha for each forest physiognomy category was estimated by using the results of the sample plot survey. For the regression, the following formula was adopted. The dependent variable is the volume/ha for each forest physiognomy category while the average tree height and crown density class are applied as independent variables.

$$Y = aX_1 + bX_2 + c$$

Y : volume/ha (m^3)
X_1 : average tree height (m)
X_2 : crown density class

a, b, c : Coefficients

Table 6 Regression Results for Stand Volume Table

Forest Type	Symbol	Data Composition	Correlation Coefficient	a	b	c
Pine Forest	NP	NP	0.89	16.93654	-37.35913	-36.14413
Larch Forest	NL	NL, L	0.97	25.62222	-30.38136	-212.99880
Pine/Larch Forest	N	N, NP, NL	0.92	19.20838	-36.07226	-75.12303
Broad-Leaved Forest	L	L	0.91	19.26609	-34.92365	-114.61709
Mixed Forest	M	M	0.91	22.04127	-16.26007	-184.73216

5.4 Stand Structure Survey

5.4.1 Structure of Natural Forests

In order to understand the structure of natural forests, a survey was conducted together with classification based on stand similarity, in turn determined by the cumulative curve of the number of trees established for each plot using the inventory data.

As the *Pinus sylvestris* forests distributed in Model Area 1 and Model Area 2 have a complex structure due to repeated forest fires and cutting in the past while they show straight trunks. The *Larix sibirica* forests distributed in Model Area 2 have a stand structure of the upper canopy layer of scattered *Larix sibirica*, the middle and lower canopy layers of *Larix sibirica* and broad-leaved trees and brushes of *Rhododendron dahuricum* growing on the forest bed.

Coniferous forests in which *Pinus sylvestris* and *Larix sibirica* are mixed with broad-leaved trees found in Model Area 2. The mixture of broad-leaved trees is less in the lower layer compared to *Larix sibirica* forests. Mixed forests of coniferous and broad-leaved trees are forests in which *Pinus sylvestris*, *Larix sibirica* and/or broad-leaved trees are mixed from the upper to the lower layers, and distribute in Model Area 2. Many stands of the broad-leaved forests have a canopy consisting of small to medium diameter trees, reflecting the damage caused by forest fires in the past, and some scattered medium to large diameter trees on the upper canopy layer with qualitative defects that have survived forest fires.

5.4.2 Growth of *Pinus sylvestris*

The stump survey results suggest specific growth relationship between the annual ring growth by decade and tree age. The growth is slow upto the age of around 20. In the next period between 20 and 50 years of age, the growth is the fastest, followed by a period of gradual decline and further slow growth after 120 years of age.

Survey plots were established at Model Area 1 and the vicinities in order to investigate the growth condition of planted trees of *Pinus sylvestris*. In general, the number of growing planted trees is less than 1,000 trees/ha. With the limited prospect, it is unlikely that these sites will become productive forests in the near future.

5.5 Natural Regeneration Survey

It was decided to describe the state of natural regeneration by indexing the number of seedlings and saplings. The standard number of trees/ha corresponding to a regeneration index of 1.0 was then decided to be 3,000 for seedlings and 2,000 for saplings. The regeneration index was rounded as 0.1-0.9 when it was less than 1.0.

In *Pinus sylvestris* stands and those mixed with a small number of broad-leaved trees, the average regeneration index for *Pinus sylvestris* is 0.4. *Larix sibirica* grows in Model Area 2. At mixed stands of coniferous and broad-leaved trees where *Pinus sylvestris* account for 25% or more, the regeneration indices for *Larix sibirica* and *Pinus sylvestris* are 0.1 and 0.2 respectively. The ratio of sub-plots of which the regeneration index for *Pinus sylvestris* stand is 1.0 is only 11% which is reduced to zero in terms of plots, indicating the extremely poor regeneration of coniferous trees.

5.6 Increment Survey

The increment was surveyed for each forest physiognomy category involving *Larix sibirica*, *Pinus sylvestris*, *Betula platyphylla* and *Populus tremula*. Regression calculations using logarithmic equations were conducted to estimate the stand gross increment rate for each forest physiognomy category by identifying the correlation between the stand gross increment rate of the sample plots and the crown density/tree height.

The stand increment rate is calculated by subtracting the mortality rate of the stand from the sum of single tree volume growth rate. In the event the stand physiognomy in question is in climax, stand increment rate is regarded as "0" because increment and mortality generally coincide. The volume by forest physiognomy category obtained from the inventory study was multiplied by stand increment rate to obtain the stand increment. The stand increment was calculated by Model Area and by forest physiognomy categories as shown in Table 7.

Table 7 Estimation of Stand Increment

Forest Physiognomy Category	Increment (m^3)		
	Model Area 1	Model Area 2	Total
NP	13,561	4,971	18,532
NL		234	234
N		474	474
L	1,280	13,442	14,722
M	3,596	10,410	14,006
Total	18,437	29,531	47,968

5.7 Preparation of Forest Inventory Book

Forest inventory book was prepared on the following items based on the content of study.

Table 8 Forest Inventory Book Items

No.	Item	Unit	No.	Item	Unit
1	Administrative Location		14	Height Class	
2	Model Area		15	Crown Density Class	
3	Compartment Number		16	Stand Density Ratio	%
4	Sub-Compartment Number		17	Stand Age	yr
5	Forest Area	ha	18	Mean Tree Height	m
6	Non-Forest Area	ha	19	Mean DBH	cm
7	Legal Designation		20	Species	
8	Management Category		21	Composition by Species	%
9	Stand Quality		22	Volume	m^3
10	Slope Class		23	Volume per hectare	m^3/ha
11	Soils		24	Annual Increment	m^3/yr
12	Forest Management Type		25	Forest Floor Vegetation	
13	Land Use & Vegetation Type		26	Remarks	

6. FOREST FIRE SURVEY

6.1 Outline

The forest and grassland fire which occurred in April through June, 1996 spread over Mongolia's entire forest land with damage extending to Selenge Aimak, the Intensive Area and the Model Areas. Reportedly the damaged forest area totalled 2.36 million ha in the entire Mongolia and 0.24 million ha in Selenge Aimak.

During the field survey conducted in June, 1996, the findings suggest that some 60% of the Intensive Area which is directly related to the forest resources management plan was affected and that damage was caused to standing trees in some 25% of the Intensive Area. The roads were observed to have a key role of breaks for fire extension.

6.2 Survey on Intensive Area

6.2.1 Aerial Photography of Fire Damaged Areas in 1996

In order to establish an accurate picture of the fire damaged areas in 1996, aerial photography (scale: 1/20,000) covering the said areas in the Intensive Study Area was conducted between June 1st and July 5th, 1997.

6.2.2 Land Use and Vegetation Survey

The survey was conducted on the fire damaged areas in 1996 in the Intensive Area by means of interpreting the aerial photographs taken in 1997 and verifying the interpretation results through ground investigation and land use and vegetation map after 1996's fire (scale: 1/50,000) were prepared.

For the preparation of the post-fire land use and vegetation maps, the newly taken aerial photographs were interpreted to identify those areas where the upper-story trees were damaged by the fire in 1996 as fire damaged forests in 1996 and the pre-fire land use and vegetation maps were accordingly modified. In the Intensive Area, pine forests have been the serious victims of the fire in 1996.

Table 9 Changes in Pre- and Post-Fire Area Composition on Land Use and Vegetation Map

Primary Category	Secondary Category	Area Before Fire (A) (ha)	Area After Fire (B) (ha)	Decrease (A)-(B) (ha)	Decrease Rate [(A)-(B)] /(A) (%)
Forest	Pine Forest	33,159	19,143	14,016	42%
	Larch Forest	3,199	2,536	663	21%
	Pine/Larch Forest	2,766	2,724	42	2%
	Planted Forest	837	1,212	-375	-45%
	Broad-Leaved Forest	30,149	23,931	6,218	21%
	Mixed Forest	23,700	19,361	4,339	18%
	Unstocked Land	8,817	2,841	5,976	68%
	Fire-Damaged Forest	5,143	431	4,712	92%
	Logged-Over Land	3,588	906	2,682	75%
	Shrub Land	8,791	8,039	752	9%
	New Fire-Damaged Forest Suffered in 1996	0	39,025	-39,025	
	Subtotal of Forest Area	120,149	120,149	0	0%
Non-Forest	Grassland	31,048	31,048	0	0%
	Farm Land	4,844	4,844	0	0%
	Settlement	115	115	0	0%
	Rocky Land	4,146	4,146	0	0%
	Subtotal of Non-Forest Area	40,153	40,153	0	0%
Total		160,302	160,302	0	0%

6.2.3 Meteorological Survey

Noticeable falls of the monthly rainfall and snow cover thickness data are considered to be important indicators for evaluation of the data for preceding months in the long-term forecasting of forest fire. To be more precise, the exceptional fall of the snow cover thickness in March, followed by an exceptionally low rainfall level, indicates an alarmingly high hazard for a large-scale forest fire.

In addition to the dry conditions in 1996, the most prominent characteristic in 1996 was the continuance of a strong wind of more than 10 m/s for one week. This strong wind appears to have been decisive in the expansion of the forest fire in 1996.

6.2.4 Survey on Administrative Response

(1) Administrative Response to Fires

As the forest fire in 1996 was nationwide, it was classified as a natural disaster. Consequently, the Forest and Grassland Fire Prevention Law [No. 116 (1334), enforced on May 28th, 1996] was enacted as part of the relief measures.

For the fire in 1996, the Forestry Office of the government of Selenge Aimak acted as the secretariat to coordinate the fire-fighting activities. Damage due to the forest fire in 1996 occurred in the following two locations in the Altanbulag District.

- Around Shamalfundi (fire broke out on May 12th)
- Near the Russian border at the northern end of the Altanbulag District (fire broke out on May 14th in Russia and extended into Mongolia)

(2) Survey Activities on Scale of Fire Damage

The Ministry of Nature and the Environment conducted an urgent survey on the massive forest fire in 1996 and prepared the 1996 Forest Fire Survey Report. The damage caused by the forest fire was classified into three categories using the ratio of damaged trees in existing stands as the yardstick. The size of the damaged area, representing the extent of ecological damage, and the total value of damage, representing the extent of economic damage, were then calculated as shown in Table 10.

Table 10 Size of Damaged Area and Estimated Total Value of Damage Due to Forest Fire in 1996

Damage Category	Corresponding Ratio of Damage Volume (%)	No. of Years Required to Restore Forests Through Natural Regeneration (years)	Size of Damaged Area Surveyed (ha)	Estimated Value of Damage Surveyed (million Tg)
Large	60 - 80	(difficult to assess)	252,238	24,218.37
Medium	30 - 40	7 - 10	331,339	5,140.29
Small	5	2 - 3	1,870,208	3,215.92
Total			2,453,785	32,574.58

According to the 1996 Forest Fire Survey Report published by the Ministry of Nature and the Environment, the damage due to forest fire in Selenge Aimak extended to 13 districts in the period from March 24th to June 5th with 65 separate fires being observed. The fire damage in Selenge Aimak is estimated as Fig. 1. However, in terms of value, the damage to *Pinus sylvestris* accounts for some 70% of the total value of damage, indicating major economic damage to this particular species compared to others.

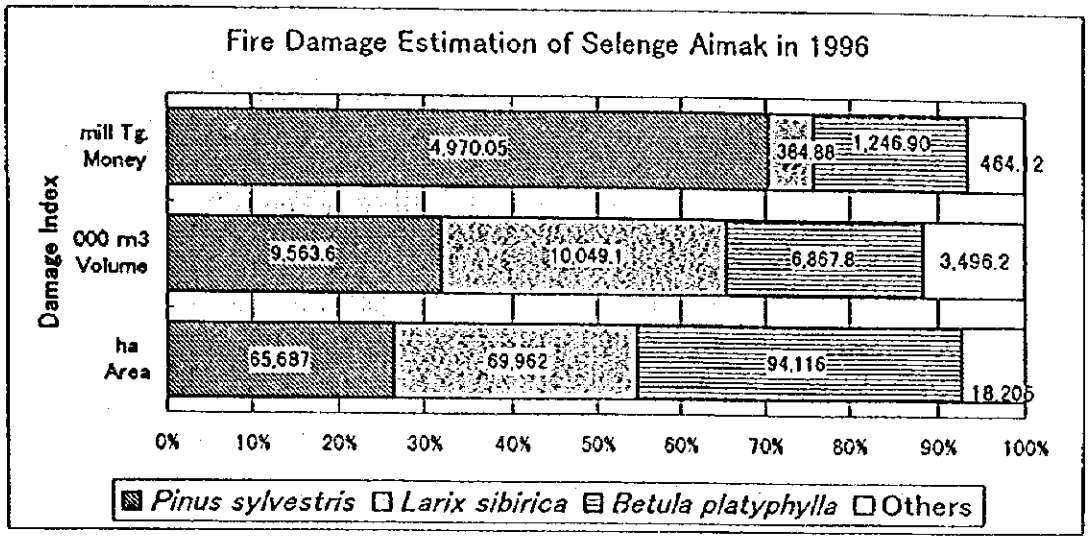

Fig. 1 Composition of 1996 Forest Fire Damage by Species in Terms of Area, Volume and Value in Selenge Aimak

6.2.5 Survey on Utilisation of Damaged Trees

The Forest Law gives the authority to permit cutting for timber production to district heads. While permits were issued on the grounds that damaged trees would be cut, the illegal cutting of trees other than damaged trees was frequently conducted.

In order to prevent activities violating the Forest Law and to promote the appropriate use of forest resources, the Ministry of Nature and the Environment issued a notification in March, 1997 affording the aimak government and the Council of Representatives the authority to monitor the cutting permit issuing process while restricting the eligible persons for such permits to logging contractors with past records.

It can be seen that damaged trees are not actively used by forest products companies, the production level of which using damaged trees is similar to the conventional production level using live trees. Trees damaged by harmful insects are not used at all. As the Ministry of Nature and the Environment has reduced the overall cutting volume, the sawing volume has accordingly declined.

6.2.6 Survey on Rehabilitation Measures and Fire Prevention

It is currently planned to reforest 30,000 ha in the four year period from 1996 to 1999 at various damaged sites throughout Mongolia. The planned reforestation area for 1997 in Selenge Aimak is 519 ha which includes areas to be planted by companies conducting cutting and sawing. A total of 294 ha of planting will be conducted in the Tojin Nars area. At present, the Forestry Office of Selenge Aimak is planning annual planting of 250 ha in the period from 1997 to 2000 to rehabilitate the fire damaged forests.

6.3 Survey on Model Areas

6.3.1 Forest Physiognomy Survey

A forest physiognomy survey consisting of field survey and the interpretation of aerial photographs was conducted to establish an accurate picture of the forest fire damage in the Model Areas. The established damage situation was then classified using interpretation categories and the findings were shown on the forest type maps after 1996's fire.

6.3.2 Volume Survey

For conducting a volume survey, sample plots were established for those *Pinus sylvestris* stands which were the most severely damaged. The surviving volume after the fire in 1996 was estimated for each site given a section number after the 1996's fire which was used as the fire damage interpretation unit for the forest type maps after 1996's fire using the tree survival ratio interpreted on the aerial photographs. The pre and post-fire areas and volumes by land use and vegetation type in the Model Areas are shown in Table 11.

Table 11 Areas and Log Volumes of Pre and Post-Fire in Model Areas

Model Area	Land Use & Vegetation Type	Before Fire (A)				After Fire (B)				Fire-Damaged Amount (A−B)				Damaged Rate	
		Area (ha)	Volume (m^3)			Area (ha)	Volume (m^3)			Area (ha)	Volume (m^3)			Area	Volume
			N	L	計		N	L	計		N	L	計		
1	Pine Forest	3,965	634,003	46,137	680,140	2,770	386,356	43,114	429,470	1,195	247,647	3,023	250,670	30.1%	36.9%
	Larch Forest														
	Pine/Larch Forest														
	Planted Forest	97				97									
	Broad-Leaved Forest	1,235	8,403	139,077	147,480	1,235	8,403	139,077	147,480						
	Mixed Forest	1,056	121,132	91,858	212,990	923	109,000	83,010	192,010	133	12,132	8,848	20,980	12.6%	9.9%
	Unstocked Land	90				18				72				80.0%	
	Fire-Damaged Forest	199				1,394				-1,195				600.5%	
	Logged-Over Land	42	320		320	247	320		320	-206				488.1%	
	Shrub Land														
	Grassland	222				222									
	Farm Land	24				24									
	Rocky Land	4				4									
	Total	6,934	763,858	277,072	1,040,930	6,934	504,079	265,201	769,280		259,779	11,871	271,650		26.1%
2	Pine Forest	1,571	281,819	26,351	308,170	1,115	141,979	16,761	158,740	456	139,840	9,590	149,430	29.0%	48.5%
	Larch Forest	1,123	283,609	51,871	335,480	1,101	255,483	46,447	301,930	22	28,126	5,424	33,550	2.0%	10.0%
	Pine/Larch Forest	1,218	310,381	45,639	356,020	1,205	275,027	39,033	314,060	13	35,354	6,606	41,960	1.1%	11.8%
	Planted Forest														
	Broad-Leaved Forest	7,376	70,414	727,766	798,180	6,563	57,957	604,643	662,600	813	12,457	123,123	135,580	11.0%	17.0%
	Mixed Forest	5,755	736,987	574,943	1,311,930	5,379	614,685	480,045	1,094,730	376	122,302	94,898	217,200	6.5%	16.6%
	Unstocked Land	1,579								1,579				100.0%	
	Fire-Damaged Forest	18				4,075				-4,057				22538.9%	
	Logged-Over Land	776	4,690	4,760	9,450					776	4,690	4,760	9,450	100.0%	100.0%
	Shrub Land	22								22				100.0%	
	Grassland	2,365				2,365									
	Farm Land														
	Rocky Land	914				914									
	Total	22,717	1,687,900	1,431,330	3,119,230	22,717	1,345,131	1,186,929	2,532,060		342,769	244,401	587,170		18.8%
1	Pine Forest	5,536	915,822	72,488	988,310	3,885	528,335	59,875	588,210	1,651	387,487	12,613	400,100	29.8%	40.5%
&	Larch Forest	1,123	283,609	51,871	335,480	1,101	255,483	46,447	301,930	22	28,126	5,424	33,550	2.0%	10.0%
2	Pine/Larch Forest	1,218	310,381	45,639	356,020	1,205	275,027	39,033	314,060	13	35,354	6,606	41,960	1.1%	11.8%
	Planted Forest	97				97									
	Broad-Leaved Forest	8,611	78,817	866,843	945,660	7,798	66,360	743,720	810,080	813	12,457	123,123	135,580	9.4%	14.3%
	Mixed Forest	6,811	858,119	666,801	1,524,920	6,302	723,685	563,055	1,286,740	509	134,434	103,746	238,180	7.5%	15.6%
	Unstocked Land	1,669				18				1,651				98.9%	
	Fire-Damaged Forest	217				5,469				-5,252				2420.3%	
	Logged-Over Land	818	5,010	4,760	9,770	247	320		320	571	4,690	4,760	9,450	69.8%	96.7%
	Shrub Land	22								22				100.0%	
	Grassland	2,587				2,587									
	Farm Land	24				24									
	Rocky Land	918				918									
	Grand Total	29,651	2,451,758	1,708,402	4,160,160	29,651	1,849,210	1,452,130	3,301,340		602,548	256,272	858,820		20.6%

6.3.3 Modifications of Forest Inventory Book

The items used for the post-fire forest inventory book include new items as shown in Table 12.

Table 12 New Items Used for Post-Fire Forest Inventory Book

Item	Unit
Section Number After the 1996's Fire	
Fire Damage Level	
Surviving Rate After Fire	10 %
Surviving Volume After Fire	m^3
Surviving Volume/ha After Fire	m^3/ha
Annual Increment After Fire	m^3/yr

6.3.4 Natural Regeneration Survey

(1) Damage Survey on Young Stands

Among natural stands, the mean death rate of young trees due to the fire in the survey plots was 100% for seedlings and 96% for saplings. The mean death rate of naturally regenerated, young *Pinus sylvestris* seedlings and saplings due to the fire was 79% at naturally regenerated sites. The death rate due to the fire of planted trees was 56% and that of naturally regenerated trees was 70% at man-made *Pinus sylvestris* stands. The mean death rate due to the fire among planted and naturally regenerated trees was 67% because the surviving number of planted trees was relatively small.

(2) Natural Regeneration Survey

The density of the seedlings grew in *Pinus sylvestris* stands in the post-fire period ranges from 0 to 150,000 seedlings/ha in the case of current year seedlings and 0 to 290,000 seedlings/ha in the case of one year old seedlings. The mean figure for the survey plots of 24,000/ha is modest. Meanwhile, seedlings of *Larix sibirica* were not found in those stands damaged by ground fire as well as crown fire.

One year old seedlings of *Betula platyphylla* and *Populus tremula* were seen to have reached a height of 1 - 2 m in the Intensive Area.

6.3.5 Secondary Damage Survey

Forests damaged by fire or wind are vulnerable to secondary damage due to borers, the threat of which can last for several years. In terms of the relationship between the fire damaged forest area and the area damaged by harmful insects in the past, a major forest fire tends to be followed by an outbreak of insect damage lasting for several years.

Harmful insects to fire damaged *Pinus sylvestris* Forests are mainly of:

① *Evetria resinella* : damaging buds
② *Monochamus galloprovinciali* : damaging inside of stem
③ *Acanthocinus aedilis* : damaging inside of stem
④ *Ips sexdentatus* : damaging inside of stem

In particular, a high density of borers (② to ④) which are secondary harmful insects were found below the bark. The damage was easily visible from the outside. A forest fire can wipe out shrub, naturally regenerated seedlings, grass, fallen leaves and fallen branches, etc. on the forest floor. A thin Ao horizon resulting from this process was observed during the field survey.

7. FOREST MANAGEMENT PLAN GUIDELINES

7.1 Basic Principles of Forest Management

The forest management plan guidelines constitute the basic guidelines to determine the contents of forest management in the Intensive Area and are referred to when a forest management plan is formulated from the long-term perspective while taking into consideration the state of the natural conditions, socioeconomic conditions, forestry and forest products industry and forest resources in the Intensive Area as well as in neighbouring areas (excepting border areas). A forest management plan must conform to the Forest Law and other forest-related laws and regulations.

The following principles are deemed vital for the formulation of a forest management plan in order to encourage the creation and maintenance of healthy forests and to allow forests to fully perform their multiple functions in an integrated manner to achieve development of the local economy and improved welfare of local people.

① Sustainment of Forest Resources
② Increase of Forest Productivity
③ Adoption of Appropriate Forest Work
④ Development of Forest Road Network
⑤ Contribution to Local Economy

7.2 Basic Issues of Forest Management Plan

7.2.1 Planning Area, etc.

Considering that the Forest Law of Mongolia stipulates the implementation of a forest resources survey every 10 years and that the present forests slowly grow showing relatively small changes over the years, it has been decided to set a plan period of 10 years for the forest management plan.

The findings of the forest survey on forest resources in the subject area of the forest management plan will be compiled in terms of area, volume and increment, etc. by management category, forest management type, forest physiognomy and age class together with their summaries.

Broadly defined forests are classified in the categories of forest and non-forest based on their purpose of use, etc. and these narrowly defined categories of forest and non-forest are further classified into the various categories described below based on the forest characteristics and origin, etc. in the case of the former and the present land use and other aspects in the case of the latter.

① Forest : natural forest; man-made forest
natural regeneration site; planted site
shrub land
hospitable site
logged-over area; fire-damaged area

② Non-forest : river; lake or pond; swamp; sandy area; landslide area
rocky area; inhospitable site
farmland; grassland
nursery; forest road; firebreak; forest recreation site
: road; water channel; electric transmission route; mining site; settlement; others

The management units to be introduced for the forest management plan are compartments and sub-compartments.

7.2.2 Forest Improvement Targets and Selection of Cutting and Regeneration Methods

The present forests have many stands containing a fairly large number of poor quality trees due to over-maturity and degraded stands due to forest fire and cutting, etc. In addition, the planted areas have not yet reached the stage of showing a sizable volume. Consequently, the annual increment is rather small.

It is difficult to put forward a forest improvement target in the form of a numerical figure given the fact that the growth characteristics of trees and the productivity of natural forests and man-made forests are not currently fully understood. Consequently, the following descriptions of forest improvement targets are adopted for the guidelines.

- Improvement target for forests to be protected/conserved: to manage these forests so as to maintain their functions
- Improvement targets for forests mainly serving for timber production: ① to systematically improve these forests to high growth forests while maintaining high quality trees with a suitable stand density and ② to systematically convert cut-over areas and fire damaged areas, etc. to forests through the encouragement of regeneration

The basic form of regeneration cutting will be selective cutting combined with shelterwood cutting. The main form of selecting cutting will be group selective cutting and single tree selective cutting will also be employed depending on the legal restrictions and other conditions.

Natural regeneration will be adopted as the main regeneration method for stocked areas. Enrichment which involves the active planting of seedlings while utilising naturally regenerated young trees and removing disruptive shrubs and grass, etc. will be introduced to facilitate speedy and assured regeneration. In addition, natural seeding regeneration which expects nature to take care of itself over a long period of time will be adopted and regeneration by sprouting will be practiced in broad-leaved forests.

7.2.3 Management Categories

The Forest Law of Mongolia principally classifies forests into three categories, i.e. strict zone forests, protected zone forests and utilisation zone forests. There are, however, forests of which the protection or conservation necessity is high from a local point of view even if these forests are not classified as either strict zone forests or protected zone forests.

The management categories of forests consist of ① Nature Preservation Forests, ② Soil and Water Conservation Forests, ③ Public Health and Culture Promotion Forests, and ④ Timber Production Forests.

7.3 Forest Management Criteria

7.3.1 Forest Management Standards for Each Management Category

The types of forest management for each management category are described as follows. When the management categories for the same forest overlap, the type of forest management with stricter forest management restrictions should be given priority.

(1) Nature Preservation Forests

Nature preservation forests are those where preservation of the natural environment should be emphasised and those where preservation of the forest ecosystem should be particularly emphasised because of the difficulty of restoring the vegetation once the forest state has been destroyed. Cutting will be strictly prohibited and other forestry activities will be permitted as long as they meet the legal restrictions.

(2) Soil and Water Conservation Forests

1) Forests with Main Emphasis on Soil Conservation

The subject forests are woods on south-facing slopes (including those on inhospitable sites), isolated woods (on slopes), woods on steep slopes, shrub lands and erosion control belts, etc., all of which are listed in the Forest Law and aiming at the soil conservation mainly. Cutting will be prohibited and other forestry activities will, in principle, also be prohibited.

2) Forests with Main Emphasis on Water Conservation

These include headwater forests, lake/pond conservation forests, riverside forests and fountain conservation forests as listed in the Forest Law. In principle, cutting will be prohibited. Natural regeneration will be adopted for selective cutting sites to obtain firewood for home use.

3) Forests with Main Emphasis on Prevention of Meteorological Damage

These include national road/railway track protection forests, isolated wood (on slopes) and windbreak forests, etc. as listed in the Forest Law. In principle, cutting will be prohibited. Natural regeneration will be adopted for selective cutting sites to obtain firewood for home use.

(3) Public Health and Culture Promotion Forests

1) Forests with Main Emphasis on Public Health and Recreation

These include green zones and scenic beauty forests (including forest recreation sites) as listed in the Forest Law. In principle, cutting will be prohibited and reforestation will be conducted to regenerate unstocked areas.

2) Forestry Experiment Forests

Forestry experiment forests are established for the development and dissemination of forests and forestry techniques.

(4) Timber Production Forests

These are forests where industrial activities, such as timber production, are permitted. In principle, cutting will comprise either shelterwood cutting or selective cutting. Basically enrichment will be conducted to regenerate group selective cutting sites while natural seeding regeneration or regeneration by sprouting will be used to regenerate shelterwood cutting or single tree selective cutting sites.

7.3.2 Cutting Standards

(1) Cutting Methods

The cutting methods to be used are selective cutting (group and single tree) and shelterwood cutting for regeneration cutting, and thinning. Selective cutting is

classified as group selective cutting which focuses on groups of trees constituting a natural forest and single tree selective cutting which focuses on single trees.

(2) Cutting Age

The results of the annual ring survey using stumps show that the tree growth of *Pinus sylvestris* hill forests on sandy soil with poor water holding capacity tends to significantly slow down from approximately 120 years of age. The cutting ages given below will be adopted for the present guidelines.

- *Pinus sylvestris*; *Larix sibirica* : 130 years
- *Betula platyphylla*; *Populus tremula* : 65 years

(3) Cutting Cycle

In the case of selective cutting, it is necessary to rotate the cutting based on the cutting cycle which is, in principle, the period required for a stand subject to selective cutting to recover its volume at the time immediately prior to selective cutting. Therefore, the cutting cycle is closely related to the selective cutting rate. The following equation expresses the relationship between the cutting cycle and the selective cutting rate.

$$\ell = - \log (1 - s) / \log (1.0\ p)$$

Where, ℓ : cutting cycle
s : selective cutting rate
p : increment rate

(4) Allowable Cut Volume

While there are many ways of calculating the allowable cut volume, a relatively simple equation using the numerical regulation method below is used as this suits the volume of available data on forests.

$$E = \frac{Ip}{2} + \frac{Vp}{T}$$

Where, E : annual allowable cut volume for regeneration cutting (m^3)
Ip : present rate of annual increment (m^3)
Vp : present volume (m^3)
T : average cutting age (years)

7.3.3 Regeneration Standards

The regeneration methods to be used are reforestation, enrichment, natural seeding and sprouting. In principle, regeneration will be conducted within two years of cutting. The regeneration area during the plan period is, in principle, set at eight-tenths (8/10) of the total cutting area during the plan period plus the new regeneration area (existing cut-over sites, forest damaged sites and feasible regeneration sites) at the time of plan formulation.

In terms of tending method, excluding those stands where cutting is prohibited, clearance of the forest floor vegetation or the removal of obstructive broad-leaved trees should be conducted according to need if the growth of the regenerated trees appear to be obstructed by the forest floor vegetation or nearby broad-leaved trees before and after the end of regeneration.

In order to eradicate un-regenerated sites among such unstocked areas as fire damaged sites and cut-over sites and to improve the forest productivity through planting, it is necessary to obtain a sizable production volume of high quality seedlings. The species produced by nurseries are mainly *Pinus sylvestris* and *Larix sibirica* and rooted cuttings of poplar are also produced.

7.3.4 Forest Road Standards

The forest road plan will be prepared for trunk forest roads and spur roads. The most appropriate choice appears to be the construction of forest roads at larger valley bottoms and the construction of spur roads at smaller valley bottoms, ridgelines or mid-slopes to link with trunk forest roads with special attention being paid to the conservation of forest land.

As the transportation of logs is mainly conducted using a trailer, this vehicle is used as the reference vehicle to determine the structural standards for forest roads and spur roads. The standard structure will be adopted for actual road construction purposes so that the broad shoulders and lane width will allow forest/spur roads to act as firebreaks at the time of a forest fire.

7.3.5 Forest Conservation Standards

The existence of a sloping site which is located near a conservation object in a forest management area or which threatens its extension makes vegetative restoration necessary by establishing erosion control belts by planting, etc. While the over-grazing of sloping land must be avoided to prevent bare land leading to soil erosion, no sites are currently observed where the ground surface vegetation has been lost due to grazing.

When growing forest is found to be particularly rare from the viewpoint of academic research in a particular region, the necessity for its protection must be comprehensively examined. If protection is deemed necessary, the area should be designated a nature reserve for scientific research to ensure its conservation.

7.3.6 Forest Protection Standards

(1) Forest Fires

Although forest fire prevention activities have long been implemented by the aimak government, district offices and other related organizations, the measures will be introduced in view of the fact that most forest fires are caused by human carelessness, including the throwing away of burning cigarette ends and matches and the inadequate extinguishing of open-air fires. The liaisoning between various administrative organizations and also between the said organizations and local people will be strengthened to establish aimak and district forest fire prevention and extinguishing systems capable of a quick response.

(2) Damage to Trees Due to Logging, etc.

In order to prevent damage to remaining trees and succeeding young trees due to logging and skidding, full tree logging will be prohibited. If necessary, logging and skidding will be modified to reduce full length logs to half length logs or specific length logs to protect the remaining trees and succeeding young trees.

(3) Weather Damage

It is very important to select appropriate species while tending those broad-leaved trees which creep into the reforestation sites.

(4) Damage Due to Diseases, Harmful Insects and Animals

Forests in and around the Intensive Area were severely damaged by the forest fire in 1996 and efforts should be made to cut, log and use the damaged trees as quickly as possible to prevent the spread of secondary damage by diseases or harmful insects. In this case, the cutting volume of the damaged trees should, in principle, be counted as part of the allowable cut volume of live trees.

While the protection of wild animals is stressed in forests other than timber protection forests, the co-existence of trees and animals/birds in timber production forests is also important for hunting insects. Accordingly, the present level of damage by wild animals should be tolerated.

7.4 Preparation Standards for Forest Management Plan Maps, etc.

In line with the formulation of the forest management plan, the following maps and documents will be prepared as appendices.

① Forest Inventory Book
② Forest Type Maps
③ Forest Management Plan Maps

8. FOREST MANAGEMENT PLAN

8.1 Basic Issues

8.1.1 Subject Areas and Related Issues

The plan period is 10 years. However, the contents of the Plan will be reviewed whenever a major change of the socioeconomic situation and/or large-scale forest damage occurs. The subject areas of the Plan are the two Model Areas established in the Intensive Area and the size of these areas is given in Table 13. The Model Areas belong to Altanbulag District and Uroo District.

Table 13 Size of Subject Areas of the Plan

(Unit: ha)

Location	Model Area 1	Model Area 2	Total
Altanbulag District	6,934	18,601	25,535
Uroo District	-	4,116	4,116
Total	6,934	22,717	29,651

8.1.2 Forest Categories and Forest Division

Forests in the Model Areas are categorised as follows. Unstocked sites appearing on the forest type map are classified as either hospitable sites or inhospitable sites (non-forest) depending on the perceived difficulty of regeneration. Table 14 shows the area by forest category.

Table 14 Area by Forest Category

(Units: ha, %)

Forest Category		Model Area 1	Model Area 2	Total	Composition Rate (%)
Forest	Pine Forest	2,770	1,115	3,885	13.1
	Larch Forest	-	1,101	1,101	3.7
	Pine/Larch Forest	-	1,205	1,205	4.1
	Mixed Forest	923	5,379	6,302	21.3
	Broad-Leaved Forest	1,235	6,563	7,798	26.3
	Planted Forest	97	-	97	0.3
	Hospitable Site	16	143	159	0.5
	Logged-Over Land	269	-	269	0.9
	New Fire Damaged Forest Suffered in 1996	1,300	2,496	3,796	12.8
	Sub-Total	6,610	18,002	24,612	83.0
Non-Forest	Rocky Area	4	914	918	3.1
	Inhospitable Site	2	1,436	1,438	4.9
	Farm Land	24	-	24	0.1
	Grassland	222	2,365	2,587	8.7
	Firebreak	72	-	72	0.2
	Sub-Total	324	4,715	5,039	17.0
Total		6,934	22,717	29,651	100.0

The resulting number of compartments and sub-compartments is shown in Table 15.

Table 15 Compartment and Sub-Compartment Numbers

Area	No. of Compartments	No. of Sub-Compartments	No. of Sections	Min./Max. Size of Compartments
Model Area 1	10	113	132	349/1,032 ha
Model Area 2	32	676	587	444/1,168 ha
Total	42	789	719	-

8.1.3 Forest Improvement Targets

The following forest improvement targets are adopted.

- Nature preservation forest	: preservation of the forest ecosystem
- Soil & water conservation forest and public health/culture promotion forest	: preservation of the specific function of each forest appropriate use of damaged trees and early restoration of site in the case of fire damaged areas in 1996 in Model Area 1
- Timber production forest	: systematic improvement of a forest with high increment while maintaining adequate stand density with good quality trees, appropriate use of damaged trees and early restoration of sites in fire damaged areas in 1996

8.1.4 Management Categories

The following management categories are adopted as suggested by the Guidelines.

(1) Nature Preservation Forests

① Nature reserves for scientific research: forests in Sub-Compartment Nos.9 through 12 and No.15 in Sub-Compartment No.8 in Model Area 2

(2) Soil and Water Conservation Forests

① Woods on south-facing slopes: woods in Sub-Compartment No.5 in Compartment No.4, Sub-Compartment Nos.3 and 4 in Compartment No.5, Sub-Compartment No.1 in Compartment No.6, Sub-Compartment Nos.10, 15, 17 and 20 in Compartment No.12, Sub-Compartment Nos.24 and 25 in Compartment No.17, Sub-Compartment No.5 in Compartment No.18, Sub-Compartment Nos.6 and 8 in Compartment No.19 and Sub-Compartment Nos.11 and 25 in Compartment No.26 in Model Area 2

② Isolated woods: woods in Sub-Compartment Nos.7 and 9 in Compartment No.3, Sub-Compartment Nos.2 and 18 in Compartment No.4, Sub-Compartment No.2 in Compartment No.5, Sub-Compartment Nos.11, 12 and 16 in Compartment No.15 and Sub-Compartment Nos.12 and 13 in Compartment No.23 in Model Area 2

③ Woods on steep slopes: woods in Sub-Compartment Nos.3 and 4 in Compartment No.12, Sub-Compartment No.9 in Compartment No.13, Sub-Compartment No.22 in Compartment No.15, Sub-Compartment No.23 in Compartment No.26, Sub-Compartment No.19 in Compartment No.27 and Sub-Compartment No.2 in Compartment No.29 in Model Area 2

④ Headwater forests: forests in Sub-Compartment No.10 in Compartment No.6 through Compartment No.15, and Compartment No.17 in Model Area 2

(3) Public Health/Culture Promotion Forests

① Green zones: all forests in Model Area 1

② Expected green zones: forests in Sub-Compartment Nos.11 through 17 in Compartment No.7, Sub-Compartment Nos.1 through 5 and 20 through 22 in Compartment No.8, Compartment No.9, Sub-Compartment Nos.1 through 9 in Compartment No.10, Sub-Compartment Nos.6 through 9 and 11 in Compartment No.11, Sub-Compartment Nos.3 through 6 in Compartment No.12, Sub-Compartment Nos.3 through 8, 10 and 11 in Compartment No.13 (all of these forests overlap with headwater forests), Sub-Compartment Nos.17 through 19 in Compartment No.22, Sub-Compartment Nos.15 through 22 in Compartment No.26, Sub-Compartment Nos.1 through 7 and 15 through 23 in Compartment No.27, Sub-Compartment Nos.2 through 16 in Compartment No.28, Sub-Compartment Nos.4 through 29 in Compartment No.29 and Sub-Compartment Nos.3 through 5, 8 through 16, 20 through 22 and 25 in Compartment No.30

(4) Timber Production Forests: forests other than those listed in (1), (2) or (3) above.

8.2 Forest Management Methods

8.2.1 Forest Management Methods by Management Category

The cutting methods to be used are selective cutting (group and single tree), shelterwood cutting, and thinning as suggested by the Guidelines while the regeneration methods will be reforestation, enrichment, natural seeding and sprouting.

The clearance of damaged trees in the soil and water conservation forests and public health/culture promotion forests damaged by the fire in 1996 will be conducted if necessary. Table 16 outlines the forest management methods by management category based on the cutting and regeneration methods to be used.

Table 16 Forest Management Methods by Management Category

Management Category	Subject Forests	Cutting Method		Regeneration Method				Cutting Age (Cutting Cycle)
		Regeneration Cutting	Thinning	Reforestation	Enrichment	Natural Regeneration: Seeding	Natural Regeneration: Sprouting	
Nature Preservation Forest	- Nature reserve for scientific research	strictly prohibited	—	—	—	—	—	—
Soil & Water Conservation Forest	<Soil Conservation> - Wood on south-facing slope; wood on steep slope; isolated wood	prohibited	—	—	—	—	—	—
	<Water Conservation> - Headwater forest	prohibited in principle	—	—	—	—	—	—
	- No disruption to preservation of forest function - Limited protection of forest, growth and improvement of restoration capability	(selective cutting of firewood) (clearance of damaged trees)	—	—	— (O)	(O)	(O)	
	- Unstocked forest land	—	—	O	—	—	—	
	<Climatic Damage Prevention> - Wood isolated	Prohibited in principle	—	—	—	—	—	
Public Health / Culture Promotion Forest	- Green zone; expected green zone; isolated wood (on gentle slope)	prohibited in principle	—	—	—	—	—	—
	- Limited protection of forest, growth and improvement of restoration capability	(clearance of damaged trees)		(O)	(O)			
	- Unstocked forest land	—	—	O	—	—	—	
	- Forestry experiment forest	(depends on experiment objective)	as left	as left	as left	as left	as left	
Timber Production Forest	Steep slope, riverside or major ridgeline	prohibited in principle	(O)	—	—	—	—	Shelterwood cutting (L: 10 years); selective cutting (N: 130years, L: 65 years) (N: 30 years) (NL: 30 years)
	Good natural regeneration site	shelterwood cutting / single tree selective cutting	O	—	—	O	O	
	Stocked land other than above	group selective cutting	O	(O) (change of species)	O	△	△	
		single tree selective cutting	O	—	—	O	O	
	Unstocked forest land	—	—	O	—	—	—	

Notes 1. ○ and △ indicate the primary and secondary means of cutting/regeneration respectively. ( ) indicates exceptional cases.
2. The clearance of damaged trees will only be conducted by the Forestry Office.

8.2.2 Cutting Plan

(1) Cutting Age

- *Pinus sylvestris*; *Larix sibirica* : 130 years
- *Betula platyphylla*; *Populus tremula* : 65 years

(2) Cutting Cycle, etc.

Some stands in Model Area 2 will be subject to selective cutting.

- Cutting cycle : needle-leaved forests/mixed forests : 30 years
- Selective cutting rate : 25% or less

The cutting cycle for the shelterwood cutting of broad-leaved forests for the second time and thereafter is provisionally set at 10 years.

(3) Allowable Cut Volume

The calculation results of the allowable cut volumes (live standing trees) for the Altanbulag District in the plan period of 10 years are given in Table 17. Taking the clearance of trees damaged by the fire in 1996 into consideration, the actual allowable cut volumes are set at 50% of the calculated figures.

Table 17 Calculation of Allowable Cut Volume for 10 Year Period in Timber Production Forests

	Area (ha)	Growing Stock (Vρ) (m^3)	Increment (Iρ) (m^3)	Cutting Age (years)	Allowable Cut Volume (in Plan Period) E = (Iρ/2 + Vρ/T) × 10 (m^3)
Needle-Leaved Trees		555,702	3,036	130	(3,036/2 + 555,702/130) × 10 × 0.9 = (57,926) × 0.9≒ 52,133
Broad-Leaved Trees		654,248	6,805	65	(6,805/2 + 654,248/65) × 10 × 0.9 = (134,679) × 0.9≒ 121,211
Total	9,609	1,209,950	9,841	-	173,344

Note: The ratio of those stands where cutting is, in principle, prohibited is set at 10% for the above calculation and subtracted from the allowable cut volume.

(4) Cutting Sites and Cutting Volume

The permitted cutting sites and cutting volume are planned in accordance with the Guidelines while taking the early clearance of the trees damaged by the fire in 1996 into consideration. Cutting volume of needle-leaved live standing trees is planned within 50% of the annual allowable cut volume (see Table 18). In addition, the cutting sites for firewood for home use are planned. Needle-leaved and broad-leaved fire-damaged trees may be cut within the full of annual allowable cut volume when those trees be sizable and possible to be used.

Table 18 Permitted Cutting Sites and Cutting Volume

District	Model Area	Management Category	Cutting Method	Nos of Compartment, Sub-Compartment and Section	Area (ha)	Needle-Leaved Trees (m^3)	Broad-Leaved Trees (m^3)	Total (m^3)
Altanbulag	1	Public Health & Culture Promotion Forest	Clearance of Damaged Trees	1①², 2①⁵, ②², 3③¹·²·⁷·⁸, ⑥, ⑧¹·³, ⑩¹·³, 4③², ④¹·⁵, ⑥¹·³	782	(78,250)		(78,250)
	2	Timber Production Forest	Group Selective Cutting	5⑨,⑪,⑬,⑭,⑯,⑰, 6⑤,⑦,⑧², ⑨³	520	25,680	13,180	38,860
			Single Tree Selective Cutting	2②⁵, 31②¹, ⑮⁴	62		2,000	2,000
			Shelterwood Cutting	5⑮, 6④	130		5,810	5,810
			Single Tree Selective Cutting (for Damaged Trees)	19⑪¹, ②³, 26⑥¹,	42	(2,000)		(2,000)
			Group Selective Cutting (for Damaged Trees)	2②³, 20②¹·², ③¹·², ④¹·², ⑤¹·², ⑦¹·², ⑨¹·⁴, ②¹, 22㉕¹·², 23⑥²·⁵, ⑩¹·², 24⑦¹·², ⑧, ⑭², ⑯²·³, ②¹·³, 31②², ⑮³	461	(20,670)	(2,000)	(22,670)
			Thinning	19㉔, 26⑥⁵	56	2,550		2,550
Subtotal					1,271	(20,670) 28,230	(2,000) 20,990	(22,670) 49,220
Total					2,053	(98,920) 28,230	(2,000) 20,990	(100,920) 49,220

Note: 1) In the case of "Compartment No.1, Sub-compartment No.2, Section No.2", the description is indicated as "1②²".

2) The subject amount for fire-damaged trees (or dead trees) is described with brackets.

(5) Cutting Methods

As suggested by the Guidelines, the cutting methods to be employed are group selective cutting, single tree selective cutting and shelter wood cutting for regeneration cutting, and thinning. The early clearance of damaged trees in 1996 in public health/culture promotion forests will be conducted at stands of which fire damage level is large or medium. In timber production forests, in order to conduct early clearance of fire-damaged trees group selective cutting or single tree selective cutting will be applied for the sizable stands of which fire damage level is large or medium.

1) Group Selective Cutting

Group selective cutting will be employed for those timber production stands which are mainly composed of mature, large and medium diameter trees with a relatively small number of small diameter needle-leaved trees and succeeding trees requiring enrichment. Those stands with a crown density of less than 50% will not be subject to cutting.

2) Single Tree Selective Cutting

Single tree selective cutting will be employed for those timber production stands which are composed of large as well as small to medium diameter trees with many succeeding trees or with a good state of natural regeneration, making enrichment unnecessary (the regeneration index is generally less than 0.8), and those sites subject to the cutting of firewood for home use.

3) Shelterwood Cutting

The subject forests are broad-leaved forests regenerated with sprouting in timber production forests.

4) Clearance of Damaged Trees

The clearance of damaged trees will be conducted at those stands which are sizable and located at gentle slopes in public health/culture promotion forests which were damaged by the forest fire in 1996. The forests located along farmland and grassland will be excluded. The cutting and regeneration methods will be adopted based on the level of fire damage.

5) Thinning

Thinning based on the tree form category will be conducted at stands below the cutting age in order to improve the health of these stands, to stimulate diameter growth and to ensure the efficient utilisation of wood resources by means of alleviating the competition between trees. In the case of existing man-made forests, thinning is not required for many years to come because of the present young age.

8.2.3 Regeneration Plan

The regeneration methods to be employed are reforestation, enrichment, natural seeding and sprouting as suggested by the Guidelines.

(1) Reforestation

The subject sites for reforestation in timber production forests will be unstocked areas, such as past forest fire damaged areas and cut-over areas, where the progress of reforestation or natural regeneration is poor and those sites where a change from a broad-leaved stand to a needle-leaved stand is required. In the case of public health/culture promotion forests, reforestation will be employed at cleared sites of damaged trees or unstocked areas where planting is required to create a forest.

(2) Enrichment

The subject sites for enrichment will be group selective cutting sites (including scattered unstocked areas). The similarly cleared sites of damaged trees will be also the subject sites.

(3) Natural Seeding Regeneration

Natural seeding regeneration will be selected for those stands subject to single tree selective felling where human assistance is unnecessary because of the presence of many succeeding trees or the excellent state of the regeneration and growth of naturally regenerated young trees and those stands where natural regeneration without human assistance is expected to take place for a long time due to the site conditions and/or legal restrictions.

(4) Regeneration by Sprouting

Regeneration by sprouting will be selected when a broad-leaved stand is to be created after cutting in a broad-leaved forest or at a broad-leaved forest site in a needle-leaved or mixed forest.

Although the forest fire in 1996 increased the land area requiring regeneration (logged-over sites, fire damaged areas and hospitable sites), the regeneration of new cutting sites will be conducted within two years of cutting. As a result of the forest fire in 1996, the area in need of regeneration has sharply increased, exceeding the present reforestation capacity. Accordingly, the regeneration work at fire damaged areas and hospitable sites will be partly postponed. Table 19 shows the expected regeneration sites and regeneration volume in the plan period.

Table 19 Regeneration Sites and Regeneration Volume

Model Area	Site to Be Regenerated		Regeneration Plan					
	Division	Area (ha)	Nos. of Compartment, Sub-Compartment and Section	Planting (ha)	Enrich-ment (ha)	Natural Seeding (ha)	Sprouting (ha)	Total (ha)
1	Hospitable Site	16						
	Logged-Over Land	269	8①[2-3], ②[1-3], ⑧[1], 9①[2]③[2]④[1]	NP 57				57
	Cleaning of Fire-Damaged Trees (UN)	1,300	2①[5], ②[4], 3②③[1-8], ⑤,⑥,⑦,⑧[1], ⑩[1], ⑪,⑫, 4③[2], ④[2], ⑥[1]	NP450				450
	Cleaning of Fire-Damaged Trees (NP)	471	1②[2], 2②[2-4,5-8], 3③[2-7], ⑧[2-3], ⑩[2-3], 4④[1,3-5], ⑥[1,2]		NP[144] 471			[144] 471
	Plantation (Fire-Damaged)	97	3①④	NP 29				
	Total	2,153		536	[144] 471			[144] 471
2	Hospitable Site	143	20⑩, 23④, ⑦⑨	NP 59				59
	Fire-Damaged Site (UN)	2,496	19⑬[1], ㉒[2], 20③[2], ④[2], ⑤[1], ⑦[1], ⑨[3-4], ㉒[1], 22㉕[2], 23③[2], ⑥[2-4], ⑩[2], 24⑦[1], ⑧, ⑪[2,4,5,7], ⑯[2]		NP[53] 186	17		[53] 203
	Fire-Damaged Forest Stand (NP, N, M, L)	289	2②[3], 20②[1-2], ③[1], ④[1], ⑤[2], ⑦[2], ⑨[2-3], 22㉕[1], 23⑥[3-5], ⑩[1], 24⑦[2], ⑪[3-6], ⑮[3], 26⑥[1], 31②[2], ⑮[2]		NP[64] 223	25	52	[64] 300
	Cutting Plan	650	2②[5], 5⑨, ⑪, ⑬, ⑭, ⑮, ⑯, ⑰, 6④, ⑤, ⑦, ⑧[2], ⑨[1], 31②[1], ⑮[1]		NP[59] NP[67] 416		154	[126] 570
	Total	3,578		59	[243] 825	42	206	[242] 1,132
	Grand Total	5,731		595	[387] 1,296	42	206	[387] 2,139

Notes 1) The numbers of the enrichment is obtained from the subject area. The numbers with brackets are the substantial areas for the enrichment.
2) The regeneration amount for the cutting plan is 8/10 of the area to be planted.
3) In the columns of Reforestation and Enrichment, NP and NL mean *Pinus sylvestris* and *Larix sibirica* respectively.
4) The site is described as "8①[2]" for Compartment No. 8, Sub-Compartment No. 1 and Section No. 2.

The supply of the seedlings required for reforestation and enrichment will mainly rely on the nursery at Hond which is run by the Forestry Office. In addition, close liaison will be established with the nursery of Vocant Lumber Company to ensure an adequate supply of the required planting stock. The quantity of seedlings required based on the reforestation and enrichment areas to be planted during the plan period is shown in Table 20.

Table 20 Required Quantity of Seedlings and Nursery Size

Species	Planting Area (ha)		Planting Density per ha	Necessary Seedlings by Thousand			Nursed Seedlings per m^2	Corresponding Necessary Area of Nursing Site (ha)
	Reforest-ation	Enrich-ment		Reforest-ation	Enrich-ment	Total		
Pinus sylvestris	595	320	3,000	1,825	982	2,807	34	8.3
Larix sibirica		67	3,000		206	206	34	0.6
Total	595	387		1,825	1,188	3,013		8.9

Notes 1) The planting area for the enrichment is the substantial area to be planted.
2) The number of necessary seedlings is used for the supplementary planting and counted as 25 % of the seedlings covering 10 % of the planting area, which is planted in the duration of 9 years followed by the initial year.
3) The amount of nursed seedlings per m^2 is decided by assuming standardized seedling production rate (some 90 %) and one year of fallow.

8.2.4 Forest Roads

The planned construction length of forest roads and spur roads during the plan period is shown in Table 21.

Table 21 Planned Construction Length of Forest Roads

Model Area	Route Name	Division	Work Type	Length (m)	Width (m)	Remarks
1	Altanbulag-Uroo	Forest Road	Improvement	12,500	10	Gravel Surface, Large Side Ditch
	Firebreak (South-North)	Spur Road	Construction	9,000	5	
	Firebreak (East-West)	Spur Road	Construction	1,700	5	
2	Altanbulag-Uroo	Forest Road	Improvement	4,300	10	Gravel Surface, Wooden Bridge (10 m)
	Hond-Uroo	Forest Road	Improvement	8,500	10	Gravel Surface, Wooden Bridge (10 m, 7 m)
	Compartment No. 5 & 6	Spur Road	Construction	12,000	5	
	Compartment No. 22	Spur Road	Construction	4,200	5	
	Compartment No. 23	Spur Road	Construction	3,000	5	
	Compartment No. 24	Spur Road	Construction	3,500	5	
Total				58,700		

Note: The above amounts are designed for the Model Areas.

8.2.5 Forest Conservation

No special forest conservation facilities are judged to be required given the present conditions of the forest land. It will, however, be necessary to avoid over-grazing when a forest is used for grazing.

One group of *Larix sibirica* forests (consisting of Sub-Compartments Nos. 9 through 12 and No. 15 in Compartment No. 8; total area of 336 ha), of which the primeval state is relatively preserved, will be preserved as a nature reserve for scientific research.

8.2.6 Forest Protection

The prevention of forest fires will be attempted together with related organizations by means of ① strengthened liaison between the various organizations and people involved in fire prevention and fire-fighting, ② promotion of PR activities using the mass media and ③ improved provision of communication, fire-fighting and other relevant equipment.

The construction, improvement of forest roads and spur roads followed by the regular maintenance and management should be appropriately conducted. In order to prevent unnecessary damage to standing trees due to logging and skidding, full tree length logging will be prohibited and half length logging or specific length logging will be employed.

8.2.7 Preparation of Forest Management Plan Maps, etc.

The forest inventory book was compiled on the basis of the aerial photo interpretation and the findings of the field survey. Also forest type maps (scale: 1/25,000) and forest management plan maps (scale: 1/25,000) were prepared.

8.3 Forest Management System

Because of the present complexity of the forest management system involving the Forestry Office, *districts* and *bags*, etc., whether or not forest management is properly conducted depends on close liaisoning between these players. If such liaisoning is not feasible, it may be necessary to establish a centralised forest management organization and/or to review the forest management system, including the assignment of forestry

experts to districts. It is necessary to improve the abilities of the nature protection officers together with upgrading of the means of communication to strengthen the on-site management system in order to achieve better forest management with limited manpower. It is essential to establish a reputation among local people through the proper implementation of day-to-day work and smooth communication with local people.

8.4 Forest Fire-Related Measures

8.4.1 Use of Damaged Trees

It is essential to swiftly cut the damaged trees and to transport them out of the forest because the trees could suffer the secondary damage due to borers. The utilization should be considered in view of substituting the damaged tree volume for the live tree cutting volume and adjusting the allowable cutting volume for individual aimaks and districts.

In Model Area 1 where large damage was caused, a combination of strip clear cutting (group selective cutting for stands with live trees) and reforestation (enrichment for the group selective cutting site) should be opted for clearance of the damaged trees. Because the subject forests are classified as green zones, the clearance must be properly conducted by the Forestry Office as stipulated by the Forest Law (the Forestry Office is responsible for such work even if the work is subcontracted.)

In Model Area 2, damaged needle-leaved trees in the fire damaged areas in Compartment Nos. 20, 23 and 24 can be used since the damage is large and the area is sizable. However, the use of scattered, damaged needle-leaved and broad-leaved trees on slopes in remote areas will be difficult for the production of general-purpose timber, partly because of the location and partly because of the small concentration in terms of area and volume together with the low commercial value.

The volume of needle-leaved trees damaged by the fire is as large as 575,000 m^3 in the Model Areas alone which is equivalent to between 10 to 20 years of allowable cut volume for the Altanbulag District. The local capacity to conduct the necessary cutting and logging within two years when the use value of the damaged trees is not significantly reduced is limited even if there is sufficient capacity to process them into timber.

8.4.2 Measures to Combat Secondary Damage

In the case of extensive damage, such as that caused by the fire in 1996, it is hardly feasible to prevent secondary damage effectively. The public sector as well as the private sector should be urged to cut and remove at least some of the usable trees damaged by the fire in 1996 in both Model Area 1 and Model Area 2 in order to reduce the number of tree feeding borers as soon as possible.

8.4.3 Restoration Measures for Fire Damaged Areas

The fire damaged areas in 1996 consist of natural forests, *Pinus sylvestris* reforestation sites and naturally regenerated young stands (fire damaged areas prior to the fire in 1996). The restoration of damaged stands is usually conducted by ① natural regeneration, ② reforestation or enrichment or ③ a combination of ① and ②, the selection of which depends on the outcome of a comprehensive review of the forest management type, site conditions, available forestry labour and available restoration funds, etc. of each stand. The restoration work will be initiated at higher priority sites. In order to restore the fire-damaged area, the improvement of reforestation system is a very crucial issue.

8.4.4 Forest Fire Prevention and Fire-Fighting Measures

Forest fires occur every year in Mongolia under such weather conditions of dry air and little rainfall, turning valuable forest resources into ash. As most forest fires are caused by human carelessness, including the throwing away of burning cigarette ends/matches and the incomplete extinguishing of open fires, etc., basic measures to prevent forest fires are ① improvement of the public awareness of the need to prevent fires and ② extinguishing of fires at an early stage. These measures must be systematically implemented by a style of national movement supported by the mass media.

9. TRANSFER OF TECHNOLOGY

The local level of technological knowledge is fairly high although there are serious problems of equipment shortage and deterioration. Technology transfer to the counterparts was conducted in the form of OJT and the actual use of the survey equipment through the field survey associated with topographical map preparation and satellite data analysis, the fact-finding survey on the

Study Area, the survey on the Intensive Area, the survey to formulate the forest management plan guidelines and the forest resources survey in the Model Areas, etc.

10. RECOMMENDATIONS

Given the current systems regarding forests and forestry, the availability of various data and information and the extensive damage caused by the forest fire in 1996, it is hoped that the forest management plan described in this report will assist the formulation and implementation of appropriate forest management plans in the future to greatly contribute to the conservation and creation of forest resources and also to the vitalisation of forestry and the forest products industry. It is extremely important to try to secure the necessary funding and manpower and to improve the techniques regarding the conservation and creation of forests together with efforts to prevent forest depletion and degradation because of the status of forests in Mongolia which are located in the critical zone for forest growth and which are extremely precious from the global point of view. In view of this importance of forests in Mongolia, the following recommendations are made based on the findings of the Study.

(1) Prevention of Forest Fires

1) Public Relations Activities for Forest Fire Prevention

As forest fires occur every year, both depleting and degrading precious forest resources, their prevention is a prerequisite for the conservation of forest resources. Forest fire prevention is also important for the assured implementation of a forest management plan. In the future, all forest-related organizations must work together to eradicate forest fires, making it a national movement. In particular, the following measures should be introduced.

① Strengthening of Public Awareness

As most forest fires are caused by human carelessness, public relations activities should be conducted with the assistance of the mass media in order to improve the awareness of individuals of the importance of forest fire prevention.

② Issue of Fire Warnings and Patrols

The issue of fire warnings is currently based on the fire hazard index, of which humidity acts as the sole factor. The maximum wind velocity should be added as another factor to improve the index's reliability while the fire warnings issued should be widely conveyed to the public via radio and TV, etc. Moreover, all

forest-related organizations should cooperate with each other to patrol forests and to provide relevant guidance and instructions for people entering forests.

2) Development of Fire-Fighting System

A forest fire can be put out if fire-fighting activities are immediately conducted after the outbreak of a fire. It is, therefore, necessary to establish an early fire-fighting system. To achieve this, the following measures should be introduced.

① Development of Fire-Fighting System

All forest-related organizations in the aimak and districts, including those in neighbouring aimaks and districts, should discuss the establishment in advance of the mobilisation, command, reinforcement, logistic supply and relief procedures for fire-fighting activities corresponding to different places and scales of fire. In addition, a quick response system must be established through map exercises and other activities.

② Development of Notification System

Such communication equipment as mobile phones and radio equipment and topographical maps, etc. should be provided for all forest-related organizations, nature protection officers and patrolmen in order to establish communication channels between all organizations and personnel (including between the headquarters and fire-fighting teams during fire-fighting activities) to ensure the immediate notification of a fire sighting to related organizations so that fire-fighting activities can quickly commence.

③ Improvement of Fire-Fighting Equipment

Fire-fighting equipment and related equipment should be provided in key places and should be properly maintained to enable a quick response to forest fires. The range of equipment should include fire engines, aircraft, backpack water bags, spades, fire beaters, bulldozers, chainsaws, brush cutters, trucks, four wheel drive vehicles and portable radio equipment, etc., all of which should be general-purpose equipment.

④ Improvement of Forest Roads

Forest roads are very important infrastructure as they can act as both firebreaks and transportation routes for swift and effective fire-fighting activities. In view of

this importance of forest roads, the construction and improvement of trunk forest roads should be conducted.

3) Early Processing of Fire Damaged Trees

Once fire damage unfortunately occurs to a forest, it is essential to swiftly cut the damaged trees and to transport them out of the forest to prevent any expansion of secondary damage due to borers and also to ensure the effective utilisation of forest resources. To achieve these objectives, the following measures should be introduced.

① Urgent Establishment of Extent of Damage

Using an aircraft, aerial photographs of the fire damaged area should be taken to establish the size of the damaged area, extent of the damage, damaged species and damage volume, etc. based on information contained on the aerial photographs and the findings of field investigations.

② Early Processing of Damaged Trees

An urgent damaged trees processing plan should be formulated based on the extent of the fire damage in view of the swift cutting and hauling of the damaged trees, substituting the damaged tree volume for the live tree cutting volume and adjusting the allowable cutting volume for individual aimaks and districts. The storage in water, barking and outdoor piling of the cut and yarded logs should be arranged in roofed, well-ventilated areas to prevent any further damage by harmful insects.

③ Improvement of Sawing Machines

As the existing sawing machines are only capable of sawing upto a log diameter range of between 18 cm and 55 cm (or 65 cm), small and large diameter trees outside this range are left in a forest, becoming feeding trees which assist the outbreak of insect damage. These sawing machines should be replaced by band saws which can process logs of any diameter class. The use of band saws can improve the sawing yield, thereby contributing to the better conservation of forest resources.

(2) Creation of Forest Resources

1) Formulation and Implementation of Reforestation Programme

At present, forest land which has become unstocked due to fire damage occupies a vast area as unregenerated land and requires quick restoration as forest land. Such improvement will not only restore the depleted forest resources but will also contribute to the prevention of global warming by the fixation of carbon dioxide gas (CO_2). As the creation of forests takes a very long time, the formulation of a reforestation programme is necessary based on a comprehensive examination of the land productivity, meteorological conditions and labour requirement for reforestation, etc., all of which determine the site conditions of the subject regeneration sites, in order to systematically eradicate unregenerated land. To achieve this goal, reforestation funds must be secured together with the establishment of the following reforestation implementation system.

① Training of Reforestation and Nursing Engineers/Technicians and Their Assignment to Field Positions

② Establishment of a Central Nursery

In order to strengthen the seedling supply system, there should be a nursery which can function as a center equipped with a wheel-type tractor (with attachments), greenhouse, cheesecloth, fertiliser, agrochemicals (germicides, pesticides and herbicides) and an equipment warehouse, etc.

③ Provision of Silvicultural Machinery

In order to implement the reforestation activities, the provision of crawler-type tractors (with attachments), chainsaws, brush cutters, planting tools, trucks and four wheel drive vehicles, etc. will be necessary.

2) Development and Improvement of Reforestation Techniques

The seedling survival rate at existing reforestation sites is rather low because of the specific land preparation method involving the removal of the top soil of vast unstocked land with severe weather conditions and also because of the poor character of the seedlings and poor planting methods. Some sites have been damaged by the weather, diseases and/or harmful insects in addition to the death of many young trees due to ground fires, resulting in a low rate of forests reaching maturity.

In order to improve the situation, the introduction of improved reforestation techniques should be attempted, including land preparation without removal of the top soil, the production of good quality seedlings through better soil and root preparation and mulching at the time of planting.

Further technical developments should be attempted to achieve (i) low cost nursing through a combination of mechanical work and herbicides, etc., (ii) mechanical reforestation through a combination of machinery or pot seedlings and (iii) reforestation by direct seeding with the skillful use of herbicides, etc.

(3) Improvement of Forest Inventory Technology

1) Introduction of New Forest Inventory Technology and Provision of Related Equipment

The latest forest inventory technology, that is remarkably advanced nowadays, should be introduced to afford more efficient and accurate survey method which would be appropriate for such a country of Mongolia having a vast land with small population.

It should be pointed out that such an introduction require the latest survey technologies on analysis of satellite images or airphoto interpretation, training of the subject engineers as well as provision of the related necessary equipment.

The equipment includes land survey equipment as GPS receivers and pocket compasses, and forest inventory equipment such as Spiegel-Relaskop or Blime-Leiss, which are needed for field inspection.

2) Storage, Accumulation and Utilisation of Technical Information

Aerial photographs were taken before and after the forest fire in 1996. While these photographs have their own value as technical information, they are more valuable in science when combined with satellite images and other information/data through forest survey. In view of their importance, the negatives of these aerial photographs must be properly stored and the photographs widely utilised.

Moreover, trial plots should be established for continuous research on the current annual increment of natural forests, the stand productivity of former selective cutting sites of natural forests and the productivity of man-made forests, etc. with a view to accumulating technical data on the ecology of forests located in the critical zone for forest growth.

(4) Consolidation of Forest Management Plan Implementation System

1) Training of Forestry Engineers

At present, only a limited number of forestry engineers for the practical implementation of forest management plans in the field are available at the aimak's Forestry Office and some timber companies while the nature protection officers at the district level lack the necessary skills to conduct forestry activities. To make matters worse, the specialist forestry college was closed down after the democratisation of the country. It is essential that forestry engineers with sufficient knowledge and experience of forest management be assigned to actual cutting and regeneration sites.

Training on the techniques required for forestry activities and forest management should be provided as soon as possible for nature protection officers at the district level in order to improve their forestry-related expertise. In addition, new training facilities for forests and forestry techniques should be established for the systematic training of forest engineers.

2) Local Forestry Activity Council

The existing selective cutting and natural regeneration work shows some shortcomings, including the cutting of fine trees, damage to remaining trees by logging and skidding work and poor natural regeneration at cut-over sites, etc., resulting in the degradation of many natural forests.

To improve the situation, a local council consisting of representatives of the Forestry Office, nature protection officers at the district level, forestry businesses and academic circles, etc. should be established to discuss various aspects of forestry activities and a forest management plan, including the characteristics of species found in natural forests, selection of cutting sites based on tree age and qualitative composition of stands, cutting methods, including tree selection criteria, preferable logging and skidding methods to avoid damage to remaining trees and appropriate regeneration methods, including enrichment, etc., so that appropriate forestry activities are conducted in accordance with the forest management plan.

3) Preparation and Distribution of Forest Type Maps and Forestry Inventory Books, etc.

At present, the nature protection officers assigned to manage forestry activities lack the relevant maps and other documents, including forest type maps, topographical maps, aerial photographs and forest inventory books, and, therefore, cannot accurately indicate a specific plan or area within a forest using such documents. Moreover, few

aerial photographs have been taken in recent years while the forest type maps do not have contour lines.

To improve the situation, new aerial photographs should be taken and forest type maps with contour lines should be prepared to assist proper forestry activities and forest management. The nature protection officers should be provided with forest type maps and aerials photographs as well as topographical maps and forest inventory books so that they can implement appropriate forest management utilising these documents.

4) Utilisation of Unused Resources

The *Pinus sylvestris* and *Larix sibirica* forests in Mongolia have been declining due to cutting and fire damage, etc. while the number of poor quality trees due to burning of the root collar, hollowing, bark pocket and decay is increasing. Meanwhile, *Betula platyphylla* is hardly used despite the high level of growing stock. As the use of the remaining poor quality trees and hitherto unused broad-leaved trees in forests is essential for the systematic improvement of existing forests to forests with high growth while ensuring a good tree character and appropriate stand density, active efforts must be made in the coming years to develop the appropriate use of poor quality trees as well as broad-leaved trees.

CHAPTER 1

OUTLINE OF THE STUDY

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1.1 Background

The Government of Mongolia envisages the sustainable utilisation of its forests which account for some 10% (15 million ha) of the total national land area. Forests with such commercially valuable trees as scotch pine and siberian larch cover some 11 million ha and Selenge Aimak is specially rich in forest resources.

The Ministry of Nature and Environment was established in 1978 to ensure environmental conservation throughout the country and an annual felling ceiling was enforced as an attempt to create an appropriate forest management regime. However, controls have been restricted to quantitative measures and accurate information on the country's vegetation has yet to be established. Consequently, forest management which takes the local characteristics into consideration has not been put into practice.

The extremely severe natural conditions and a felling cycle of more than 100 years make the smooth progress of reforestation work difficult to achieve. To make matters worse, concern has been expressed in regard to the declining forest area due to forest fires and the process of industrialisation.

Against this background, the Government of Mongolia made a request to the Government of Japan in November, 1992 to conduct a land use survey in Selenge Aimak and to prepare guidelines for a forest resources management master plan as well as a forest management plan for the Model Areas. In response to this request, the Government of Japan sent the Fact-Finding Mission to Mongolia in August, 1993 to confirm the contents of the request and to discuss the contents of the required assistance and proposed study area. In January, 1994, the Preliminary Study Team was sent to Mongolia and the Scope of Work was signed.

1.2 Objective

The ultimate objective of the Study is the preparation of a forest management plan for the Model Areas of some 30,000 ha based on land cover maps to be prepared through analysis of Landsat data for some 4.28 million ha of Selenge Aimak in Mongolia and also based on the forest management plan guidelines to be formulated for the Intensive Area of some 160,000 ha.

1.3 Study Area

The Study Area is Selenge Aimak consisting of some 4.28 million ha, of which some 160,000 ha are designated as the Intensive Area for the formulation of the forest management planning guidelines. Within the Intensive Area, two Model Areas (subject areas of the forest management plan) have been established. The locations of the Study Area, Intensive Area and Model Areas are shown in Fig. 1.

1.4 Outline of Study Processes

Following the preparatory work in Japan in fiscal 1993 (first year of the Study) the Study in fiscal 1994 (second year of the Study) through fiscal 1997 (fifth year of the Study) consists of the following issues.

(1) Second Year Study (Fiscal 1994)

1) Explanation of and discussions on the Inception Report

2) General survey of the Study Area

3) Gathering of relevant information/reference materials and field survey

4) Survey to formulate the forest management planning guidelines

5) Aerial photography (of the Intensive Area of some 160,000 ha; scale of 1/25,000)

6) Analysis of Landsat data

7) Preparation of topographic maps using SPOT data (for the Intensive Area of some 160,000 ha; scale of 1/50,000)

8) Preparation of topographic maps (for the Model Areas, scale of 1/25,000)

9) Interpretation of aerial photographs on land use and vegetation (for the Intensive Area)

10) Preparation of land use and vegetation maps (for the Intensive Area; scale of 1/50,000)

11) Formulation of forest management planning guidelines

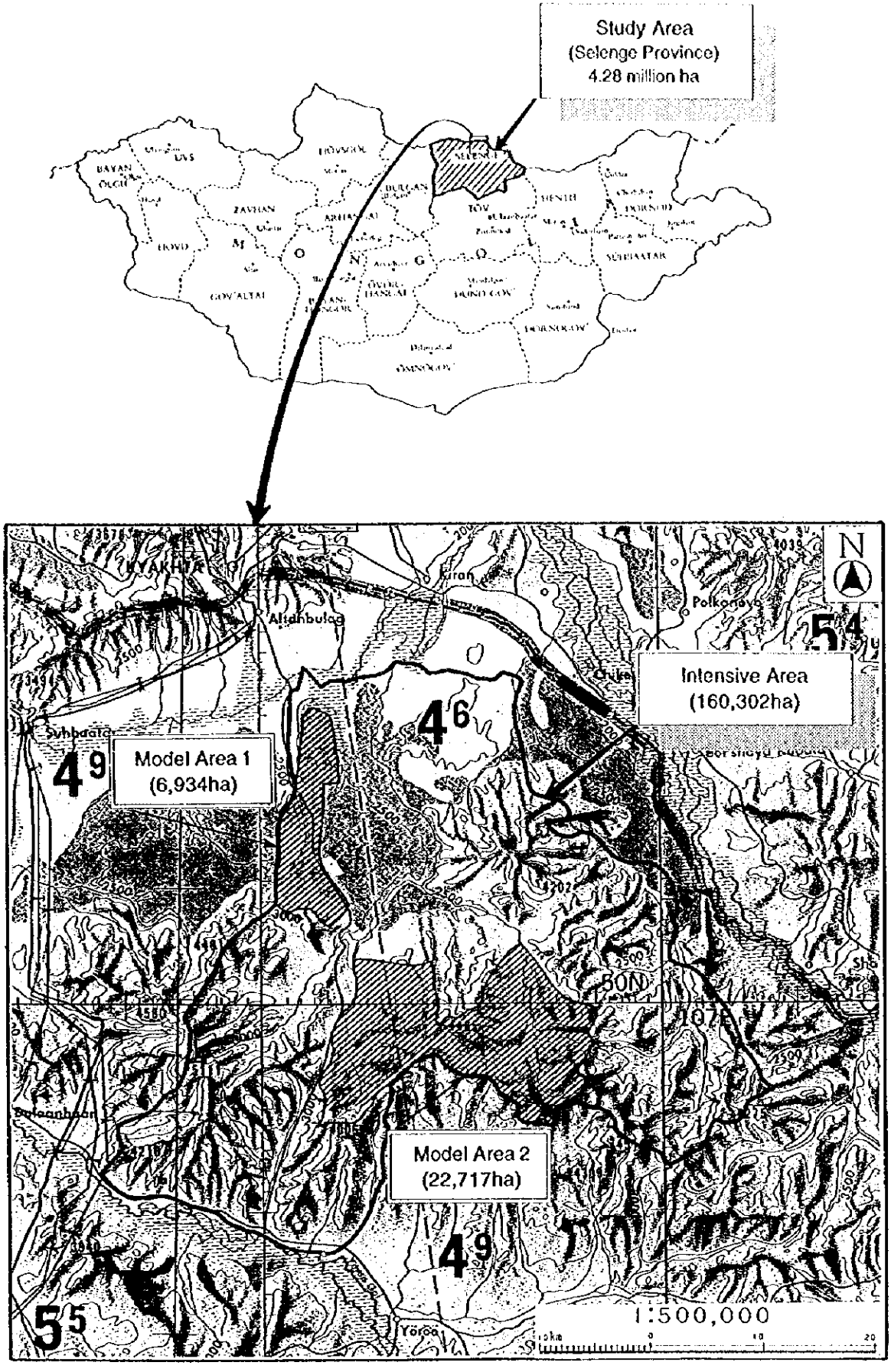

Fig. 1 Location Map of Study Area, etc.

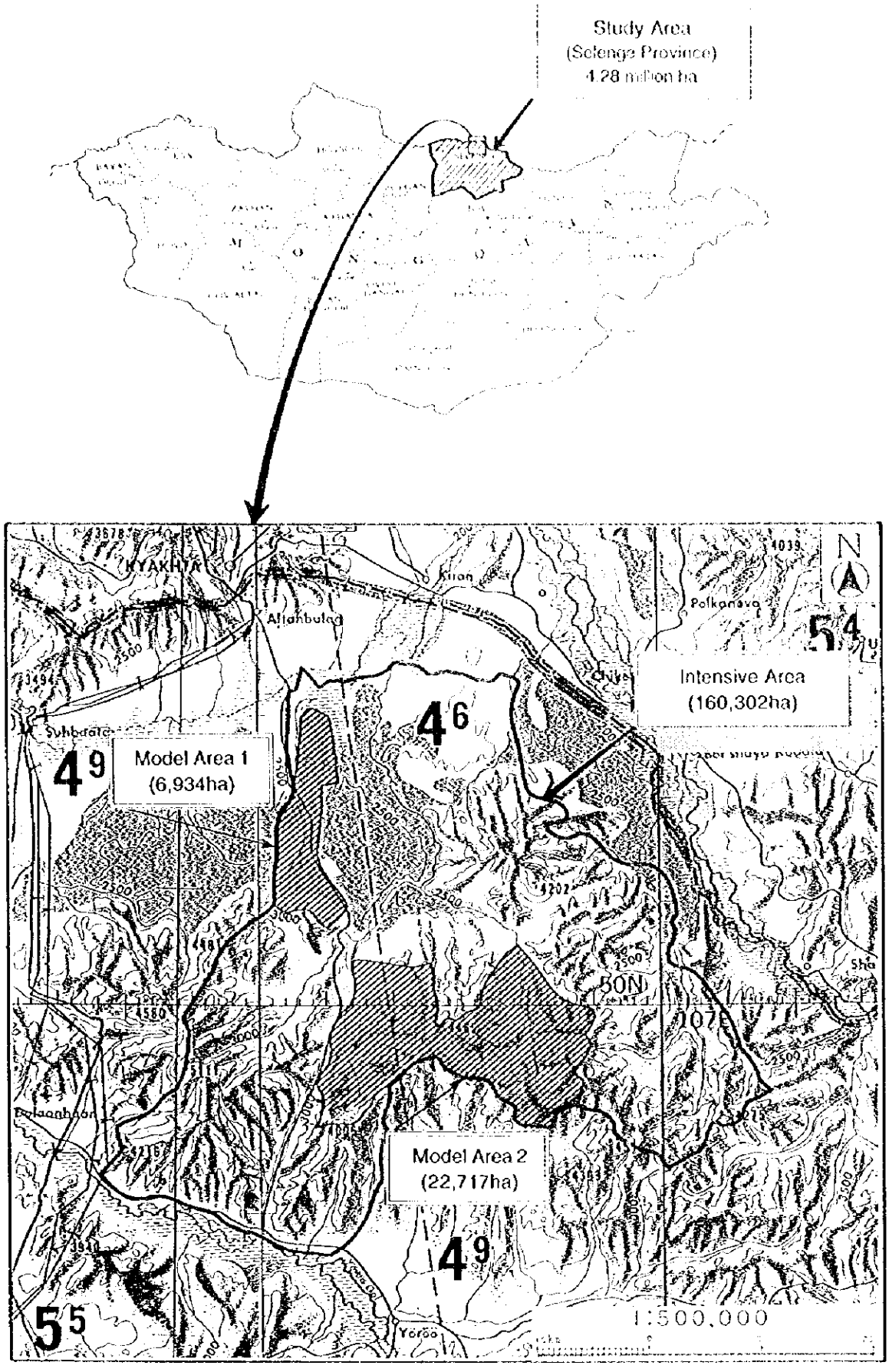

Fig. 1 Location Map of Study Area, etc.

(2) Third Year Study (Fiscal 1995)

1) Explanation of the Progress Report

2) Forest resources survey (for the Model Areas)

a) Forest type and vegetation survey

b) Natural regeneration survey

c) Volume table survey

d) Soil survey

e) Others

3) Analysis of field survey and reconnaissance findings

4) Preparation of the provisional forest management plan

5) Preparation of thematic maps, etc. for the Model Areas

a) Forest type map (scale: 1/25,000)

b) Soil map (scale: 1/25,000)

c) Forest management plan map (scale: 1/25,000)

d) Forest inventory book

6) Preparation of the Interim Report

(3) Fourth Year Study (Fiscal 1996)

1) Explanation and discussion of the Interim Report

2) Field verification study

(4) Fifth Year Study (Fiscal 1997)

1) Aerial photography (of the area damaged by forest fire in the Intensive Area of some 110,000 ha; scale of 1/20,000)

2) Study for preparation of interpretation criteria for the aerial photos

3) Study for forest management plan

a. Secondary damage such as pests at forests damaged by forest fire

b. Relationship between forest and climate

c. Prevention and extinction of forest fire

d. Utilization of damaged trees

e. Restoration of the area damaged by forest fire

4) Preparation of Draft Final Report

5) Preparation of thematic maps etc.

   a. Land Use and Vegetation Map After 1996's Fire (scale: 1/50,000)

   b. Forest Type Map After 1996's Fire (scale: 1/25,000)

   c. Forest Inventory book

   d. Forest Management Plan Map (scale: 1/25,000)

6) Explanation and discussion of Draft Final Report

7) Preparation of Final Report