Japan International Cooperation Agency (JICA)
Ministry of Waters, Forests and Environmental Protection (MWFEP)
Romania

THE FEASIBILITY STUDY ON FORESTS RESTORATION IN ROMANIAN PLAIN

FINAL REPORT

VOLUME 1

MAIN REPORT

JANUARY, 2000

JAPAN FOREST CIVIL ENGINEERING CONSULTANTS FOUNDATION

PASCO INTERNATIONAL INC.


1155099 (3)

PREFACE

In response to the request from the Government of Romania, the Government of Japan decided to conduct a development study on Forests Restoration in Romanian Plain and entrusted the study to Japan International Cooperation Agency (JICA).

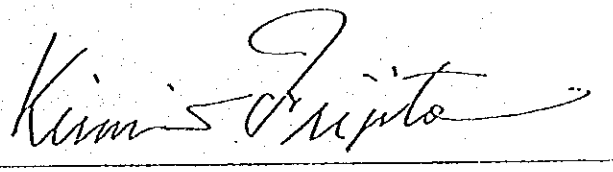
JICA sent to Romania a study team headed by Dr. Keiji TAKESHITA, Japan Forest Civil Engineering Consultants Foundation, six times between September 1997 and November 1999.

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

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

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

January, 2000



Kimio Fujita
President
Japan International Cooperation Agency

January, 2000

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Kimio Fujita

Letter of Transmittal

It is our great pleasure to inform you that the Feasibility Study on Forests Restoration in Romanian Plain has successfully been completed and the Final Report has also been compiled for submittal to your Agency.

The Study has been conducted for a period of 29 months, from September, 1997 to January, 2000, by the Japan Forest Civil Engineering Consultants Foundation and Pasco International Inc. in accordance with the agreement concluded with the Japan International Cooperation Agency (JICA). Under the Study, the causes and grades of forest decline have been specifically established, taking the current situation and cases of forest decline in a total forest area of 115,806 ha in Olt County and Dolj County which comprise the Study Area into consideration, and the Forest Restoration Plan has been formulated, incorporating damage restoration measures as well as decline prevention measures. The subject forest area of the Plan is 13,470 ha which accounts for some 12% of the total forest area of the Study Area.

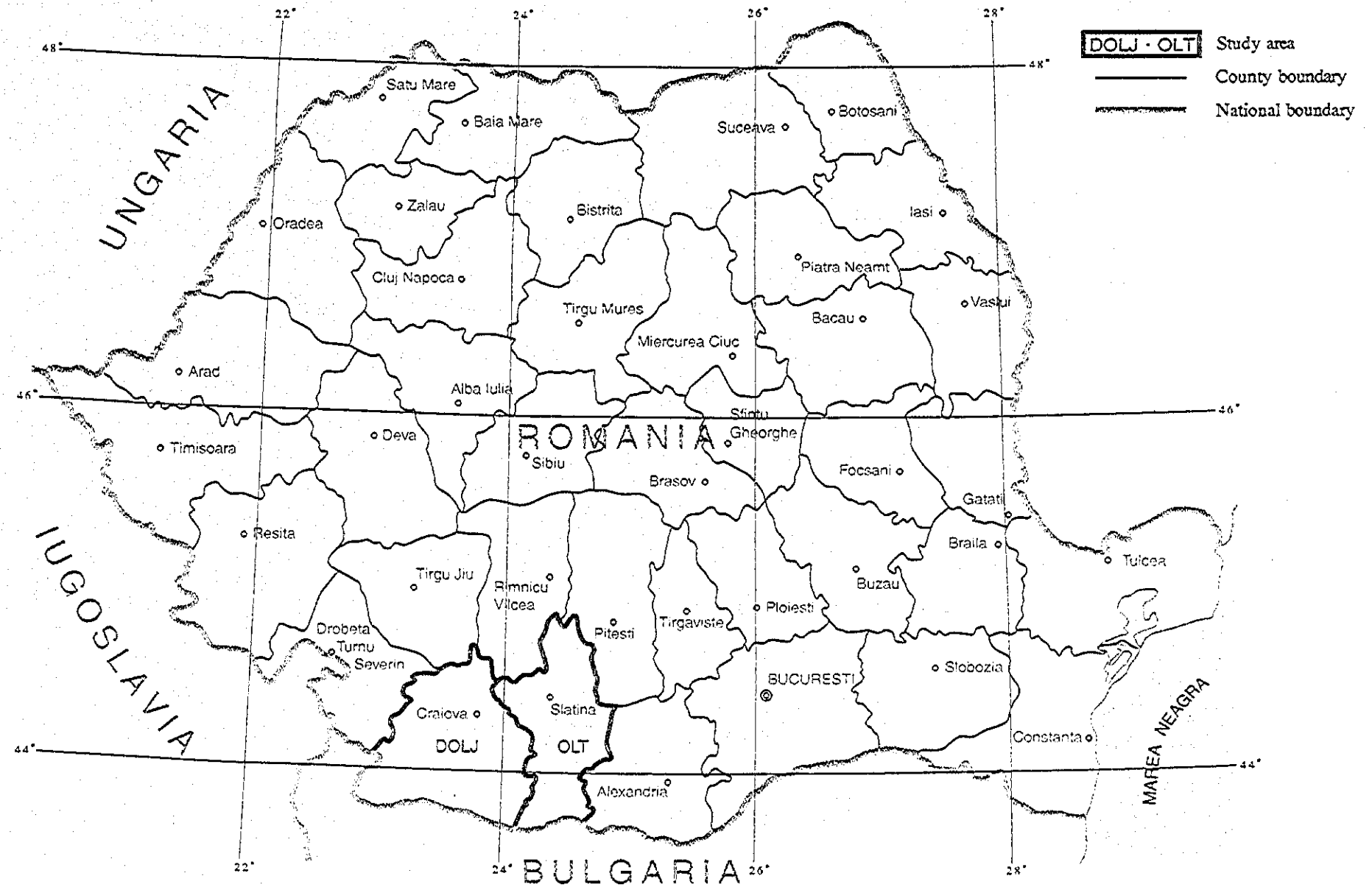
We sincerely hope that the Plan will be implemented in a precise manner through the efforts of the Government of Romania and all other related organizations to successfully restore forests in Romania, contributing to the further development of the country.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Agriculture, Forestry and Fisheries for their understanding of and assistance for the Study throughout the study period. We also wish to express our deep gratitude to the JICA/JOCV Romania Office, Embassy of Japan, Ministry of Waters, Forests and Environmental Protection, the National Administration of the Forests and the Forest Research and Management Institute for the close cooperation and assistance extended to us during our investigations and study.

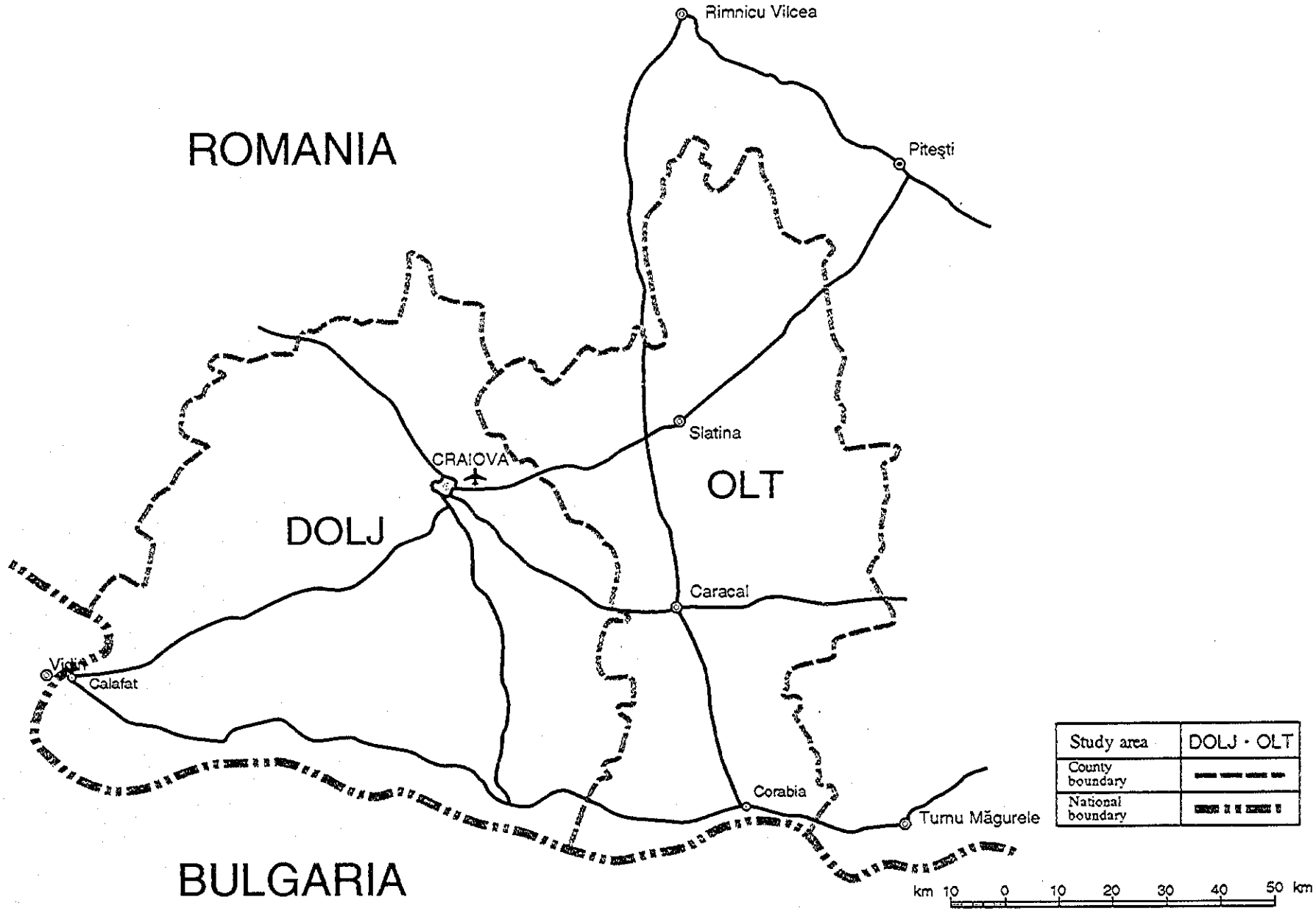
Very truly yours,

Keiji Takeshita

Keiji Takeshita
Team Leader
Study Team for the Feasibility Study on
Forest Restoration in Romanian Plain



Map of Romania


ROMANIA
Rimnicu Vilcea
Piteşti
Slatina
CRAIOVA
OLT
DOLJ
Caracal
Vidin
Calafat
Corabia
Turnu Măgurele
BULGARIA
Study area
DOLJ - OLT
County boundary
National boundary
km 10 0 10 20 30 40 50 km

Northern part of the Study Area
(O.S Amaradia)

Middle part of the Study Area
(O.S Craiova)

Southern part of the Study Area
(O.S Apele Vii)

Quercus spp.

Damage grade : strong

Quercus spp.

Damage grade : moderate

Quercus spp.

Damage grade : weak

Robinia pseudoacacia

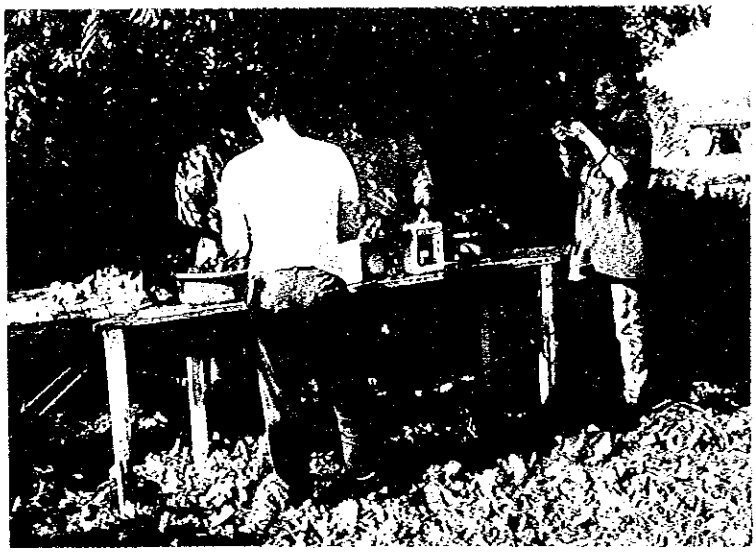
Damage grade : strong

Robinia pseudoacacia

Damage grade : moderate

Robinia pseudoacacia

Damage grade : weak



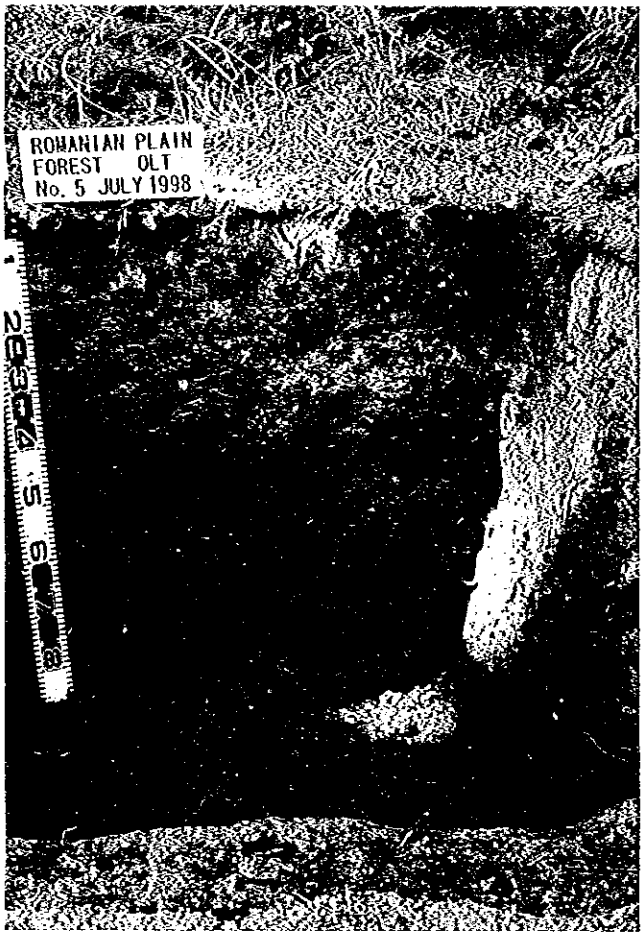
Breeding experiment

Preparation of cutting

Breeding experiment

Breeding experiment

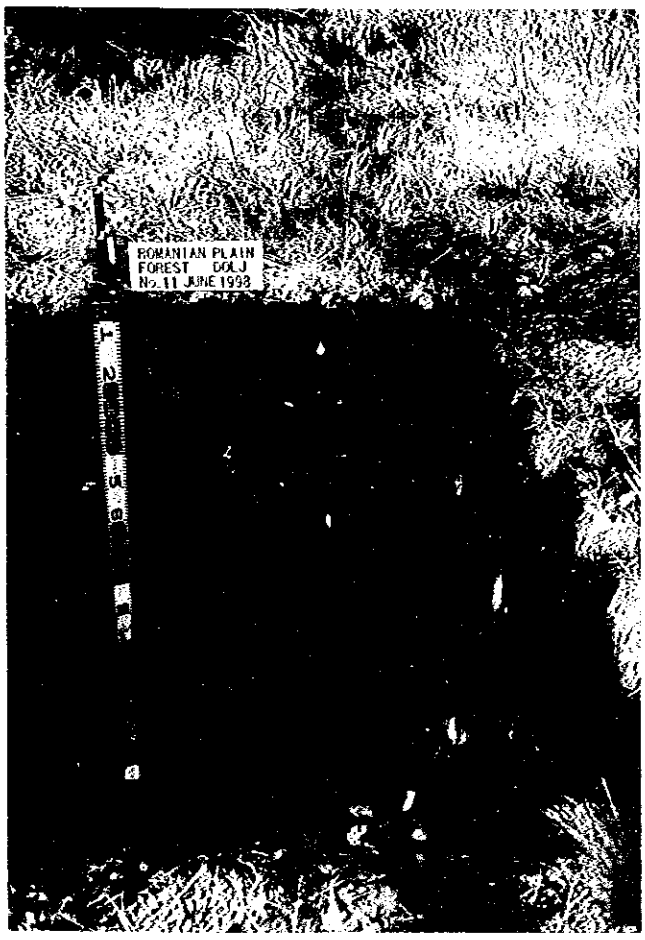
Quercus frainetto



Soil profile

Chromic Luvisols

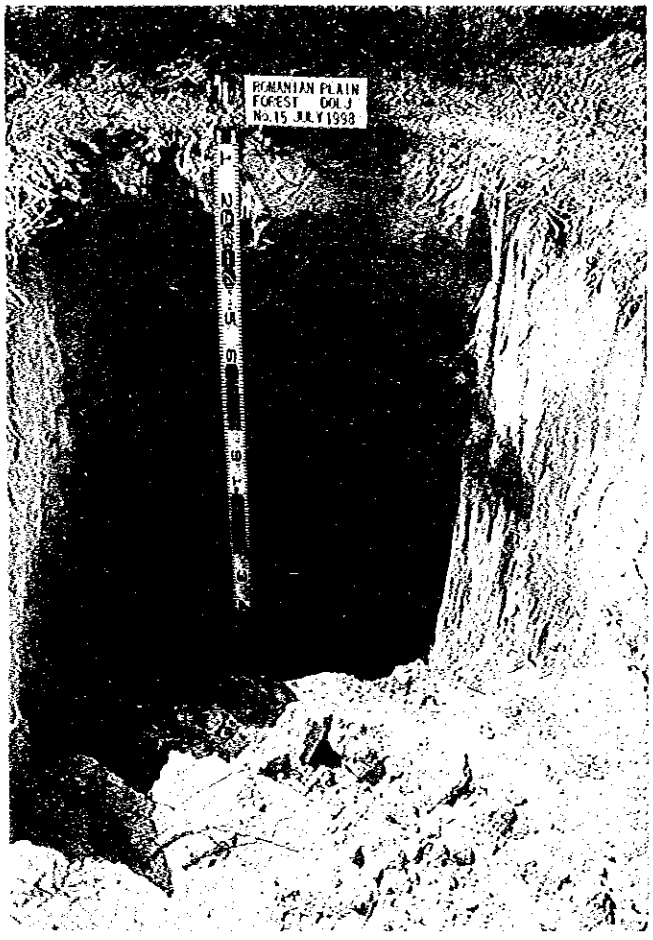
Craiova UP IV ua144A



Soil profile

Calcic Chernozems

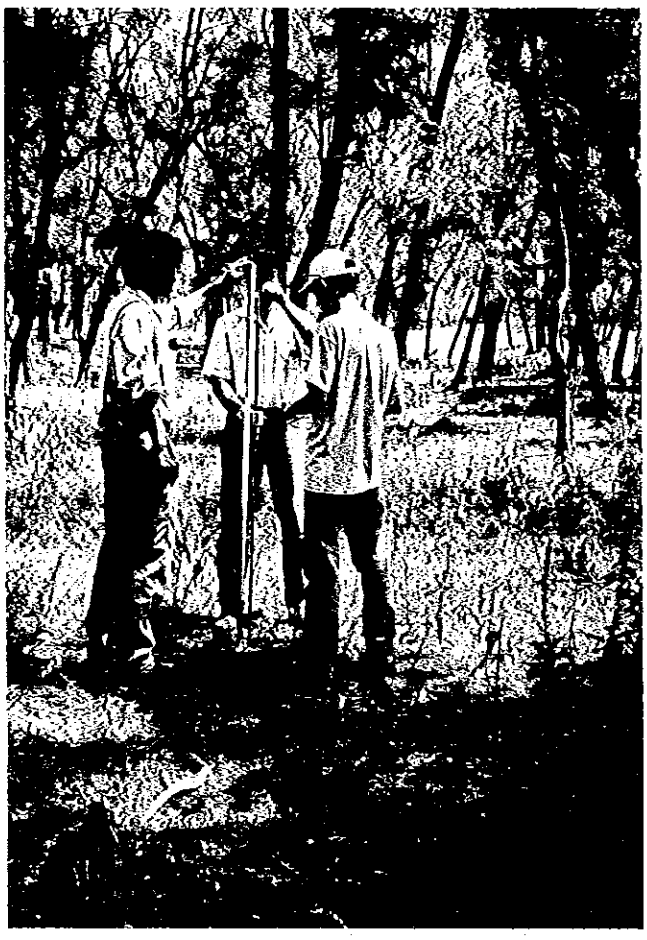
Perisor UP III ua57A



Soil profile

Haplic Arenosols

Apele vii UP II



Hasegawa type penetration tester

On-site discussion
for the technical standards
14 June, 1999
Craiova UP III, ua 51A

Meeting with counterpart personnel regarding result of on-site discussion
Slatina Forest Branch Office, 17 June 1999

Transfer Technology Seminar

RNP, 4 November, 1999

Transfer Technology Seminar

RNP, 4 November, 1999

SUMMARY AND RECOMMENDATION

SUMMARY

PART I: STUDY FINDINGS

1.1 Background of the Study

In September, 1994, the Government of Romania made a request to the Government of Japan for the provision of technical cooperation for the formulation of a forest restoration plan to deal with the phenomenon of forest decline at the southern plain caused by the decrease of rainfall since 1984. The signing of the S/W in April, 1997 by the two governments led to the implementation of the Feasibility Study on Forest Restoration in the Romanian Plain (hereinafter referred to as "the Study").

1.2 Objectives of the Study

Using aerial photographs and field survey results, this study set out to investigate the state of forest decline, the cause and extent of damage, and vegetation in the Study Area, and to formulate a forest restoration plan for Olt and Dolj Counties (hereinafter referred to as "the Plan") based on Romania's existing forest decline measures.

1.3 Scope of the Study

The scope of the Study covers 115,806 ha of national forests located in Olt and Dolj Counties. The main targets of the Study are national forests which have already been damaged and threatened with decline due to drought.

1.4 Basic Principles of the Study

In regard to the implementation of the Study, the main focus was placed on various issues related to the subject forests with a view to analysing the most characteristic issues using existing information.

In regard to the formulation of the Plan, countermeasures that would be appropriate for the types and degree of forest damage were formulated while taking into consideration Romania's laws and public works structure. An assessment of the environmental impact and benefit of execution of the Plan was also conducted.

1.5 Outline of Study Items

The Study consisted of a forest ecology and environmental survey, a survey on reforestation and nursing, a survey on forest disease and harmful insects, a climate and forest hydrology survey, a forest survey, a forest management survey, a financial and economic analysis and socioeconomic survey. The Plan and its measures were formulated by using the survey results to analyse the causes of forest decline.

The total subject area of the Plan is 13,470 ha.

1.6 Technology Transfer

Technology transfer was conducted by means of on-site OJT and training in Japan for counterpart personnel mainly selected from staff members of the RNP, ICAS and forest range offices.

2.1 Status of the Study

The Plan has been formulated for the national forests stipulated in Article 1 of the Forest Code of Romania and basically conforms to the various technical standards set forth in Article 9 of the Forest Code. The Plan also conforms to such related laws as the Environmental Protection Law and the Land Law, etc.

In regard to the formulation of the Plan, its relationship with the framework of the Forest Management Plan, Forestry Development Strategy, budget system and related organizations (RNP, ICAS, a local self-governing body) in Romania has been clearly identified.

2.2 Natural Conditions

2.2.1 Climate

While mean annual precipitation in the Study Area was approximately 550 mm from 1962 to 1994, 1992 to 1995 were dry years with annual precipitation of less than 500 mm. Mean monthly precipitation is in the range of 30 - 70 mm, with high precipitation in the May through July and November periods and low precipitation in September, October, January and February.

The mean annual temperature is approximately 11°C but has been gradually rising since the late 1980s. Mean monthly humidity is 79% and is low from spring to summer (April to September) but high in winter (November to February).

2.2.2 Topography

The main part of the Study Area is located in the lower and medium terraced plains extending from the southern foot of the Carpathian Mountains. This area became terraced as a result of the scouring and deposition of thick alluvial-fan deposits carried by the Danube River. The northern area of the Study Area is hilly, and flood plains and low terraces mark the southern area along the Danube, Olt and Jiu Rivers. In the southern area near the Danube, dunes are forming and burying some of the lower and middle terraces.

2.2.3 Geology and Soil

The surface geology of the Study Area is characterised by clay and aqueous deposits at hilly mountain foot areas, loess-like deposits at the central area of the plains, loess and loess-like deposits at riverside terraces and sandy fluvial deposits at riverside lowland along Danube River.

The soil units mainly distributed in forest areas in the Study Area mostly correspond to the topographical and vegetational conditions. The typical soil units are Luvisols and Cambisols at hilly mountain foot areas, Luvisols, Phaeozems and Podzoluvisols at tableland, Chernozems and Phaeozems at middle terraces, Cambisols, Fluvisols and Gleysols at low terraces and riverside terraces and Arenosols at riverside lowland. In the Study, the soil classification and codes used in Romania were translated to the FAO/UNESCO (1988) soil classification units by the Study Team.

2.2.4 Hydrology

Middle and high terraces in the Study Area are composed of a compacted layer of fine soil with low permeability, resulting in a low contribution to groundwater levels in surrounding areas. This compacted layer of fine soil is extremely thick, suggesting a high likelihood of a continuous fabric of fine pores. It is therefore estimated that the water storage capacity of these fine pores is great. Once stored, the water in the fine pores acts as a stable reservoir for trees.

The hilly area in the northern part of the Study Area is characterized by comparatively high precipitation and many thickly weathered spots. The thickly weathered soil layer has relatively high storage capacity and high water storage levels, creating stability and resistance to drought and consequently few incidences of forest decline.

In the central and southern parts of the Study Area, river plains carve through middle and high terraces. The top soil layer of these middle and high terraces becomes dry in drought years.

Few declined forests are found among sand dunes covering low terraces due to the relatively wet condition of the base terraces and stable groundwater levels. On the other hand, many declined forests are found among sand dunes covering middle terraces due to the arid environment.

2.3 Socioeconomic Conditions

Since 1989, Romania has proceeded with its shift towards a market economy, implementing the elimination of price controls, deregulation of foreign investment, privatisation of state enterprises and other measures. In 1996, however, substantial public funds were used to subsidize state enterprises and agriculture. This and a considerable increase in energy prices contributed to a rise in the fiscal deficit, acceleration of inflation and a decline of the value of Romania's currency, rapidly worsening the country's economic situation.

The populations of Olt (approx. 520,000) and Dolj (approx. 750,000) Counties are declining primarily due to an outflow of young people to large cities. Fifty-two (52) % and 40% of their respective working populations are engaged in agriculture, and those engaged in forestry account for less than 1% of the working population in both counties. Agriculture is the predominant industry in both counties and occupies 80% of the land.

Interviews with local people on the roles of forests produced the following results.

- There were high expectations that forests would continue to supply timber.
- Interest concerning forests' role in environmental conservation is rising. In the Middle and South parts of the Study Area, there is strong awareness of forests' role as a windbreak to protect agriculture, as well as a source of recreation and tourism.
- Forests are also appreciated for their uses in apiculture (bee keeping) and hunting.

2.4 State of Forest Management

2.4.1 Organizations Related to Forests and Forestry

Forestry administration in Romania is under the jurisdiction of the MWFEP. National forests are managed by the RNP which is directly controlled by the MWFEP. National forests in Olt County and Dolj County were formerly managed by the Slatina Forest Branch Office and the Craiova Forest Branch Office respectively but, following the reorganization at the end of December, 1998, the Slatina Forest Branch Office was integrated to the Rimnicu Vilcea Forest Branch Office in Vilcea County while the Craiova Forest Branch Office was integrated to the Tirgu Jiu Forest Branch Office in Gorj County. This reorganization reduced the number of forest range offices under each forest branch office from six to four in the case of the former Slatina Forest Branch Office and from nine to seven in the case of the former Craiova Forest Branch Office.

The operational expenditure as of 1998 was some two million dollars for the former Slatina Forest Branch Office and some three million dollars for the former Craiova Forest Branch Office. National forests in each forest range office area are divided into production forest units (UP: Unitatea de Productie) for management purposes. The four forest range offices in Olt County have 31 UPs while the seven forest range offices in Dolj County have 38 UPs.

The Romanian Forest Planning is formulated every 10 years for each forest range office and UP thereof, in accordance with the technical standards for forest management. The Romanian Forest Planning is planned on the basis of survey findings by ICAS researchers and is implemented by the RNP.

2.4.2 Forest Distribution

National forests in the Study Area cover an area of 115,806 ha. These forests are mainly distributed at the top, sloping, foot and riverside sections of hilly mountain foot areas and at the tableland, sloping and riverside sections of plains. The main species of national forests in the Study Area are *Quercus* spp., *Populus* spp., *Fraxinus* spp. and *Robinia pseudoacacia*. The forest vegetation can be classified into 11 types.

The analysis of LANDSAT TM data has found an east-west belt of plant stress along Danube River in the southern part of the Study Area. The results of the LANDSAT TM data analysis were actively used to determine the forest vegetation survey plots, forest survey plots and soil survey plots for the third field survey.

2.4.3 Forest Composition

The Study Area has many naturally regenerated forest of *Quercus* spp. Plantation forests created by artificial seeding or planting have many young stands. Belt-transect survey and plot surveys were conducted to confirm the composition of declined forests. The identifying characteristics of declining forests are as follows.

- Mixed stands of *Q. frainetto* and *Q. cerris* show a high decline grade for *Q. frainetto*. These stands are frequently observed in hill forests in the North Part and in plain forests in the Middle Part.
- Mixed stands of *Q. petraea*, *Q. frainetto* and *Q. cerris* show a high decline grade for *Q. petraea*. These stands are often observed in hill forests in the North Part.
- The proportion of declining trees with a decline grade of 2 or higher increases with a lower crown density.
- Declined forests are mainly observed in the case of forests which are 40 years of age or more. The damage to young forests is not significant.

2.4.4 Forest Land Productivity

The following relationship between the site index and land conditions is judged to exist.

Site Index (Tree Height of 100 Year Old Stand) for *Q. frainetto* and *Q. cerris* and Land Conditions

Site Quality	Tree Height (m)	Land Conditions
Special I	30.1 - 34.0	•Low terraces with swollen and soft A and B horizons
I	26.1 - 30.0	•Low terraces; slightly compact A and B horizons in the case of *Q. robur*
II	22.1 - 26.0	•Slopes with thick soil or weathered layer; compact low terrace
III	18.1 - 22.0	•Terrace surface with gentle inclination, minor undulations and good drainage •Flat surface of middle and high terraces with swollen and soft A and B horizons
IV	14.1 - 18.0	•Flat surface of middle and high terraces with crown coverage of approximately 60%
V	10.0 - 14.0	•Flat surface of middle and high terraces covered by compact A and B horizons •Narrow terraces with low level of water stored in fine pores •Forest edges and windy sites with crown coverage of 50%

Notes Special I : Class I *Q. robur* site
Thickness of A horizon : healthy forest land = 15 - 20 cm; not healthy land = < 15 cm
Depth of B horizon : healthy forest land = 25 - 30 cm; not healthy land = very compact below 5 - 15 cm

Many declined forests are found at site-index Class V sites and IV sites and their frequency of appearance declines with better site indices.

2.4.5 Yield Tables

Yield tables serve as the basis for understanding forest composition, estimating annual change and predicting future change. Yield tables based on crown coverage ratios are required for the financial and economic analyses in this Plan. As highly accurate yield tables are available in Romania for each species and variety, these tables were employed as base data and adapted primarily using the growth analysis method of the crown form model to prepare yield tables based on crown coverage ratios.

2.4.6 Environmental Conservation Functions of Forests

There are seven forest functions related to environmental conservation in the Study Area, i.e. water conservation function, windbreak function, soil conservation function, climate mitigation function, wildlife protection function, recreational use and landscape maintenance function and CO_2 fixation. These functions are classified into 58 designated forest functions in

Romania. For the purpose of the Study, the 58 forest functions in Romania were classified into ten forest function groups from the viewpoint of identifying the effects of the implementation of management practice and evaluating the forest functions envisaged by the Plan.

2.4.7 Forest Work and Forest Management

Romania has joined an international monitoring project (ICP Forest) of the EU and has been continuously monitoring declined forests since 1990. The nationwide distribution of declining trees in Romania is related to altitude and defoliated forests classified as Grade 2 through Grade 4 are more frequently found at plains and hilly areas than in mountain areas. The degree of decline is categorised into the following five grades in correspondence with the defoliation rate.

0 = upto 10%, 1 = 11% - 25%, 2 = 26% - 60%, 3 = 61% - 99%, 4 = dead

The cutting of damaged trees and planting at cut-over sites have been conducted in Romania to deal with forest decline. However, the scattered nature of declined forests has left many damaged stands unaddressed.

As a result of the survey on damage due to defoliators, borers and seed insects and the survey on the parasitic situation of natural enemies and the state of implementation of pest control measures as part of the efforts to identify the necessary diseases and pest control measures under the Study, it is judged that the continued implementation of the conventional pest control method in Romania has been sufficient to control defoliators and that the planning of new pest control measures under the Plan is unnecessary.

In Romania, regeneration by planting, coppicing and natural seeding is selected at clear cutting sites while regeneration by coppicing and natural seeding is selected at selective cutting sites. Appropriate tending and the numerical control of the number of growing trees are also practiced depending on the specific conditions of each site. Regeneration by coppicing mainly consists of regeneration by root suckers.

The Study Area has two central nurseries with a total nursing area of 68 ha. The production level of these nurseries is adjusted every year in accordance with the respective work plan.

The total area of seed stands where seeds can be collected is 314 ha at 35 sites in Olt County and 31 ha at five sites in Dolj County. However, as most of these are more than 100 years of

age, the quantity of collected seeds is small. In fact, no seeds have been collected for more than 10 years in Dolj County. New seed stands have been designated to produce the necessary quantity of seeds required for the reforestation work under the Plan.

The production of wood from national forests in the Study Area used to be conducted by the wood processing divisions of state enterprises in possession of a sawmill. As a result of the decrease of the production volume linked to the international poor demand for processed wood products in recent years, however, the forest branch office responsible for the management of national forests has also been responsible for the direct management of timber production for several years. The local sales price of logs is extremely low in relative terms compared to the corresponding international market prices. The volumes of cutting and reforestation work in both Olt County and Dolj County in recent years have been decreasing compared to the volumes in the 1980's.

Although forest road density in the Study Area is rather low at 2.0 m/ha, the construction of new forest roads is unnecessary due to high accessibility of forest land by broad compartment borders, public roads and agricultural roads. However, given the presence of road sections where vehicle traffic is prevented due to scouring by surface flow, work to improve existing forest roads is judged to be necessary.

Along Jiu River and Olt River (the main rivers in the Study Area), bank failure sites can be seen in spots along steep sections of valley banks and riverbank terraces. As no failure site threatens to cause damage to nearby settlements and settlements in the lower reaches in the subject area of the Plan, the construction of erosion control facilities is not planned.

2.5 Breeding Experiment Using Cuttings

At present, planting stock production of *Quercus frainetto* is nearly impossible due to the shortage of superior seed trees and the lengthy interval of 8 - 10 years between bearing years. In view of this fact, a breeding experiment using cuttings was conducted from 1997 to 1999 to examine the feasibility of producing planting stock using cuttings. The experiment results suggest that the mass production of *Q. frainetto* planting stock from cuttings will be difficult. However, the results at the mist house indicate that there is scope to produce a sufficient quantity of planting stock to create seed orchards.

2.6 State of Forest Decline

2.6.1 Causes of Forest Decline

The Study has established that forest decline is caused by climatic drought damage, repeated water stress from drought or excessive wetness, and soil compaction due to livestock grazing. The relationship between regeneration by coppicing and forest decline has not been clearly established.

The processes of forest decline are outlined below.

The sedimentation layer that constitutes the diluvial upland in the Study Area has a continuous presence of fine pores ($pF > 2.7$). When water is stored in these fine pores and the sedimentation layer is thick, the amount of water trapped in the bed formation is substantial. As a result, despite severe dry weather, most forest trees in the Study Area continued to grow without experiencing decline. As the water in fine pores is retained by strong capillary tension, a root system with excellent water absorption capabilities is required to access it.

Normally, most forest trees grow in a dry environment and enjoy strong water absorption capabilities, continuing to grow even during drought periods by using the water in fine pores. In contrast, the root systems of the few forest trees that grow in favorable water conditions lack such strong water absorption capabilities and experience decline.

Many incidences of forest decline were also observed at sites where the A2 and B horizons immediately below the surface layer (A1 horizons) had been compacted by trampling. When the A2 and B horizons become impermeable, water stagnation occurs in the top soil layer and the root system weakens. The insufficient water absorption capabilities of the weakened root system cause the decline.

It is therefore essential that physical conditions of soils be improved in order to avoid forest decline.

2.6.2 Area of Declined Forest

For the purpose of the Study, declining trees were classified in accordance with the relevant categories used by the ICP Forest. In the case of declining trees, defoliation immediately leads to the death of new branches and young branches, changing the crown form. This change of the crown form is a factor which can be interpreted on the aerial photographs. This change of

the crown form was noticed by the Study Team and was used as an additional criterion for the classification of declining trees.

In regard to the grade of stand decline, three damage grades were established based on the proportion of standing trees with a decline grade of 2, 3 and 4 in a stand:

- damage grade weak (proportion of declining trees: 20 - 39%),
- damage grade moderate (proportion of declining trees: 40 - 59%) and
- damage grade strong (proportion of declining trees: 60% or more).

For the purpose of the Study, declined forests were classified as damaged forests and prevention forests. A damaged forest is a forest of which the future growth cannot be anticipated due to excessive opening of the canopy. Meanwhile, a prevention forest is a forest of which a future increase of declining trees is anticipated due to damage by drought. The total area of damaged forests and prevention forests is 9,204 ha and 4,265 ha respectively.

2.7 Initial Environmental Examination (IEE)

As the Plan mainly focuses on reforestation measures to restore declined forests, no negative impact on the environment is anticipated.

3.1 Costs

Under the Plan, operation mainly consisting of artificial regeneration is planned for *Quercus* spp. stands together with the tending of existing naturally regenerated trees in the case of *Quercus* spp. stands. In the case of *R. pseudoacacia* stands, operation mainly consisting of artificial regeneration is planned for stands with "strong" damage while regeneration by coppicing is mainly planned for stands with "moderate" damage. In the case of damaged *Populus* spp., artificial regeneration by the mixed planting of *Q. robur* and other species is planned at that forest land with dry soil.

Assuming the above regeneration method for different types of stands, the series of operation from cutting to regeneration, tending and thinning and the cost per ha are summarised below based on the relevant actual results in 1998.

The standard costs per ha from cruising and wood production work upto the stacking of logs at the forest edges in damaged forests in the two counties are outlined in the following table.

Standard Costs of Cruising and Wood Production Work

Species	Standard Cruising Cost	Standard Wood Production Cost	Remarks
Quercus spp.	93,440 Lei/ha (US$ 11)	798,000 Lei/ha (US$ 90)	520 trees 57 m^3 (log production: 32 m^3)
Robinia pseudoacacia	116,800 Lei/ha (US$ 13)	1,023,000 Lei/ha (US$ 115)	650 trees 66 m^3 (log production: 36 m^3)
Populus spp.	25,500 Lei/ha (US$ 3)	1,198,000 Lei/ha (US$ 135)	137 trees 96 m^3 (log production: 57 m^3)

The cost of the reforestation work at existing stands mainly consisting of *Quercus* spp., *R. pseudoacacia* and *Populus* spp. is outlined in the following table.

Standard Cost of Reforestation Work

1,000 Lei/ha (US$/ha)

Work at Existing Stands	*Quercus* spp.	*R. pseudoacacia*	*Populus* spp.
Soil preparation/Ploughing	7,350 (845)	7,350 (845)	7,350 (845)
Planting	4,977 (572)	3,765 (433)	1,935 (222)
Tending (Supplementary Planting, Scarifying and Improvement Cutting, etc.)	13,953 (1,604)	5,546 (637)	5,774 (664)
Thinning	1,774 (204)	1,032 (119)	488 (56)

The following table outlines the standard prices of planting stock based on the actual prices at RNP nurseries in Olt and Dolj Counties in the period from 1996 to 1999.

Standard Prices of Planting Stock

(US$/1,000 Seedlings)

Species	Unit Price	Species	Unit Price
Quercus frainetto	20.5	*Acer tataricum*	12.0
Quercus frainetto (cutting stock)	304.0	*Acer campestre*	17.0
Quercus cerris	15.3	*Tilia platyphyllos*	19.1
Quercus petraea	16.6	*Pyrus pyraster*	20.0
Quercus pedunculiflora	17.0	*Prunus cerasifera*	16.9
Quercus robur	17.0	*Crataegus monogyna*	18.8
Robinia pseudoacacia	13.5	*Gladitschia triacanthos*	17.0
Fraxinus excelsior	12.9	*Elaeagnus angustifolia*	17.8
Fraxinus ornus	11.8	*Populus euroamericana*	100.8
Fraxinus pennsylvanica	11.8	*Populus alba*	235.5
Cornus sanguinea	12.8		

PART II: FOREST RESTORATION PLAN

1.1 Status of the Plan

1.1.1 Relationship with Existing Laws

The Plan is formulated for national forests among those referred to in the Forest Code. As all of the planning items conform to the Environmental Protection Law, an environmental impacts assessment is not required. The Plan excludes private forests which have been returned pursuant to the Land Law.

1.1.2 Relationship with Forest Planning System

All of the planning items in the Plan will be incorporated in the existing forest management plans. The Plan conforms to one key objective of the Forestry Development Strategy.

1.1.3 Relationship with Various Organizations

The Plan will be controlled by the MWFEP. Detailed planning will be conducted by the ICAS and the actual work will be carried out by the RNP. Local administrative bodies will assist the fire prevention as well as fire-fighting work at national and private forests, including those in the subject area of the Plan, pursuant to the stipulations of the Forest Code.

The work under the Plan will be conducted by the relevant forest range offices which will directly employ mainly local people as day labourers under the supervision of the respective forest branch offices. In the case of work involving large machinery, private companies will be subcontracted to conduct the said work.

1.2 Basic Concept of Plan Formulation

The subject forests of the Plan are classified into the following two groups.

① Forests with trees with a decline grade of 2 or higher requiring restoration of their health by means of mainly cutting, regeneration and tending work. In other words, forests of which the damage must be restored (hereinafter referred to as "damaged forests").

② Forests with trees with a decline grade of 0 or 1 and characterised by topographical conditions prone to standing water or forests with a strong likelihood of future decline

depending on the species, age and topography as well as soil conditions in a low rainfall year. In other words, forests of which the decline must be avoided (hereinafter referred to as "prevention forests").

The creation of stands with an appropriate density vis-a-vis the stand age with species of excellent growth to increase wood production is important in the formulation of the Plan to restore various forest functions.

1.2.1 Basic Principles of the Plan

The implementation period of the Plan is 10 years. The period of individual work under the Plan has been decided in view of the contents of each planning item and work implementation capability. The calculation period for the financial and economic analyses under the Plan is 169 years as the period required to realise the forest type after restoration.

The basic principles for the formulation of various measures to be implemented under the Plan are described next.

(1) Measures to Restore Forest Damage (Damage Restoration Measures)

1) Establishment of Regeneration Methods

i. Promotion of effective regeneration
ii. Promotion of experiments using cuttings technique
iii. Expansion of seed stands and seed orchard

2) Establishment of Environmental Conservation Function of Forests

i. Avoidance of damage by drought or excessively wet conditions
ii. Improvement of environmental conservation function
iii. Promotion of local development

3) Promotion of Efficient Forest Restoration

i. Promotion of forest road improvement and introduction of machinery
ii. Promotion of development and extension of new techniques

(2) Measures to Prevention Forest Decline (Decline Prevention Measures)

1) Prevention of damage by drought and excessively wet conditions

2) Restoration of forest mantle

1.2.2 Contents of Main Planning Items

(1) Main Planning Items for Damaged Forests

1) Cutting of Standing Trees

In order to restore declined stands by means of an appropriate regeneration method, a cutting method and cutting rate mainly featuring damaged and declined trees will be determined by species as well as decline grade and cutting will be conducted at the stands subject to damage restoration measures.

2) Reforestation

- Selection of Suitable Sites

As damaged *Quercus* spp. forests are unsuitable for the planting of fast growing species because of their site and soil conditions, the planting of *Quercus* spp. is planned. In the case of damaged forests of *Robinia pseudoacacia* where the soil conditions are unsuitable for growth, the planting of species which are suitable for the soil conditions is planned. In the case of damaged *Populus* spp. forests, their conversion to mainly *Quercus* spp. forests is planned.

- Control of Drought by Improvement of Soil Structure

The transition of new reforestation sites to declined forests because of drought must be prevented. For this purpose, a large machine equipped with a ripper will be used to dig ripped strips of 50 cm in depth to create stands which are highly resistant to drought.

- Adjustment of Timing of Thinning as Drought Damage Control Measure

In order to foster standing trees with a high recovery capability from drought damage, thinning will be conducted five years earlier than suggested by the Romanian silviculture standards in the case of *Quercus* spp. to create a crown form with well grown, large spreading branches.

- Measure to Compensate Planting Stock Shortage Due to Seed Shortage Caused by Drought

In view of the present production shortage of *Q. frainetto* planting stock, the mixed planting of *Q. cerris* as well as other assistant trees and shrubs will be conducted to compensate for the shortage of *Q. frainetto* planting stock.

- Reduction of Reforestation Cost

In order to achieve efficient forest management, reduction of the reforestation cost will be attempted. At cut-over sites of damaged trees in *Quercus* spp. forests, soil preparation method by two-thirds of the ground, i.e. alternation of 10 m wide soil preparation belts and 5 m wide uncleared strips (67% soil preparation), will be selected for stands with strong damage. In the case of stands of moderate damage, soil preparation method by half of the ground, i.e. alternation of 0.8 m wide soil preparation belts and 0.8 m wide uncleared strips (50% soil preparation), will be employed. Small machinery will be used for scarifying to reduce its frequency in order to reduce the tending cost.

3) Nursing

- Measures to Increase Production of *Q. frainetto* Seeds

Healthy forests capable of producing seeds among existing *Q. frainetto* forests will be newly designated as seed stands and thinning will be repeatedly conducted at these forests to facilitate seed bearing. In addition, appropriate management will be conducted at the existing seed orchard to increase seed production.

4) Construction of Drainage and Infiltration Works

Drainage and infiltration works will be constructed at those areas of damaged *Quercus* spp. forests where standing trees are remained to facilitate the drainage of stagnant water from the top soil layer and the infiltration of drained water.

5) Protection of Forest Mantle

The supplementary planting of *R. pseudoacacia, Elaeagnus augustiflora* and *Gladitschia triacanthos* at forest mantle will be conducted as a measure to prevent damage by drought, high temperatures, strong wind and stock raising, all of which are caused by the destruction of forest mantles, in order to suppress the process of forest decline.

6) Improvement of Forest Roads

There are many sites where vehicle traffic is prevented due to scouring of the road surface by rainwater. Forest road improvement work will, therefore, be conducted to ensure the efficient implementation of the various work envisaged under the Plan.

7) Forest Machinery

The introduction of large and small forest machinery is planned to create forests with a high resistance to drought damage and to ensure efficient production and reforestation work.

8) Local Development

Under the Plan, the creation of a general arboretum and forestry work demonstration forests will be planned for the purposes of further enhancing the recreation function of forests, the expectations of which among local people have been increasing, and facilitating people's understanding of proper forest management.

9) Technical Development

Technical development to breed highly resistant species is planned as a measure to hasten the restoration of damaged forests. Using the breeding method of resistant species, individuals with excellent quality and growth will be selected from among those which are resistant to drought and clones will be produced by cutting. A seed orchard will then be created using these clones as mother trees.

(2) Main Planning Items for Prevention Forests

1) Drainage and Infiltration Works

Hard soil with a low permeability produces a layer containing stagnant water. Drainage and infiltration works will, therefore, be constructed to drain and to facilitate the infiltration of stagnant water. These works will have a depth of 20 cm and a width of 50 cm and will be constructed at a rate of 800 m per ha.

2) Protection of Forest Mantle

The supplementary planting of *R. pseudoacacia*, *Elaeagnus augustiflora* and *Gladitschia triacanthos* at forest mantle will be conducted as a measure to prevent damage by drought, high temperatures, strong wind and stock raising, all of which are caused by the destruction of forest mantles, in order to suppress the process of forest decline.

1.2.3 Targets and Planned Work Volumes of the Plan

For the restoration of damaged forests, regeneration will be attempted, taking the natural conditions of each stand into consideration using species which promise a successful outcome

of the intended reforestation and improvement of the soil conditions. In view of the urgency of the current situation and the implementation volume of the present forestry work, the damage restoration measures will be conducted within 10 operation years.

The period of tending means the period upto the improvement cutting of the planted species at *Quercus* spp. stands and is, therefore, 29 operation years. The implementation of thinning at the planted sites of *R. pseudoacacia* and *Populus* spp. can be planned during this period. The period to reach the target stage is planned based on the Romanian yield tables and is 120 years for stands mainly consisting of *Quercus* spp. and 30 years for *R. pseudoacacia* stands from initial planting. Thinning at *Quercus* spp. reforestation sites can be planned for five times between the 35th year and the 75th year. The decline prevention measures will be implemented in the first half of the period of the anticipated 10 operation years in parallel with the implementation of the damage restoration measures.

1.3 Items Related to Plan Implementation Body

The RNP will be responsible for implementing the Plan, and needs to liaise with each project and ordinary forest operations. To that end, full-time personnel need to be assigned to oversee plan implementation at the two forest branch offices with jurisdiction over the two counties, and the 11 forest range offices in the two counties.

The actual work on site will be conducted by the forest range offices while the forest branch offices will instruct and supervise the work conducted by the forest range offices. The RNP will be responsible for the overall command and supervision of the implementation of the Plan.

2.1 Forest Selection Criteria

2.1.1 Subject Forests for Damage Restoration Measures

The selection criteria and main items of the damage restoration measures to restore the functions of declining stands due to water stress are described below.

(1) Selection Criteria

Forests which meet all of the following criteria are regarded as damaged forests.

i. Stands of *Quercus* spp., *Fraxinus excelsior* and other broad-leaved species with a stand age of mainly 10 - 100 years and stands of *Robinia pseudoacacia* or *Populus* spp. with a stand age of mainly 10-25 years

ii. Stands of which the proportion of standing trees with a decline grade of 2 or higher is 20% or more

iii. Stands of which the crown density is less than 60%. Here the crown density is expressed as the relative percentage of the crown density of a healthy stand when the latter is set at 100%. The latter is equivalent to 80% in terms of the geometrical crown coverage (crown coverage = 0.8 x crown density)

iv. Stands with a declining area of 0.1 ha or more

The total area of damaged forests is 9,204 ha.

(2) Classification of Forest Management Type of Damaged Forests

In order to examine forest management operation which is appropriate for the actual conditions of each stand under the Plan, damaged forests are classified into the following 13 types based on the composition of the main species or forest age in the case of *R. pseudoacacia* stands. Accordingly, the Plan is formulated to deal with each of these 13 types although F4 type damaged forests are not observed in the subject area of the Plan.

Contents of Forest Management Types of Damaged Forests

Forest Management Type	Contents
F1	Seed stand of *Q. frainetto*
F2	Seed stand of *Q. cerris*
F3	Seed stand of *Q. pubescens* or *Q. pedunculiflora*
F4	Seed stand of *Q. robur*
F5	Pure forest of *Q. frainetto*
F6	Pure forest of *Q. cerris* or mixed forest of *Q. frainetto* and *Q. cerris* or mixed forest of *Q. cerris* or Q. *frainetto* and other *Quercus* spp.
F7	Other *Quercus* spp. forest, *Q. robur* forest or *Q. petraea* forest
F8	Mixed forest of *Quercus* spp. and other species
F9	*Robinia pseudoacacia* forest of 20 years of age or more (the target species written in the Romanian Forest Planning is *R. pseudoacacia*)
F10	*R. pseudoacacia* forest of less than 20 years of age (the target species written in the Romanian Forest Planning is *R. pseudoacacia*)
F11	*R. pseudoacacia* forest of 20 years of age or more (the target species written in the Romanian Forest Planning is other than *R. pseudoacacia*)
F12	*R. pseudoacacia* forest of less than 20 years of age (the target species written in the Romanian Forest Planning is other than *R. pseudoacacia*)
F13	*Populus* spp. forest

(3) Main Items of Damage Restoration Measures

The following items are determined in regard to the main types of work to restore and maintain the expected functions of damaged forests.

i. Cutting method and cutting rate by forest management type and damage grade

ii. Regeneration method by forest management type and damage grade

iii. Tending method by forest management type and damage grade

iv. Construction of drainage and infiltration works at remaining areas

2.1.2 Subject Forests for Decline Prevention Measures

The selection criteria and main items of the decline prevention measures to avoid damage to stands which are expected to decline due to water stress are described below.

(1) Selection Criteria

Forests which meet all of the following criteria are regarded as prevention forests.

i. Stands at middle or high terraces and adjacent to a damaged forest

ii. *Quercus* spp. stands with a stand age of 35 - 65 years

iii. Stands of which the soil unit is Chromic Luvisols (LVx), Vertic Luvisols (LVv), Albic Luvisols (LVa), Stagnic-Vertic Luvisols (LVv-j), Haplic Luvisols (LVh), Vertic-Chromic Luvisols (LVx-v), Cambisols (CM), Chernozems (CH) or Phaeozems (PH)

iv. Stands of 0.1 ha or more containing trees with a decline grade of less than 1

v. Stands with an inclination of three degrees or less

The total area of prevention forests is 4,266 ha.

(2) Main Items of Decline Prevention Measures

i. Construction of drainage and infiltration works

ii. Supplementary planting to maintain or restore forest mantle

2.2 Location and Area of Subject Forests

The total area of forests subject to the Plan is 13,470 ha, of which 9,204 ha consists of damaged forests and 4,266 ha consists of prevention forests.

3.1 Damage Restoration System

Under the Plan, the cutting and regeneration methods are determined based on the species, stand age and damage grade (Figure 1).

3.2 Items Related to Cutting

3.2.1 Items Related to Tree Selection and Cutting

(1) Items Related to Tree Selection

The tree selection method based on damage grade is described below.

Damage Grade	Cutting Rate	Selection Method of Damaged Trees
Strong	60%, 80% or 100%	• Group reservation at sites of many healthy trees • Selection of all trees, including healthy trees, in cutting areas • Selection of only Grade 3 and Grade 4 declined trees in remaining areas
Moderate	40%, 50% or 100%	• Group selection of trees at sites with many declined trees (minimum cutting area per site: 0.05 ha) • Selection of all trees, including healthy trees in cutting areas • Selection of usable Grade 3 and Grade 4 declined trees and trees which may damage forests in remaining areas
Weak	0%, 15% or 20%	• Individual selection of usable Grade 3 and Grade 4 declined trees and trees which may damage forests

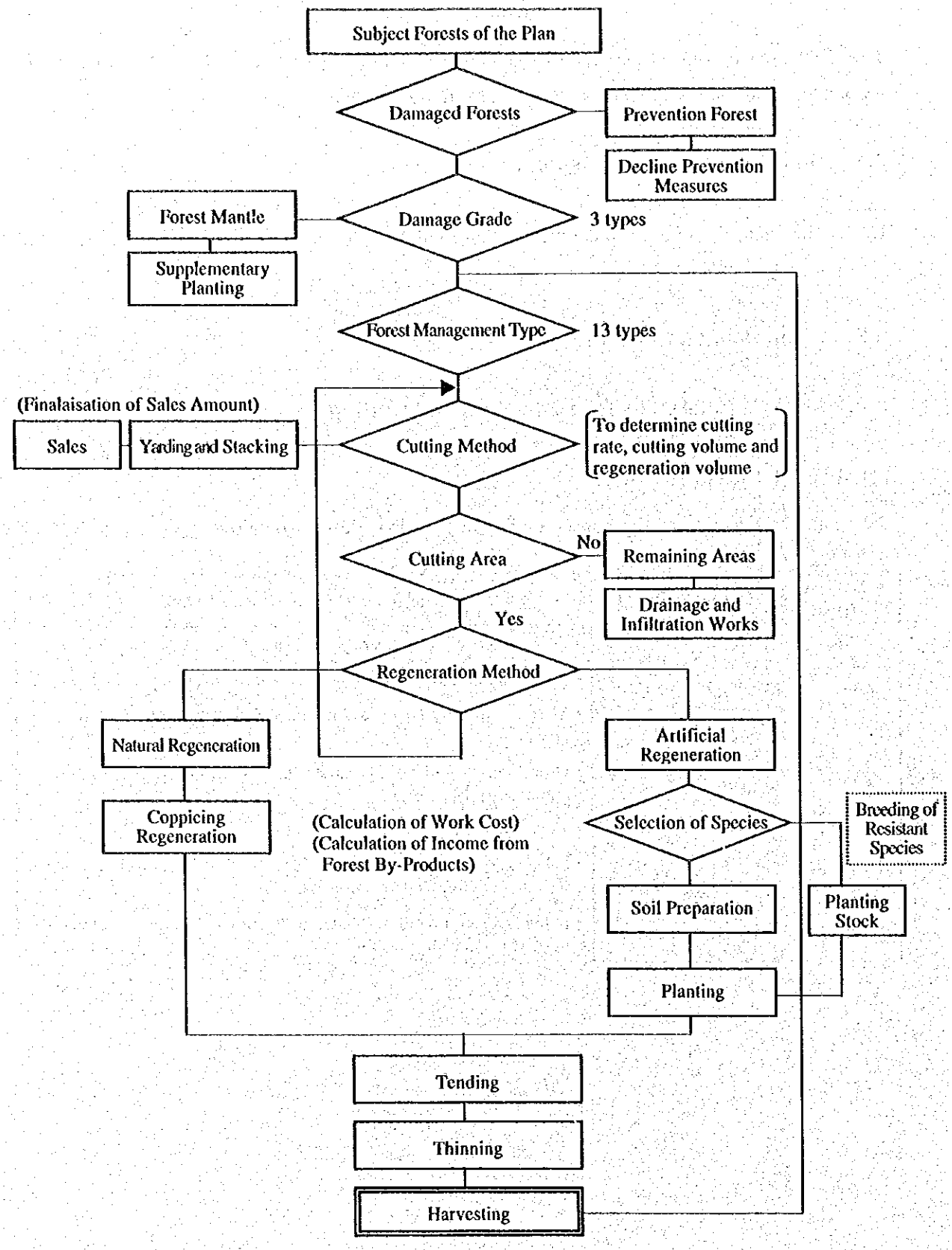


Figure 1 Damage Restoration System

(2) Items Related to Cutting

The standard cutting method and cutting rate by main species and damage grade are described below.

1) *Quercus* spp. Forests (F5, F6, F7 and F8)

Damage Grade	Cutting Rate	Cutting Method of Damaged Trees
Strong	80%	• Group reservation of sites with many healthy trees • Cutting area (80%) - clear cutting (including healthy trees) • Remaining area (20%) - only Grade 3 and Grade 4 declined trees
Moderate	50%	• Group cutting of sites with many damaged trees (minimum cutting area per site: 0.05 ha) • Cutting area (50%) - clear cutting • Remaining area (50%) - cutting of usable Grade 3 and Grade 4 declined trees and trees which may damage forests
Weak	20%	• Individual cutting of usable Grade 3 and Grade 4 declined trees and trees which may damage remained trees

2) *Quercus* spp. Forests (Seed Stands) (F1, F2, F3 and F4)

Damage Grade	Cutting Rate	Cutting Method of Damaged Trees
Strong	60%	• Cutting of only Grade 3 and Grade 4 declined trees
Moderate	40%	• Cutting of only Grade 3 and Grade 4 declined trees
Weak	15%	• Cutting of only Grade 3 and Grade 4 declined trees

3) *R. pseudoacacia* Forests (F9 and F10)

Damage Grade	Cutting Rate	Cutting Method of Damaged Trees
Strong	100%	• Clear cutting
Moderate (20 years old or more) (F9)	100%	• Clear cutting
Moderate (less than 20 years old) (F10)	50%	• Group cutting at sites with many damaged trees (minimum cutting area per site: 0.05 ha) • Cutting area (50%) - clear cutting • Remaining area (50%) - cutting of only usable Grade 3 and Grade 4 declined trees and trees which may damage forests
Weak	20%	• Individual cutting of usable Grade 3 and Grade 4 declined forests and trees which may damage forests