2) Disease and Pest Control Measures

In September and October each year, the RNP conducts a national survey on the state of defoliator outbreaks, state of forest decline, egg mass density of the insect, rates of parasitism and predation by natural predators and rate of predation by birds, etc. The data obtained by forest engineers of each forest range office is compiled by the local forest range office to prepare the pest control plan for the following year. These local plans are submitted to the RNP for examination by a special committee, the members of which are engineers of the forest range offices, those responsible for forest protection at the RNP and researchers of the ICAS, etc. The committee analyses the nationwide state of forest decline and determines the subject sites for pest control in the following year based on the degree of forest decline and the egg mass of *Lymantria dispar*. The subject sites are forests where the rate of defoliation due to pests is expected to be more than 50%. The current conditions of insect damage and specific measures for dealing with disease and pests are as described in (3) Damage by Insects and Disease and Pest Control Measures.

(2) Monitoring of Forest Decline

Forest monitoring has been continuously conducted in Romania since 1990. A trial to continually monitor the environmental factors of forest decline commenced in 1983 using the method developed by Patrascoiu and others and the nationwide application of this system began in 1990. Romania joined an international monitoring project (ICP Forest) the same year, resulting in the comprehensive coverage of Romania's forest areas by a permanent monitoring site network.

The monitoring of forest decline checks damage due to animals and insects, damage due to diseases, defoliation and discolouration of the leaves, etc. The most typical monitoring subject is defoliation which indicates the state of tree health. There are five grades indicating the state of health. Grade 0 indicates a defoliation rate of 0 - 10% while Grade 1, Grade 2 and Grade 3 indicate a defoliation rate of 11 - 25%, 26 - 60% and 61 - 99% respectively. Grade 4 means that the tree is dead.

The actual survey data for the period from 1990 to 1998 at the permanent survey sits shows much fluctuation of the Grade 0 ratio for all species. The ratio was 52% in 1990, declined to 47.7% in 1994 and bounced back to 66.9% in 1998. By species, *Abies alba* showed the most drastic fluctuation during this period among coniferous species as its defoliation rate of 9% in 1991 worsened to 22.3% in 1994 and then dropped to 10.7% in 1998. Among broad-leaved species, *Q. pedunculiflora* and *Q. frainetto* were the most affected species. The combined ratio of Grade 2 through Grade 4 defoliation, i.e. high levels of defoliation, for *Q. pedunculiflora* increased from 24% in 1990 to 42.6% in 1994 and then dropped to 31.2% in 1998. In the case of *Q. frainetto*, the ratio increased from 19% in 1990 to 45.5% in 1997 but dropped to 28.7% in 1998.

Forest decline is also related to altitude and there are more defoliated forests classified as Grade 2 through Grade 4 in plain and hilly areas than in mountain areas.

The monitoring survey for 1997 and 1998 was conducted between 15th July and 15th September. The survey in 1997 involved 42 staff members of the forest branch offices and 400 engineers of the forest range offices. The obtained data was then analysed by the ICAS monitoring team.

The results of the defoliation monitoring survey in 1998 are shown in App. D-12. *Quercus* spp. with a defoliation grade of 2 through 4 relating to forest restoration measures are *Q. pedunculiflora* and *Q. pubensens* (both 31.2%), *Q. frainetto* (28.7%), *Q. robur* (22.4%), *Q. cerris* (17.8%) and *Q. petraea* (16.8%). *Robinia pseudoacacia* recorded 20.4%.

Source: Forest Monitoring System in Romania, ICAS, Ovidiu Badea, 1996. Technical assistance for operation of forest monitoring system on Level 1, Dr. Eng. Romica Tomescu, Eng. Ovidiu Badea, 1997.

(3) Damage by Insects and Disease and Pest Control Measures

1) Main Pests and Their Predators

During the field survey, pests of 26 species of 14 families (defoliators, borers and seed insect borers) were identified (Table 2-4-25). Of the pests listed in this table, *Otiorhynchus multipunctatus* (Frabricius) and *Stauronema compressicornis* (Fabricius) are supposed to have been newly discovered in Romania. Many adults of the former were collected in the crown of a *Q. robur* and *Fraxinus* seed orchard at Secui. Although four species in this genus are known in Romania, the existence of this particular species has not been reported. The larvae eat the tree roots at nurseries and plantations. The latter are found in *Populus* spp. forests. The larvae eat the leaves of *Populus* spp. and are known for their peculiar habit of developing a bubbly enclosure around the eaten parts but the overall damage is not very serious. A new ecological survey will be required to obtain basic data to prepare a new plan to control these two species.

Table 2-4-25 Main Pests of Broad-Leaved Species (Standing Trees) in Romania's Southern Plain

Scientific Name (Family and Species)		Food Trees
Defoliators		
Lymantriidae	*Lymantria dispar* (Linneacus)*	*Quercus, Ulmas, Populus, Salix*, etc.
	Euproctis chrysorrhoea (Linneacus)	*Quercus, Crataegus, Prunus*, etc.
Notodontidae	*Thaumetopoea processionae*	*Quercus*, etc.
Geometridae	*Operophtera brumata* (Linneaeus)	*Quercus, Betula, Crataegus, Prunus*
	Erannis defoliaria (Clerck)	*Quercus, Betula, Crataegus, Prunus*
Tortricidae	*Tortrix viridana* (Linneacus)*	*Quercus*
Lasiocampidae	*Malacosoma neustria* (Motschulsky)*	*Quercus, Populus, Prunus*, etc.
Arctiidae	*Hyphantria cunea* (Drury)*	*Platanus, Prunus, Morus*, etc.
Meloidae	*Lytta vesicatoria* (Linneacus)*	*Fraxinus*
Curculionidae	*Stereonichus fraxini* (DeGeer)*	*Fraxinus*
	Otiorhynchus multipunctatus (Fab.)	*Quercus, Fraxinus*
Chyrsomelidae	*Melasoma populi* (Linneacus)*	*Populus, Salix*
Tenthredinidae	*Stauronema compressicornis* (Fab.)	*Populus*
Wood Borers		
Cerambycidae	*Cerambyx cerdo* (Linneaeus)*	*Quercus*, etc.
	Saperda populnea (Linneacus)*	*Populus, Salix*
	Prionus coriarius Linnacus	*Quercus*, etc.
	Morimus funereus Mulsant	*Quercus, Populus*
Curculionidae	*Cryptorhynchus lapathi* (Linneacus)*	*Populus, Salix*
Cossidae	*Cossus cossus* (Linneaeus)*	*Quercus, Ulmus, Fraxinus, Populus*
Seed Insects		
Curculionidae	*Balaninus glandium* (Marsham)*	*Quercus*, etc.

* Confirmed species, the family and species names are those used in Romania.

① Defoliators

In order to estimate the larva density of gypsy moth in forests based on the amount of frass, seed traps (80 cm in diameter; 0.5 m^2) were evenly distributed with a density of 25 traps/ha on the floor of a *Q. frainetto* stand where 50% defoliation was anticipated to occur. This survey was conducted from 3rd June to 3rd July, 1998 when leaf eating was supposed to be almost completed and the frass was collected every three days. The number, weight, dry weight and size of the frass in each trap were analysed to determine the age composition of the larvae.

Compared to the corresponding species in Japan, gypsy moth in Romania is smaller and the larval period has 5 - 6 years. In a laboratory experiment, approximately three weeks were required for the second instar become prepupae. The food consumption was 130 - 161 cm^2 of *Q. robur* leaf with an average of 150 ± 11.1 cm^2 per male and 423 - 579 cm^2 with an average of 491 ± 80.1 cm^2 per female. The average food consumption of all samples (six males and three females) was 264 cm^2 which is equivalent to 7 - 8 leaves of either *Q. frainetto* or *Q. cerris* weighing 8 - 9 g (the dry weight is approximately half). The frass number during the larval period was 633 - 844 with an average of 728 ± 83.7. The average pupal weight was found to be 0.43 g for males and 1.39 g for females which is similar to that of individuals raised in a group in the open air (ICAS nursery: 0.36 g for males and 0.86 g for females) and that of individuals collected from a damaged forest (Schitu forest: 0.34 g for males and 1.21 g for females). See App. D-14-17 and App. D-18-20 for more detailed survey data.

② Borers

Damage due to *Cerambyx cerdo* (large-sized, long-horned beetle of which the larvae may be as long as 80 mm) is particularly severe. The rate of damaged trees in a *Q. robur* forest regenerated by coppicing is as high as 40% (Table 2-4-26). The damage caused by this insect is often seen at the lower stem of over-matured trees of 80 years of age or more and places with good sunlight, such as forest borders and areas around the cut-over sites of declined trees. The damage is less obvious in natural forests, closed forests and young stands. Excessive thinning under forest management causes a population increase of this insect. In general, coppiced *Quercus* spp. is vulnerable to drought, diseases and pests. The quality tends to be seriously damaged by the invasion of rotting bacilli through old stumps. Measures to combat this inset have not yet been taken locally.

As declined trees tend to be severely damaged by the attack of *Cerambyx cerdo*, *Sirex* sp., *Xyleborus* sp. and *Agrilus* sp. etc., they can seldom be used for high quality timber. These trees are mostly sold as firewood.

Table 2-4-26 Damage by Cerambycids and Rot in *Quercus* spp. Forests

Forest District	No. of Trees Examined	Tree Age (years)	DBH (cm)	Cerambycids*	Disease +	Damage Rate (%)
Verbicioara (Dolj) (*Quercus cerris*)	116 (standing trees)	80	35	46	unknown	39.7
Piatra (Dolj) (*Quercus frainetto*)	100 (felled trees)	70	29	8	34	34.0

* *Cerambyx cerdo* + heart rot disease

③ Seed Insects

In recent years, the seed bearing rate of *Quercus* spp., particularly *Q. frainetto*, has been declining in southern Romania, causing problems in regard to the fostering of seedlings. The reasons for this are assumed to include the early falling of seeds due to pest attack, damage to fallen seeds by pests and consumption of fallen seeds by small animals.

The main pests for seeds of *Quercus* spp. are the larvae of *Balanninus glandium* as well as several species of Lepidoptera (moth).

Examination of immature seeds collected from a *Q. robur* forest in July 1998 revealed that 9.3% of the seeds suffered from damage by the larvae of *B. glandium* with a total damage rate of 39.5%, including rotten seeds and deformed seeds which were swollen due to parasitic gall insects. A survey conducted in October, 1997 at Cosoveni forest under the jurisdiction of the Craiova Forest Range Office fund that damage by the larvae of *B. glandium* and Lepidoptera occurred at 80% of the nuts found on the floor of a *Q. cerris* stand. The detailed life-cycle of these insects has not yet been established in Romania. One generation appears to require 2 - 3 years to complete the life-cycle and the adults and larvae spend the winter in the ground. The adults begin to reappear around May, eat the new leaves of *Quercus* spp. and insert the ovipositor into the seed via the calyx in June/July to lay 2 - 3 eggs inside.

A larva grows inside the seed and continues to eat the fruit even after the seed falls to the ground. The occurrence period of the adult from May to September is long and the uncertainty of the peak occurrence makes it difficult to determine the best time for control. However, the overall state of the seed bearing of *Q. frainetto* is determined by other natural conditions and there is little relationship between pest damage and seed bearing.

Pests which constitute an additional factor for the top end death of *Quercus* spp. appear to be *Lymantria dispar* and *Tortrix viridana* based on the their abundance and the feeding portions. The larvae of *T. viridana* only eat new buds at the tree top in April and May. In mixed forests of *Q. robur* and *Q. frainetto*, they prefer *Q. frainetto*. The new leaves which emerge in June are eaten by the larvae of *L. dispar*. As the tree top can die due to continual attack for two to three years in succession, such damage should be treated as an important causative factor of tree decline.

Ten species (six families) of parasitic insects and predacious insects were collected and identified as the natural enemies of pests (Table 2-4-27).

Table 2-4-27 Predators of Gypsy Moth Collected in the Study Area

Scientific Name (Family and Species)		Host Stage	Place of Collection
Parasitic Insects			
Tachinidae	*Exorista larvarum* (Linneacus)	larva and pupa	Secui, Podari, Schitu
	Senometopia separata (Rondani)	larva and pupa	Secui, Podari, Schitu
	Compsilura concinnata (Meigen)	larva and pupa	Secui, Podari, Schitu
	Eumea linearicornis (Zetterstedt)	larva	Schitu
Braconidae	*Cotesia (Apanteles)* sp.	larva	Schitu, Morteanca
Encyrtidae	*Ooencyrtus kuvanae* (Howard)	egg	Bechet
	Anastatus japonicus (Ashmead)	egg	Bechet
Predatory Insects			
Dermestidae	*Dermestes* sp.	egg	Bechet
Carabidae	*Calosoma sycopanta* (Linneaeus)	larva and pupa	Secui, Schitu, etc.
Forliculidae	*Forficula auricularia* (Linneaeus)	larva and pupa	Secui, Schitu, etc.

Many of these natural predators target the egg, larva and pupa of gypsy moth and their rate of parasitism is quite high (Table 2-4-28). The raising of larvae collected from uncontrolled forests at Secui, Podari and Schitu revealed that the rate of parasitism of the larva is as high as 34.7% - 77.3%. The rate of parasitism is particularly in the case of four species of Tachinidae which were found inside the larva and pupa. A parasitic fly which emerges from one host and becomes a pupa in the ground is a monoparasite. All of these four species are also found in Japan but *Exorista japonica* is a polyparasite parasite as 2 - 7 parasitic flies emerge at the same time.

The number of such predators as *Calosoma sycophanta* and *Forficula auricularia*, the propagation of which depends on the food density, appears to be increasing. These are predatory insects which move around the crown and ground to catch the larvae of gypsy moth. Other parasitic wasps for eggs and predatory insects were also collected (Table 2-4-27). These natural enemies play an important role in controlling the density of gypsy moth.

Table 2-4-28 Parasitism Rate of Natural Enemies of Larvae of Gypsy Moth Found by Raising of Individuals

Place of Collection (Food Tree)	Date of Collection	Number of Larva	Natural Enemies		Parasitism Rate (%)	Control Situation
			Tachinidae*	Braconidae**		
Secui (Dolj Country) (*Populus euroamericana*)	29th May	75	58	0	77.3	no control
Podari (Dolj County) (*Quercus frainetto*)	1st June	80	44	0	55.0	no control
Schitu (Dolj County) (*Quercus frainetto*)	2nd June	75	22	4	34.7	no control
Morteanca (Dambovita County) (*Quercus frainetto*)	9th June	85	5	5	11.8	Bt. control

* Tachinidae: four species; ** Braconidae: *Apanteles* sp.

2) Pest Control System in Romania

Tree damage due to pests occurs every year in various places in Romania. In fiscal 1997/98, as area as large as 610,000 - 700,000 ha was affected, accounting for 62% of the total area of broad-leaved forests. In pure forests of *Quercus* spp. spread over the Southern Plain where the growing species are less diverse, outbreaks of defoliators are chronically occurring. Although these pests can be temporarily controlled by biological pesticides, outbreaks repeatedly occur after a quiescent period of several months or upto several years due to migration from uncontrolled neighbouring forests and environmental changes, including weather conditions.

From 1957 to around 1975, a chemical pesticide (DDT) was mainly used for pest control purposes. The increased resistance of pests to pesticides and concern in regard to environmental pollution caused by chemical pesticides led to the wide use of natural pesticides (pyrethrin, etc.) in 1991. Since 1992, however, biological control with less adverse impacts on the ecosystem has become the main pillar of pest control using a biological pesticide (*Bacilus thuringeiensis*) and insect growth retarding agents (Dimilin and Dipel, etc.) Such agents are mainly sprayed from the air using a light airplane and kill 97% or more of pests with the effects lasting 3 - 5 years.

Research is currently in progress to develop a more effective biological pesticide (NPV, a type of virus) and a field experiment is in progress to establish an application method. An experiment using Mimic, a growth retarding agent developed and commercialised in Japan has confirmed its highly efficient and quick insecticidal effects and its extensive use in the future is planned. In the case of nurseries, the well-planned use of chemical pesticides with an immediate effect has minimised the economic damage to nurseries by diseases and pests. For the spring of 1998, 41 forest branch offices of the RNP nationwide put the estimated total forest area likely to be affected by pest damage at 698,857 ha. Of this area, the final area subject to pest control was 160,438 ha, accounting for only 23% of the total area. The pests subject to control are almost exclusively *Lymantria dispar* and *Torrix viridana* in the case of *Quercus* spp. Other subject pests are *Stereonichus fraxini* and *Lytta vesicatoria* in the case of *Fraxinus* spp. and *Lymantria dispar*, etc. in the case of *Populus* spp. (Table 2-4-29).

Table 2-4-29 Area Subject to Control of Defoliators in Romanian National Forests

Local	Year	Damaged Area (ha)	Area of Scheduled Control (ha)	Area of Decided Control (ha)	Control						
					Ld	Tv	Ld+Tv	Tv+Ge	Ge	St	Others
Whole Country	1997	613,415	77,465	73,122	21,254	8,400	31,933	10,682	303	550	0
	1998	698,858	162,476	160,438	58,164	11,048	86,311	4,361	0	435	119
Craiova	1997	39,023	16,934	14,643	7,134	464	7,045	0	0	0	0
	1998	49,629	22,997	21,814	11,663	1,934	8,217	0	0	0	0
Slatina	1997	26,595	7,190	6,768	921	5,847	0	0	0	0	0
	1998	27,745	9,200	8,480	1,413	4,952	2,115	0	0	0	0

* Ld: *Lymantria dispar*, Tv: *Tortrix viridana*, Ge: Geometridae, St: *Stereonichus fraxini*, etc.
Source: Former Craiova Forest Branch Office

As far as the Craiova Forest Branch Office is concerned, the estimated area of pest damage in 1998 was 49,629 ha, of which an area of 21,814 ha was to e controlled and control was actually conducted for 19,842 ha. A biological pesticide was sprayed from the air over 40% of the damaged area. The total cost was approximately 1.9 billion Lei (US$ 220,000), including the pesticide storage cost and aerial spraying cost. Spraying was entrusted to a private company and the unit cost was US$ 11/ha at a rate of 220 ha/hour (Table 2-4-30).

Table 2-4-30 Control Area of Defoliators and Cost for Former Craiova Forest Branch Office

Damaged Area (ha)	Controlled Area (ha)	Cost of Aerial Spraying by Aircraft (Lei, US$) *				Cost/ha
		Pesticide Cost**	Pesticide Storage Cost, etc.	Flying Cost	Total	
49,629	19,842	1,497,643,500	113,263,500	243,318,400	1,854,225,400	93,449
		172,143	12,019	27,968	213,129	11

* Rate: US$ 1 = 8,700 Lei ** Pesticides: *Becilus thuringiensis*, Dimilin, etc.
Source: Former Craiova Forest Branch Office

Given the above-described state of pest damage and pest control, the introduction of new pest control measures under the Plan will be unnecessary.

Source: W. Ciesla et al. (1994): Decline and disback of trees and forests - A global overview -, FAO, Forestry paper 120.

(4) Existing Management Standards for Regeneration and Tending of Natural Forests and Artificial Forests

1) Natural Forests

① Mixed Forests of *Quercus robur*, etc.

Regeneration:

A mixed forest of *Q. robur* is regenerated by group selective cutting. Regeneration cutting, accretion cutting and final cutting are conducted at 20 year intervals. The regeneration conditions of existing natural forests show the good regeneration of *Fraxinus excelsior* and *Tilia platyphyllos*. In the case of *Q. robur*, there is a mixture of excellent regeneration sites and relatively poor regeneration sites depending on the actual year of cutting as its seed bearing performance greatly varies from one year to another.

Weeding:

As the highest protection priority is given to *Q. robur* and *Q. petraea,* anything which may adversely affect their growth is subject to weeding. *F. excelsior* and *T. platyphyllos* are preserved in groups as long as they do not obstruct the growth of *Q. robur* and *Q. petraea.* Other species are also preserved to protect the forest land and to form a shrub layer as long as their presence does not obstruct the growth of the trees to be preserved.

Improvement Cutting:

This is conducted at a tree age of approximately 13 - 17 years. The cutting priority is given to unhealthy trees regenerated by sprouting and minus trees of dominant trees. Trees adversely affecting the growth of *Q. robur* and *Q. petraea* are the next priority. Improvement cutting is conducted at 2 - 3 year intervals.

Thinning:

Thinning is conducted at a tree age of approximately 20 - 30 years. The maximum cutting intensity is, in principle, 0.8 of the stand density. The thinning interval is 4 - 5 years for the first thinning and 7 - 8 years thereafter.

② *Quercus* spp. Stands with Dominant *Q. frainetto* and *Q. cerris* Species

Regeneration:

Regeneration is conducted by either seeding or coppicing. In regeneration cutting, the cutting method for mixed forests is also used here. Regeneration by seeding is frequent in the case of *Q. cerris* but rare in the case of *Q. frainetto.* One characteristic of *Q. frainetto* is frequent regeneration by root suckers.

Weeding:

Priority is given to the conservation of seeded trees and root suckers command the next priority for preservation. The priority order of species is, from the highest, *Q. petraea, Q. robur, Q. frainetto* and *Q. cerris.* The weeding interval is generally 2 - 3 years.

Improvement Cutting:

This starts when the trees reach an age of 15 - 18 years. The subject trees are poor quality trees and dead trees, etc. and coppice shoots from the stem are subject to density control. The improvement cutting interval is 4 - 7 years.

Thinning:

Thinning starts at a tree age of 20 - 25 years in the case of *Q. cerris* stands and 25 - 30 years in the case of *Q. frainetto* stands. The subject trees are damaged trees by diseases or pests and poor quality trees, both of which are likely to affect the growth of fine trees. At mixed stands of *Q. cerris* and *Q. frainetto*, preservation priority is given to fine *Q. frainetto* trees. The thinning intensity is 0.85 of the stand density for a stand without undergrowth and slightly more than 0.85 for a stand with undergrowth. The thinning interval is 5 - 8 years for the first then which then gradually increases to 8 - 12 years thereafter with the final thinning at a tree age of 60 - 70 years.

2) Artificial Forests

① *Quercus* spp. (*Q. frainetto, Q. cerris, Q. robur*)

Reforestation is conducted to restore former regeneration cutting sites of *Q. frainetto* and *Q. cerris* forests and declined forests.

Soil Preparation:

Large forest machinery (bulldozers, etc.) is used to remove stumps and to plough the entire site.

Planting:

The planting distance is 1.5 m x 1.0 m with a planting density of approximately 6,700 trees/ha. *Quercus* spp. is planted in two lines and a line of assistant species is introduced between these lines (*Quercus* spp.: 67%; assistant species: 33%). *Fraxinus excelsior* is sometimes selected as a mixing species.

Supplementary Planting:

Supplementary planting is conducted for a period of two years after initial planting if the area of dead trees is found to exceed 9 m^2 or a sampling survey finds that the pre-determined growth criteria are not met.

Weeding:

Weeding by hoeing is conducted three times a year for approximately six years. In addition, grass cutting is conducted once or twice a year for 1 - 2 years after planting.

Improvement Cutting:

Improvement cutting is conducted once or twice (the first cutting is conducted for non-target species in the seventh year or later and the second cutting is conducted for both target and non-target species in the twelfth year or later).

Thinning:

Thinning starts at a tree age of approximately 30 years. The selection of the target trees is the same as that for natural forests of *Quercus* spp.

② *Robinia pseudoacacia*

Soil Preparation:

Large forest machinery (bulldozers, etc.) is used to remove stumps and to plough the entire site.

Planting:

The planting distance is 2 m x 1.5 m with a planting density of 5,000 trees/ha. The mixed planting of *Gleditsia triacanthos* (Gladita) may be conducted with a mixing rate of some 20%.

Supplementary Planting:

Supplementary planting is conducted for a period of two years after initial planting if the area of dead trees is found to exceed 9 m^2 or a sampling survey finds that the pre-determined growth criteria are not met.

Weeding:

Weeding is only conducted in the first year when deemed necessary.

Improvement Cutting:

In the case of trees regenerated by coppicing, coppiced branches are selected in the second or third year.

Thinning:

Thinning is conducted twice or three times a year three full years after initial planting.

③ *Populus euroamericana*

P. euroamericana is planted at former cutting sites.

Soil Preparation:

Large forest machinery (bulldozers, etc.) is used to remove stumps and to plough the entire site.

Planting:

The planting distance is 4 m x 4 m with a planting density of 625 trees/ha.

Supplementary Planting:

Supplementary planting is conducted for a period of two years after initial planting if the area of dead trees is found to exceed 9 m^2 or a sampling survey finds that the pre-determined growth criteria are not met.

Weeding:

Weeding by hoeing is conducted twice a year for the first two years and once a year thereafter for another one or two years.

Improvement Cutting: None

Thinning: None

(5) Conditions of Nurseries

Each county has one central nursery which supplies seedlings throughout the county. In addition, each district has its own smaller nursery. The size of the central nursery in Olt and Dolj Counties is shown in Table 2-4-31.

Table 2-4-31 Central Nurseries in Olt and Dolj Counties

County	Nursery Name	Facility and Scion Garden	Nursing Area	*Salix* spp. Plantation	Total
Olt	Bobicesti	19 ha	26ha	10 ha	55 ha
Dolj	Zaval	16 ha	42 ha	-	58 ha

The production volume of nursery stock is determined each year based on the supply and demand plan for the year. The nursery stock produced mainly consists of broad-leaved species. In the case of *Populus* spp. and *Salix* spp., cloned stock is produced using cuttings. Each nursery is accompanied by a scion garden. Seedlings of such *Quercus* spp. as *Q. cerris*, *Q. robur* and *Q. frainetto* and *Robinia pseudoacacia* are also produced in large quantities. Each central nursery has an established mass production system to cater for large projects and enjoys a high level of nursing skills in terms of seed handling, fertiliser control and the use of herbicides.

(6) Current Conditions of Seed Stands and Seed Orchard

1) Seed Stands

The designated *Q. frainetto* seed stands are described in App.E-6. The total area of seed stands where seeds can be collected in 314 ha with 35 sites in Olt County and 31 ha with 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 several decades in Dolj County.

Given these circumstances, the need to designate new seed stands was recognised to produce the required seeds for the planned reforestation under the Project. A survey on the feasibility of such designation was subsequently conducted by selecting forests capable of producing seeds among forests which had not been designated as seed stands.

To be more precise, a sample plot survey was conducted at two sites, i.e. Vulturesti UP III ua. 43B and UP V ua. 32C, to measure the DBH, tree height, crown size and location by species and also to determine the ability of the trees to function as mother trees. The results shown in Table 2-4-32 and Fig.2-4-11 indicate that these forests are fully capable of functioning as seed forests. In addition, the field survey and interview survey identified forests which can be newly designated as seed forests as described in App. E-6.

Table 2-4-32 Sample Plot Survey Results on Possible Seed Forests

Forest Range	UP	ua.	Stand Age	*Q. frainetto*			*Q. cerris*			Total		
				+Tree	-Tree	Total	+Tree	-Tree	Total	+Tree	-Tree	Total
Vulturesti	III	43B	113	130	190	320	60	150	210	190	320	530
	V	32C	102	170	100	270	–	–	–	170	100	270

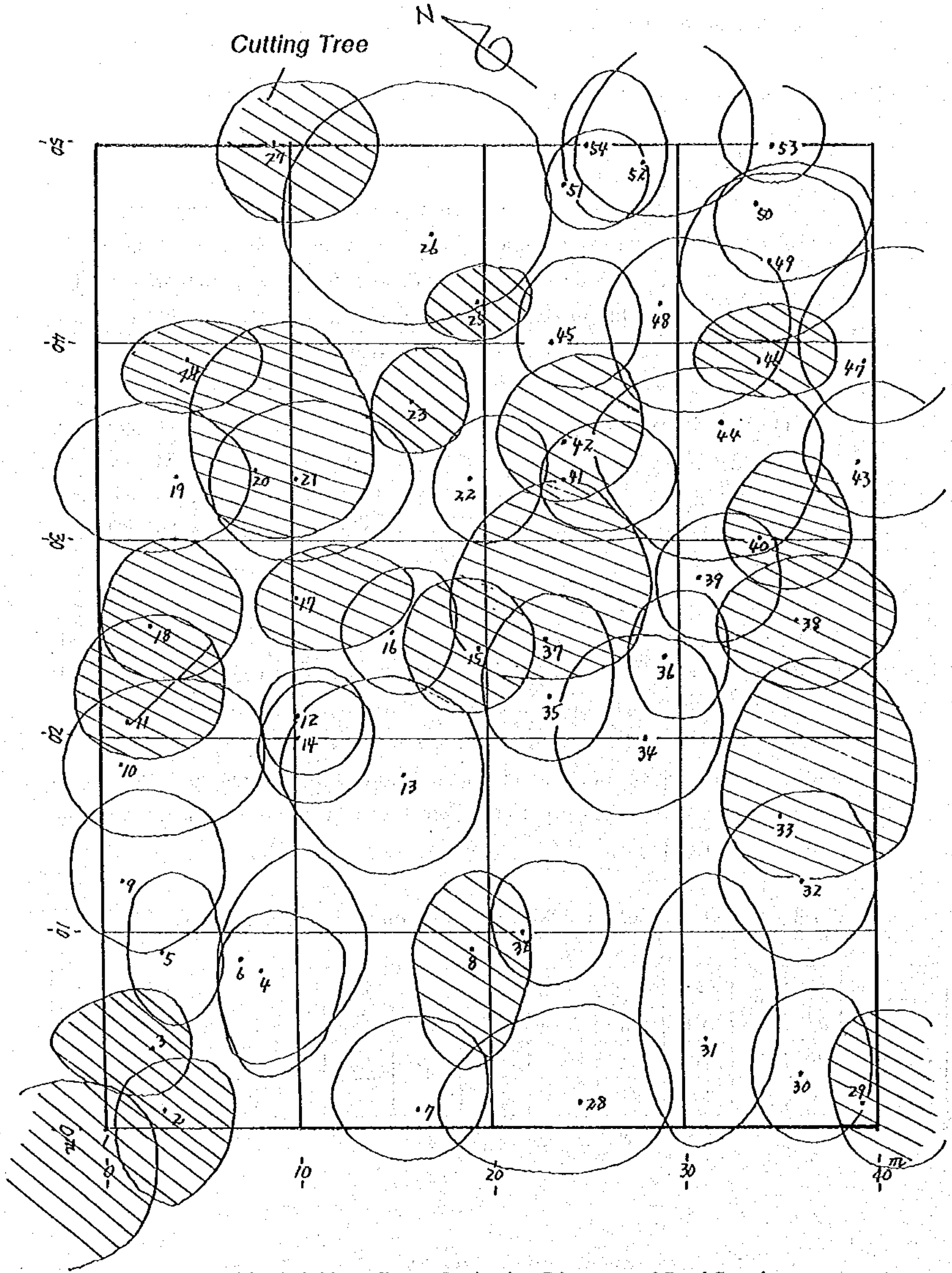


Fig. 2-4-11 Crown Projection Diagrams of Seed Stand
(1) Seaca Optasani, UP V, ua. 32C

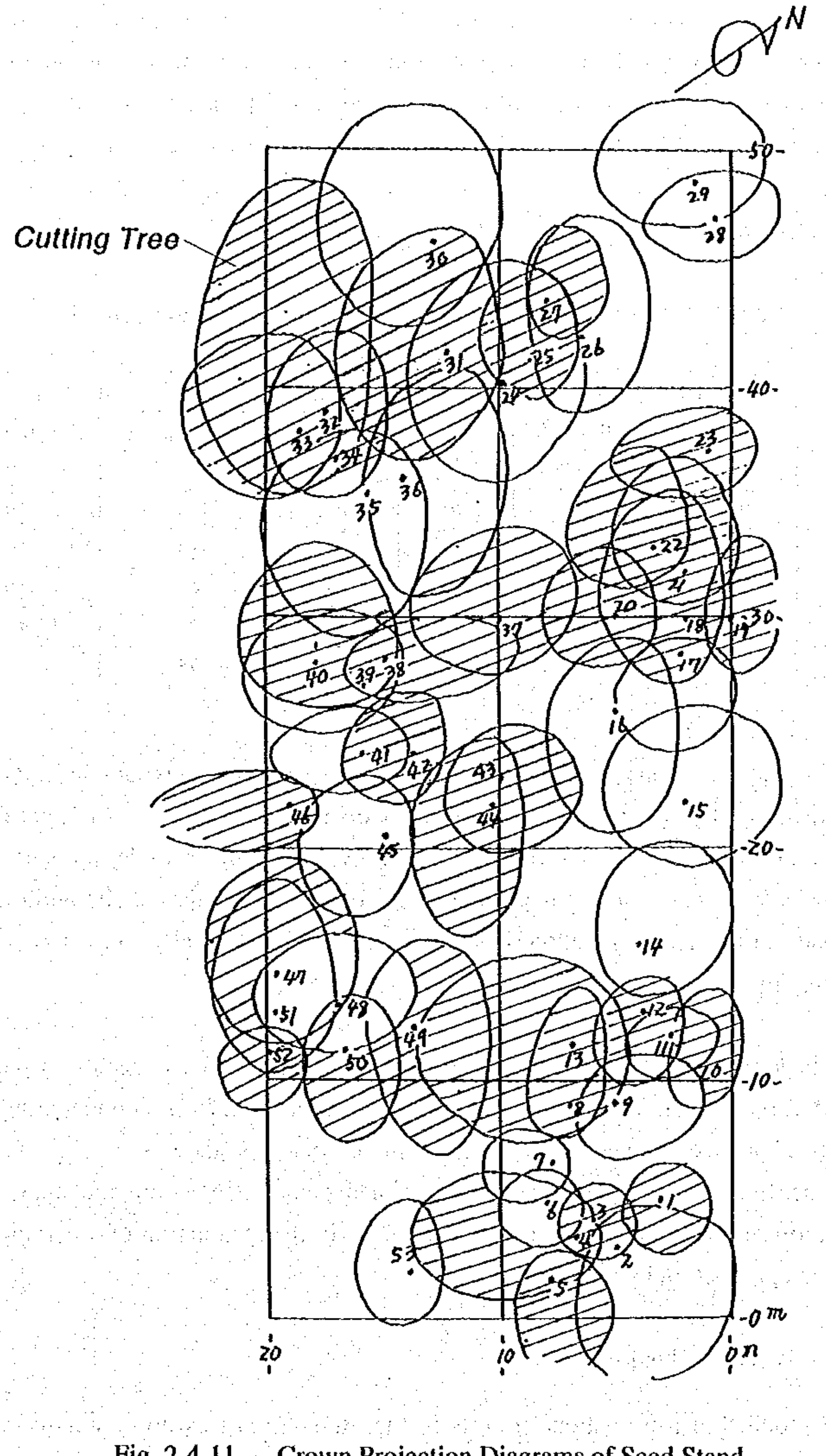


Fig. 2-4-11 Crown Projection Diagrams of Seed Stand
(2) Topana, UP III, ua. 43D

2) Seed Orchard

The seed orchard located at Perisor UP II 57A was established during the period from 1982 to 1985 by collecting 50 clones throughout Romania and planting 1,893 mother trees by means of grafting over an area of 10.8 ha. Most of these 50 clones were collected in Olt and Dolj Counties. The number of trees has currently been reduced to 805 trees of 14 - 17 years of age. The general conditions of this seed orchard are shown in Table 2-4-33.

Table 2-4-33 General Conditions of *Q. frainetto* Seed Orchard

No.	Area (ha)	Year of Establishment	Number of Trees			Tree Height (m)
			Original	(1999.5.15)	Density per ha	
1	1.6	1982	326	115	72	7 - 10
2	2.0	1983	408	200	100	7 - 10
3	3.5	1984	564	295	84	7 - 10
4	2.2	1985	360	150	68	7 - 10
5	1.5	1985	235	45	30	7 - 10
Total	10.8		1,893	805	75	

The site conditions of the seed orchard are not particularly favourable as its location was carefully determined at the necessary distance from other *Q. frainetto* forests to avoid pollination by other *Q. frainetto* individuals. For example, the soil is sandy. *Robinia pseudoacacia* was planted in the 1920's at an adjacent site and the second and third generations following natural regeneration currently show a good state of growth.

The seed orchard has failed to produce seeds in recent years because of damage by seed pests, including *Balaninus*. Pest control has not been conducted because of its high cost. Nevertheless, a fair number of trees show flowering as well as fructification, implying that adequate management, including the application of fertiliser and pest control, is likely to result in the resumption of a certain scale of seed production by this seed orchard.

(7) State of Wood Production and Sales

Wood production from national forests in the Study Area used to be conducted by the wood processing divisions of state enterprises in possession of a sawmill. However, there has been an increasing tendency in the last several years for the forest branch offices responsible for the management of national forests to directly conduct timber wood production as a result of the decreasing production volume. Changes of the wood production volume over the years are shown in Table 2-4-34.

Table 2-4-34 Transition of Wood Production Volume Since 1980

(Unit: 1,000 m^3)

Year		1980	1985	1990	1993	1996	1997	1998
Coniferous Trees	Olt	-	-	0.1	0.1	-	-	0.1
	Dolj	-	0.1	0.2	0.7	0.4	2.8	1.2
Fagus spp.	Olt	-	-	-	-	0.1	-	-
	Dolj	-	-	-	0.3	0.5	1.3	-
Quercus spp.	Olt	65.6	66.0	70.0	58.7	79.6	65.0	48.2
	Dolj	80.2	70.0	65.6	76.6	86.1	81.7	57.2
Hard Broad-Leaved Trees	Olt	24.3	35.9	7.7	23.9	35.3	26.3	16.8
	Dolj	89.3	100.9	34.2	59.6	96.1	72.5	86.0
Soft Broad-Leaved Trees	Olt	77.5	88.1	48.8	48.9	28.7	20.6	28.8
	Dolj	78.5	104.2	86.0	75.4	64.7	52.5	10.0
Total	Olt	167.4	190.0	124.8	131.6	143.7	111.9	93.9
	Dolj	248.0	275.2	186.0	212.6	247.8	210.8	154.4

Note : Hard broad-leaved trees: *Fraxinus* spp. and *Acer* spp.
Soft broad-leaved trees: *Robinia pseudoacacia* and *Populus* spp.
Source : RNP

The total production volume has gradually declined in the 1990's from the level recorded in the 1980's. Nationally, the production level in the 1990's has declined by some 40% compared to the 1985 level but the decline of around 15% in Olt and Dolj Counties is less conspicuous. In the case of *Quercus* spp., the production volume maintained its level although the quality declined because of the phenomenon of forest decline. A rapid decline was experienced by other broad-leaved trees. In terms of the sales value, the average sales price has been extremely low as shown in Table 2-4-35 when converted to US$.

Table 2-4-35 Transition of Sales Value of Wood

Year		1985	1990	1993	1996	1997	1998
Sales Value of Wood (US$ 1,000)	Olt	835	1,141	675	1,461	1,168	1,480
	Dolj	1,612	1,059	1,078	1,845	1,902	2,278
Simple Average Price (US$/$m^3$)	Olt	4.4	9.1	5.1	10.2	10.4	15.8
	Dolj	5.9	5.7	5.1	7.4	9.0	14.8

Source: RNP

The interview survey results also show a generally very low local price of wood compared to international market prices as shown in the table below.

Table 2-4-36 Local Sales Price of Wood by Species

(Unit: US$/m³)

Species	For Forest Products Industries Use		For Firewood	
		Average		Average
Quercus spp.	17.2 - 57.5	23.0	12.6 - 23.0	16.1
R. pseudoacacia	18.4 - 25.3	19.5	11.5 - 20.7	14.9
Populus spp.	14.9 - 23.0	18.4	9.2 - 18.4	12.6
Fagus spp.		18.4		12.6

As the price of wood for firewood use is not much lower than the price of wood for forest products industries use, it gives the impression of being very expensive for users, i.e. local people. Based on the actual sales of the RNP in 1998, the average wood price per m^3 for forest product industries is estimated to be relatively high at US$ 32 for *Quercus* spp., US$ 19 for *Robinia pseudoacacia* and US$ 18 for *Populus* spp. The sales price of standing trees is also estimated to be US$ 18 for *Quercus* spp., US$ 16 for *R. pseudoacacia* and US$ 14 for *Populus* spp.

The allocation of wood for different purposes of use largely depends on the wood demand of forest product industries. Because of the currently poor international demand for sawn timber, only 30% of the wood produced in Olt and Dolj Counties is sold to forest product industries with the rest being sold as firewood. Wood sold to the pulp industry fetches a price similar to that of wood sold to forest product industries. One notable feature regarding the use of wood in recent years is the decline of the demand for *Quercus* spp. For example, the sawn volume of *Quercus* spp. at a long-established sawmill in Craiova is currently running at some 20% of the level in 1985, primarily because of poor sales to the domestic furniture industry which is the main user of *Quercus* spp. wood and which is experiencing sluggish sales of furniture caused by its slow reaction to international competition from high quality furniture. Consequently, local furniture factories have begun to use *Fagus* spp. and *Populus* spp. to produce inexpensive furniture. Nevertheless, there was a large timber factory which produced plywood and various panels using *Quercus* spp. in a large quantity upto 1989 and which exported its products to European countries, including the Soviet Union, and revival of the effective utilisation of *Quercus* spp. resources is hoped for.

A new sawing and furniture factory equipped with the latest foreign processing machinery was constructed in Craiova in 1997 and it is hoped that this factory will revive the use of *Quercus* spp. *Populus* spp. is being increasingly used in recent years by furniture factories in various places because of its stable supply due to fast growth, availability of straight wood and easy processing. *R. pseudoacacia* is conventionally used for local building timber including fencing, mine timber, ox-cart and barrels. Its use as a flooring material is currently increasing.

(8) Impacts on Local Economy

The phenomenon of forest decline causing a qualitative degradation of forests and wood has the advantage of an increased supply of firewood but the disadvantages of (i) a decline of good quality trees, (ii) damage to the ecological balance due to worsening weather conditions (drought), (iii) deterioration of the plant regeneration conditions, (iv) lower honey production due to less flowering of *R. pseudoacacia*, (v) decreased production and quality of medicinal herbs, small fruit and fodder, (vi) adverse impacts on hunting, (vii) damage to farmland due to strong wind and flying sand, (viii) soil erosion and (ix) decreased production of farm products, etc. Strong wind damage to forests and farmland occurred in 1996 at Apele Vii due to hailstorms. The phenomenon of forest decline by wind damage is observed to the west edge of the forest land. However, numerical data is as yet unavailable in regard to damage to farmland and the adverse impacts on forest by-products and the production of honey of forest decline. In regard to wood production, although a qualitative as well as quantitative decline is observed, the decreased demand for *Quercus* spp. can be primarily attributed to the harsh international competition faced by the timber industry.

While the overall production volume of wood led by *Quercus* spp. has been steady throughout the 1990's, the wood transportation industry has reported a decline of the transportation volume by 40% compared to the 1980's. The use of wood by forest product industries shows a declining trend because of the qualitative decline of wood while the amount of wood used as firewood has been increasing.

It is assumed that the future supply and demand situation of firewood will be affected by the high price of firewood and increased use of butane gas. At present, the survey findings are that the current firewood consumption per household is some 20 - 40% higher than some time ago. However, the low level of consumption in the past was caused by restrictions on firewood supply in the 1980's.

Forest product industries in Olt and Dolj Counties have experienced a decline of the number of factories in operation and the factory size is rather small in Olt County. The wood produced in national forests for forest product industries is mainly purchased by enterprises operating in other counties and the capital region and, therefore, it is transported out of these counties. Consequently, the wood produced in national forests has little impact on the local economy of Olt and Dolj Counties.

In regard to forestry work, local farmers have been employed on a daily basis for various types of forestry work in national forests for many years. The phenomenon of forest decline has slightly increased the volume of forestry work, including stand improvement, in some areas. Compared to the cutting and planting operations in the 1980's, however, the total work volume has been declining in both counties, underlining the strong hope of local farmers for more employment opportunities.

The contribution of national forests to local development, ranging from the construction as well as maintenance and improvement of forest roads (which can be used as local roads) to reforestation at cut-over sites, devastated land and riversides and the supply of building materials for schools, hospitals and monasteries, etc., is appreciated by local people. Local people strongly hope that the construction, maintenance and improvement of roads, reforestation at devastated land, proper management and protection of forests, establishment of windbreak forests to protect farmland, assistance for planting at private forest land and activities to promote local tourism will continue.

In terms of forest use for recreation, the advancement of motorisation has increased the use of national forests located along trunk national roads in the Middle Part for picnic purposes. As commercial activities have yet to materialise, however, the use of forests for recreational purposes has not had any tangible effect on the economy.

(9) Present State of Forest Roads and Erosion Control Facilities

1) Present state of Forest Roads

The forest road density in the Study Area of 3.4 m/ha in Olt County and 1.1 m/ha in Dolj County is low but almost all forests are accessible using broad compartment borders, public roads and agricultural roads. The present state of forest roads in the Study Area is shown in Table 2-4-37.

Table 2-4-37 Present State of Forest Roads in Study Area

County	Forest Range Office	Forest Area (ha)	Total Length of Existing Forest Roads (km)	Total Length of Existing Public Road (km)	Current Forest Road Density (m/ha)	Current Public Road Density (m/ha)	Degree of Access*	Remarks
Olt	Bals	12,110	59.4		4.9		n.a	
	Caracal	4,934	13.0	38.8	2.6	7.9	100.0	
	(Corabia)	4,235		138.4		32.7	100.0	
	Slatina	9,825	27.4		2.8		n.a	
	(Draganesti-Olt)	4,629	21.5	41.6	4.6	9.0	93.0	
	Vulturesti	7,265	27.0	258.1	3.7	35.5	100.0	
Sub Total		42,998	148.3	476.9	3.4	11.1		
Dolj	Amaradia	10,722	13.9	229.8	1.3	21.4	n.a	
	Calafat	6,942	1.1	149.5		21.5	100.0	
	(Poiana Mare)	6,929	17.7		2.6		n.a	
	Craiova	11,667	19.5	235.9	1.7	20.2	100.0	
	Filiasi	9,163	21.1	373.0	2.3	40.7	100.0	
	Perisor	9,461	3.0	236.5	0.3	25.0	100.0	
	Sadova	6,356	3.0	318.7	0.5	50.1	100.0	
	(Apele Vii)	3,849		338.0		87.8	100.0	
	Segarcea	7,718		260.2		33.7	89.0	
Sub Total		72,807	79.3	2,141.6	1.1	29.4		
Total		115,805	227.6	2,618.5	2.0	22.6		

* The degree of access is determined by the relevant criteria in Romania. na = not assessed

Surface treatment, such as paving or gravelling, is absent at some sections despite the steep gradient and scouring due to surface flow is often observed at these sections. In the case of forest roads built on Luvisols or similar soil, stagnant water occurs during the rainy season, making the passage of many sections difficult. In general, ditches are dug manually at the side of roads for drainage purposes as well as to prevent illegal cutting. There are many sections where the drainage facilities are inadequate, not properly managed or damaged. Scouring of the roadbed near drainage facilities is also observed in many places. In view of the state of existing forest roads described so far, the emphasis of the Plan will be placed on the improvement of existing forest roads rather than on the construction of new roads. The gravel used for roadbed purposes in Olt and Dolj Counties is taken from quarries near dams on Olt River (Olt County) and Gilort River (Gorj County). The present price of gravel is 21,000 Lei (US$ 2.41) - 89,000 Lei (US$ 10.22)/m^3, although the price is also affected by the transportation distance.

2) Present State of Erosion Control Facilities

① State of Devastation

Bank landslide sites are dotted along the banks and steep riverside terraces of Jiu River and Olt River, both of which are major rivers in Dolj and Olt Counties. In addition, hillside landslide sites are observed at hilly grassland in the North Part. These landlide can be attributed to water erosion, wind erosion, and the excavation of gravel as a building material, etc. In Olt County, devastated sites are observed in the catchment areas of Scorburoaia River, Dejasca River and Cungrea Mare River which run through Vitmana and Pruns in the area managed by the Vulturesti Forest Range Office located in the northernmost part of the county. The existence of some facilities, such as local houses, to be protected is confirmed in their lower reaches. The most typical devastation site in Dolj County is Vurteju on the right bank of Proska River, a tributary of Amaradia River, in the area managed by the Amaradia Forest Range Office. At this location, local vegetation, including forests, has been completely destroyed due to the accidental spillage of crude oil and the land has been entirely denuded. The area still remains bare today except for national forest sites and major gullies are developing.

② State of Erosion Control Work

In Olt County, several erosion control works, mainly featuring stream work, have been conducted along the above-mentioned Scorburoaia, Dejasca and Cungrea Mare Rivers to prevent sediment discharge to Olt River and were mainly conducted prior to the revolution in 1989. Dam work and channel work are predominant and 26 dams and 69.9 km long channel work have been completed between 1979 and 1999. As the sedimentation basins located upstream of the dams have already been converted to forest land or farmland, these facilities appear to have fully fulfilled their intended functions. Erosion control work in the Study Area is summarised in Table 2-4-38. In Dolj County, stream work has been conducted at several sites along minor rivers, mainly by the Ministry of Agriculture. The only erosion control work conducted by the former Craiova Forest Branch Office is hillside work at the former spillage site of crude oil described earlier. This work began in 1993 with a planning area of 23.5 ha, of which 14.8 ha has so far been completed. The remaining work will be completed by 2004. The types of work being conducted are fascine soil retaining work as foundation work, terracing as revegetation work and fascine hurdle work and the planting of *Robinia pseudoacacia*.

Table 2-4-38 Erosion Control Work in Study Area

County	Forest Range Office	Hillside Work	Stream Work
Olt	Vulturesti	-	Check Dams: 26
		-	Channel Work: 69.9 km
Dolj	Amaradia	14.8 ha	-

As the subject areas of the above work do not constitute damaged forests, they are not qualified as subject areas of the Plan. The field survey and interview survey on sites (hillside landslide sites and devastated torrent sites) selected on the basis of aerial photograph interpretation in the target area of the Plan found that erosion control facilities at these sites are unnecessary. Consequently, the planning of erosion control facilities is unnecessary for the target area of the Plan.

2.5 Breeding Experiment Using Cuttings

At present, seedlings of *Q. frainetto* are hardly produced because of the scarcity of good seed stands and the long interval of 8 - 10 years between bearing years. In view of this situation, an experiment using cuttings was conducted to examine the feasibility of producing planting stock using cuttings.

A similar experiment using *Q. robur* was also conducted as a controlled experiment as *Q. robur* has been used in Romania for breeding experiments using cuttings. According to available data in Romania, *Q. robur* is a species of which the cutting survival rate is high.

2.5.1 Results of Breeding Experiment Using Cuttings

The results of the experiment conducted in 1998 are shown in Table 2-5-1 and Table 2-5-2.

Table 2-5-1 Breeding Experiment Results Using Cuttings
(Mist House Experimental Plots)

Treatment	Plot No.	*Q. robur*		*Q. frainetto*		*Q. petraea*	
		No. of Rooting Trees	%	No. of Rooting Trees	%	No. of Rooting Trees	%
Oxyveron	1	80	50.0	25	15.6	57	35.6
	4	62	38.8	28	17.5	51	31.9
	7	78	48.8	32	20.0	41	25.6
	10	58	36.3	40	25.0	44	27.5
	13	97	60.6	29	18.1	21	13.1
Mean			46.9		19.2		26.7
S2	3	133	83.1	87	54.5	48	30.0
	6	36	22.5	16	10.0	44	27.5
	9	79	49.4	18	11.3	62	38.8
	12	88	55.0	31	19.4	37	23.1
	14	91	56.9	19	11.9	66	41.3
Mean			53.4		21.4		32.1
H_2O	2	108	67.5	21	13.1	72	45.0
	5	61	38.1	1	0.6	8	5.0
	8	21	13.1	4	2.5	17	10.6
	11	71	44.4	37	23.1	5	3.1
Mean			40.8		9.8		15.9

Note: The number of cuttings in each experiment plot is 160.

Table 2-5-2 Breeding Experiment Results Using Cuttings
(Open Air Experimental Plots)

Treatment	Plot No.	*Q. robur*		*Q. frainetto*		*Q. petraea*	
		No. of Rooting Trees	%	No. of Rooting Trees	%	No. of Rooting Trees	%
Oxyveron	1	6	9.4	1	1.6	7	10.9
	4	10	15.6	0	0.0	11	17.2
	7	10	15.6	4	6.3	8	12.5
	10	9	14.1	0	0.0	8	12.5
	13	7	10.9	1	1.6	1	1.6
Mean			13.1		1.9		10.9
S2	3	7	10.9	1	1.6	7	10.9
	6	2	3.1	0	0.0	11	17.2
	9	11	17.2	0	0.0	9	14.1
	12	3	4.7	0	0.0	5	7.8
	14	1	1.6	0	0.0	8	12.5
Mean			7.5		0.3		12.5
H_2O	2	5	7.8	0	0.0	6	9.4
	5	7	10.9	2	3.1	4	6.3
	8	8	12.5	0	0.0	2	3.1
	11	10	15.6	1	1.6	4	6.3
Mean			11.7		1.2		6.3

Note: The number of cuttings in each experiment plot is 64.

The most crucial survival rate of *Q. frainetto* cuttings from the viewpoint of the present Plan was 54.5% for the best performing experiment plot involving the use of a mist house. The lowest rate was 0.6%. The average figure was 21.4% for plots treated with S2, 19.3% for plots treated with oxyveron and 9.8% for plots treated with H_2O, showing less than half of the survival rate of *Q. robur*. The results of the experiment are further described below.

(1) Mist House Experiment Plots

1) The survival rate of the subject species was the highest for *Q. robur* and the lowest for *Q. frainetto* for all treatment methods.

2) The S2 treatment and H_2O treatment produced the highest and lowest survival rates respectively for all species.

3) In the case of *Q. robur*, the different treatment did not produce significantly different results. The S2 and oxyveron treatment produced little difference between *Q. frainetto* and *Q. petraea*. The results between the S2 treatment and H_2O treatment, however, completely differed (approximately 2:1).

4) The experiment using *Q. robur* and the S2 treatment in 1997 returned a mean survival rate of 85.0% while the latest experiment in 1998 produced a mean survival rate of only 54.3%. This difference, i.e. drop of the survival rate by some 37% compared to the performance in 1997, can probably be attributed to the timing of the experiment as the latest experiment in 1998 took place later in the year, missing the best timing for the use of cuttings. The survival rate of *Q. frainetto* may be improved by conducting the experiment during the most suitable season.

(2) Open Air Experiment Plot A (shading net, electric thermostat and irrigation computer)

1) The experiment plots of *Q. robur* and *Q. petraea* produced the highest survival rate of 17.2%.

2) At plots treated with oxyveron and H_2O, the highest survival rate was recorded by *Q. robur*, followed by *Q. petraea* and *Q. frainetto*. At plots treated with S2, the survival performance was headed by *Q. petraea*, followed by *Q. robur* and *Q. frainetto*. The survival rate of *Q. frainetto* was much lower than that of *Q. robur* and *Q. petraea*.

3) Compared to the mist house experiment results, the survival rate was considerably lower for all species.

4) It is believed that improvement of the survival rate is possible by means of conducting the experiment in the right season.

(3) Open Air Experiment Plot B (covering of cutting beds with shading nets and vinyl sheeting)

Only one *Q. petraea* cutting treated with oxyveron survived. This treatment is unsuitable under the hot and dry climate in Romania.

Taking the above results into consideration, it was agreed to continue the experiment in 1999 in view of the following reasons.

- The seasonal change occurred earlier than usual in Romania in 1998 and the cutting experiment missed the best timing.

- The experiment results are too low to justify an reforestation project relying on cuttings. As a result, it was decided to incorporate the creation of a seed orchard and seed stand in the Plan.

2.5.2 Results of Breeding Experiment Using Cuttings in 1999

(1) Breeding Experiment Using Cuttings

1) Test Method

① Species (*Q. frainetto* and *Q. robur*)

Five types of cuttings were used, are as follows.

Q. frainetto : - Cuttings from young trees were supplied by the Gaesti Central Nursery (Targoviste Forest Branch Office) (two yeas old: Plot No. 3, 4, 11, 12, 19, 20) and the Bobicesti Central Nursery (Rimnicu Vilcea Forest Branch Office) (three years old: Plot No. 27, 28, 35, 36).

- Cuttings from mature trees were supplied from a 30 year old natural forest (Hurbesti UP I of the Targoviste Forest Branch

Office, Valea Caselor) (forests from coppice shoots and root suckers).

Q. robur : - Cuttings from young trees were supplied by the Gaesti Central Nursery (Targoviste Forest Branch Office) (two years old).

- Cuttings from mature trees were supplied from the same forests as the *Q. frainetto* cuttings.

② Treatment Methods

Two types of treatment, i.e. S2 and oxyveron, were used. The oxyveron treatment this time consisting of the dipping of the cuttings in a one-thousandth part silver nitrate solution for 12 hours, followed by the application of oxyveron powder to a section.

③ Conditions

Mist House

Open air (using a shading net, electric thermostat and irrigation computer)

④ Repetition

The combination of 1) and 2) was repeated five times.

2) Test Results

The results of the test conducted in 1999 are shown in Table 2-5-3 and Table 2-5-4. The planting of cuttings was conducted at a reasonable time in most cases. The test results are outlined below.

① Mist House Experimental Plots

i) The survival rate by species shows that *Q. robur* is superior to *Q. frainetto* in the case of each treatment method.

ii) The survival rate by treatment method shows that cuttings from young *Q. robur* are the best, followed by those of old *Q. robur*, young *Q. frainetto* and old *Q. frainetto* in this order, in the case of oxyveron treatment and that cuttings from young *Q. robur* are the best, followed by those from young *Q. frainetto*, old *Q. robur* and old *Q. frainetto* in that order, in the case of S2 treatment.

Table 2-5-3 Breeding Test Results on Cuttings in 1999 (Mist House Experimental Plots)

Treatment	Plot No.	*Q.robur* Young		Plot No.	*Q.robur* Old		Plot No.	*Q.frainetto* Young		Plot No.	*Q.frainetto* Old	
		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%
Oxyveron	1	76	70.4	5	33	30.6	3	20	18.5	7	6	5.6
	9	90	83.3	13	54	50.0	11	49	45.4	15	2	1.9
	17	87	80.6	21	48	44.4	19	19	17.6	23	1	0.9
	25	90	83.3	29	35	32.4	27	17	15.7	31	4	3.7
	33	98	90.7	37	35	32.4	35	17	15.7	39	1	0.9
Mean			81.7			38.0			22.6			2.6
		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%
S2	2	95	88.0	6	18	16.7	4	40	37.0	8	4	3.7
	10	87	80.6	14	21	19.4	12	20	18.5	16	7	6.5
	18	89	82.4	22	32	29.6	20	11	10.2	24	6	5.6
	26	92	85.2	30	24	22.2	28	18	16.7	32	0	0.0
	34	92	85.2	38	18	16.7	36	27	25.0	40	5	4.6
Mean			84.3			20.9			21.5			4.1

Note: The number of cuttings in each experiment is 108.

Table 2-5-4 Breeding Test Results on Cuttings in 1999 (Open Air Experimental Plots)

Treatment	Plot No.	*Q.robur* Young		Plot No.	*Q.robur* Old		Plot No.	*Q.frainetto* Young		Plot No.	*Q.frainetto* Old	
		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%
Oxyveron	1	20	48	5	5	11.9	3	4	9.5	7	0	0
	9	15	36	13	6	14.3	11	2	4.8	15	0	0
	17	21	50	21	4	9.5	19	5	11.9	23	1	2.4
	25	13	31	29	7	16.7	27	1	2.4	31	0	0
	33	9	21	37	2	4.8	35	-	-	39	-	-
Mean			37			11.4			7.15			0.6
		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%		No. of rooting trees	%
S2	2	12	29	6	4	9.5	4	2	4.8	8	2	4.8
	10	12	29	14	4	9.5	12	5	11.9	16	0	0
	18	17	41	22	6	14.3	20	2	4.8	24	0	0
	26	9	21	30	2	4.8	28	2	4.8	32	0	0
	34	11	26	38	2	4.8	36	2	4.8	40	0	0
Mean			29			8.58			6.22			0.96

Note: The number of cuttings in each plot is 42.

iii) The different treatment methods produce large differences in the survival rate of cuttings from old *Q. robur* and *Q. frainetto* while they do not significantly affect the survival rate of cuttings from young *Q. robur* and *Q. frainetto.*

iv) The survival rate of young *Q. frainetto* treated with oxyveron by production site considerably varies from an average of 27.2% for cuttings produced by the Gaesti Central Nursery to an average of 15.7% for those produced by the Bobicesti Central Nursery. In the case of S2 treatment, the corresponding figures are 21.9% and 20.8%, showing little impact of the production site. However, the highest survival rate is recorded by cuttings from the Gaesti Central Nursery for both types of treatment.

v) Compared to the test results in 1998, the survival rate of cuttings from young *Q. robur* in 1999 is quite different for both the oxyveron method (174%) and the S2 method (158%) while no such difference is observed in the case of cuttings from young *Q. frainetto.*

② Open Air Experimental Plots

i) The tendency of the survival rate by species is similar to that of the mist house test plots.

ii) Compared to the mist house test plots, the survival rate is considerably lower for each species.

iii) The highest survival rate of 37.1% is recorded for cuttings from young *Q. robur* treated with oxyveron. In contrast, cuttings from old *Q. frainetto* show an extremely low survival rate of less than 1%.

iv) Except for old *Q. frainetto* cuttings, the oxyveron treatment results in a better survival rate than the S2 treatment.

3) Conclusions

i) As the survival rate of *Q. robur* cuttings is very similar to that of the test in 1997 (85.0%), the timing of planting is believed to be fairly adequate.

ii) Even though the overall survival rate of cuttings from young *Q. frainetto* is around 20% in both 1998 and 1999, some test plots show such particularly high rates as 54.5% at the S2 treated No. 3 plot in 1998 and 45.4% at the oxyveron treated No. 11 plot in 1999. It is believed that further tests should be able to secure a survival rate of around 50%.

iii) As described by the test results in ①-iv) above, the collection of cuttings from sites distant from the test site (involving some three hours transportation) is a factor contributing to the lowering of the survival rate. To improve the survival rate, it will be important to quickly treat the cuttings which should preferably be collected at the planting site.

iv) To improve the survival rate, it will be necessary to examine the appropriate time for the planting of *Q. frainetto* cuttings and to analyse the work processes at each plot (comparison between plots with a high survival rate and plots with a low survival rate in terms of the time from the collection of cuttings and treatment, weather on the day of the collection of cuttings and actual time of day of collection, etc.)

(2) Grafting Experiment

1) Test Method

① Stock: Three species were used.

Q. frainetto: Naturally regenerated saplings were dug from the Hurbesti UP I forest in the area of the Targoviste Forest Branch Office in the autumn of 1997 and were transplanted in a nursery.

Q. cerris: Seedlings from the Gaesti Central Nursery

Q. pedunculiflora: Seedlings from the nursery of the Slobozia Forest Range Office were transplanted.

② Grafts

Grafts were collected from trees which are bearing seeds in the UP I, Valea Caselor Forest (30 years of age) of the Hurbesti Forest Branch Office. Collection of the grafts took place between 6th and 10th March in 1999 and the grafts were placed in sand covered by a wet cotton cloth, kept in a refrigerator and grafted three weeks later.

2) Experiment Results

At the time of the survey (4th June, 1999) only one *Q. pedunculiflora* graft appeared to have survived.

3) Analysis of Results

The poor result is assumed to have been caused by the following. The biggest cause is probably that those who conducted the grafting lacked the necessary skill. The death of most of the *Q. frainetto* stock is also a major cause of the poor grafting results. The training of grafting technicians will pose a challenge in the coming years. And there has successful examples of seed orchard creation in Romania (with a high graft survival ratio). This fact suggests that the accumulation of clones by means of grafting can be successfully conducted by means of training grafting technicians.

2.6 State of Forest Decline

2.6.1 Causes of Forest Decline

The study findings described so far suggest the following causes of forest decline.

- Change of the climatic conditions, i.e. rising temperature and declined precipitation up until recently since the 1980's as analyzed in 2.2.1
- Damage by *Lymantria dispar* and other pests
- Decline of tree vigour due to repeated regeneration by coppicing
- Soil compaction caused by drying
- Soil compaction caused by repeated stock raising

The survey on the decline of tree vigour due to repeated regeneration by coppicing was unable to produce a conclusive causal relationship between regeneration by coppicing and tree decline as there are stands where new shoots regenerated from old roots show healthy growth. In regard to damage by such defoliators as *Lymantria dispar* and others, forests in the Study Area are liable to pest damage because of the simple composition of species and continual dry weather. Nevertheless, these conditions are not judged to be directly responsible for forest decline in view of the fact that the prediction of pest outbreaks and pest control are systematically conducted by the RNP. Accordingly, the main cause of forest decline is judged to be soil compaction by stock raising and insufficient soil moisture due to dry weather.

(1) Growth of Forests and Characteristics of Water Environment

The biggest cause of forest decline in the Southern Plain in Romania is believed to be the abnormally low level of precipitation. As a result, the conspicuous phenomenon of decline has occurred at some 10% of forests.

While the precipitation in the area in a normal year is approximately 650 mm, a dry year with annual precipitation below the normal level of around 100 mm or more occurred 11 times in the 13 years from 1982 to 1994. In particular, the extraordinary low levels of annual precipitation of 410 mm in 1983, 290 mm in 1992 and 400 mm in 1993 made forest decline manifest more clearly.

The water balance in these 13 years is analysed here to establish the situation of drought in a concrete manner. To simplify the issue, the evapotranspiration and basic outflow were assumed for this analysis. The outflow is usually calculated as the surplus of precipitation over evapotranspiration. Even in the case of a low rainfall area where such surplus does not exist, there is always some annual outflow. This outflow is considered to be the basic outflow and is primarily determined here.

- Annual free outflow to rivers and groundwater

  = annual precipitation - annual evapotranspiration - basic outflow

- Annual precipitation : 6,800 mm/13 years

- Basic outflow to rivers and groundwater

  0.25 (annual precipitation - 250) mm : 888 mm/13 years

- Annual evapotranspiration from forests and vegetation sites

  approximately 550 mm (450 - 650 mm) : 7,150 mm/13 years

- Evapotranspiration: as there is no extreme decline of the annual ring width even for dry years, it is assumed that the annual water consumption is constant

- Rough estimation of water balance for 13 years : - 1,235 mm

The overall result of this calculation is that the water supply fell short by some 1,250 mm over a period of 13 years (equivalent to two years normal precipitation). Next, it is necessary to estimate the quantity of water stored in the soil. Assuming a fine pore ratio of the soil of 20% where no water outflow occurs due to gravity, the storage capacity is 200 mm per 1 m soil thickness. To meet the above water shortage, water must be retained by a 6.5 m thick soil formation (1,300 mm). Similarly, if the fine pore ratio is 25%, the soil thickness should be 5 m (1,250 mm). If the ratio is small, i.e. 15%, the soil thickness should increase to 8.5 m (1,275 mm).

The phenomenon of decline is observed at some 10% of forests, meaning that despite such a dry spell, some 90% of forests have somehow maintained their healthy growth upto the present. This in turn means that water to compensate for the shortage of 1,250 mm in the 13 years was available somewhere in the ground and that many trees used this water to enable their continual growth.

The thickness of the soil in which the root system of trees is located is usually not very thick with a maximum depth of 2 - 3 m and forest trees are believed to grow using the water retained within this range. The fact that many forests are continuously growing in this area suggests the availability of water above the estimated shortage in the ground.

The water preserved by a capillary tension of pF 2.7 (or 3.0) or more does not move by gravity and is thought to only be lost by absorption by plant roots and evaporation. The water stored in fine pores is such water. The continuous capillaries in fine pores allow the vertical movement of water at least for 5 m (or 10 m) or more. In the case of ordinary soil formations, however, the existence of many large pores cuts off this continuity of capillaries, making water movement for as much as 10 m difficult. The sedimentation layer (silty) which constitutes tableland in the Study Area is quite compact and has a thickness of more than 20 m (see Fig. 2-6-1). To be more precise, the capillaries in fine pores continue for more than 10 m within the sedimentation layer of middle and high terraces and it is believed that the water stored in this soil formation replenishes areas of water shortage throughout this soil formation. The survival of many forests during the long period of dry years can be explained by the use of water stored in the fine pores in this geological formation by forest trees.

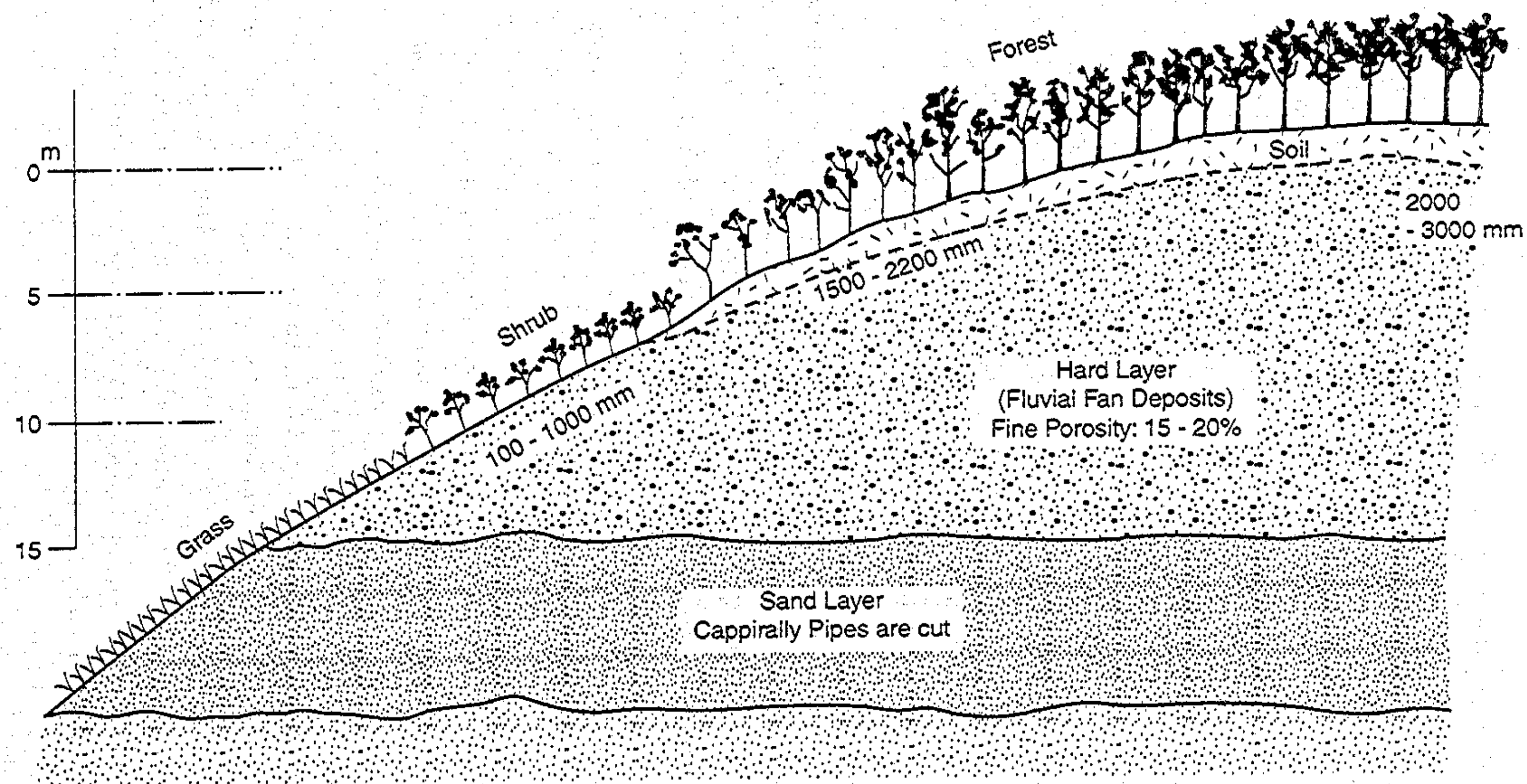


Fig. 2-6-1 Hydrological Properties of Geological Deposits in Southern Plateau

It is commonsense that the root system of forest trees growing in a wet temperate zone begins to experience growth difficulties with a soil hardness index of 23 mm and that penetration of the root system is difficult in the case of a compact soil formation with a hardness index of 27 mm or higher. From this viewpoint, it was originally thought that the existence of a compact base soil formation devoid of fine pores constituted a negative factor for the growth of forest trees. However, the survey on root system distribution in the soil formation found the main roots (both a depth and radius of more than 2 m) as well as fine roots of *Q. frainetto* and *Q. cerris* in a compact formation with a hardness index of 26 - 31 mm, suggesting vigorous activity of the root system. Taking into consideration the fact that a compact soil formation presents a stable place for water storage in fine pores, such a soil formation is now evaluated as a positive factor for these species (varieties).

(2) General Growth and Environment of Forests

A plot survey was conducted at 166 plots on the following items for the purpose of establishing the general correspondence between the growth and environment of forests.

location; topographical (land) conditions; species (varieties);

stand age (Y); tree height (H); dbh (D); tree density (N);
relative stance (Sr) ($Sr = 100\,(10{,}000/N)^{0.5}/H$)

single tree volume (v); stand volume (V); crown coverage (Cc);

number of dead trees and their volume; number of declined trees and their volume; d-N and d-V based on the sum of the previous two items;

decline ratio (volume) and estimation of crown coverage before and after damage based on the decline ratio;

shrub coverage; herb coverage; undergrowth coverage; litter coverage; ratio of soil erosion area

Fig. 2-6-2 is a graph showing the relationship between the stand age and tree height based on the land conditions of the surveyed stands of *Quercus* spp. It also includes the tree height curves for Class I site of *Q. robur* and Class I, Class III and Class V sites of *Q. frainetto*.

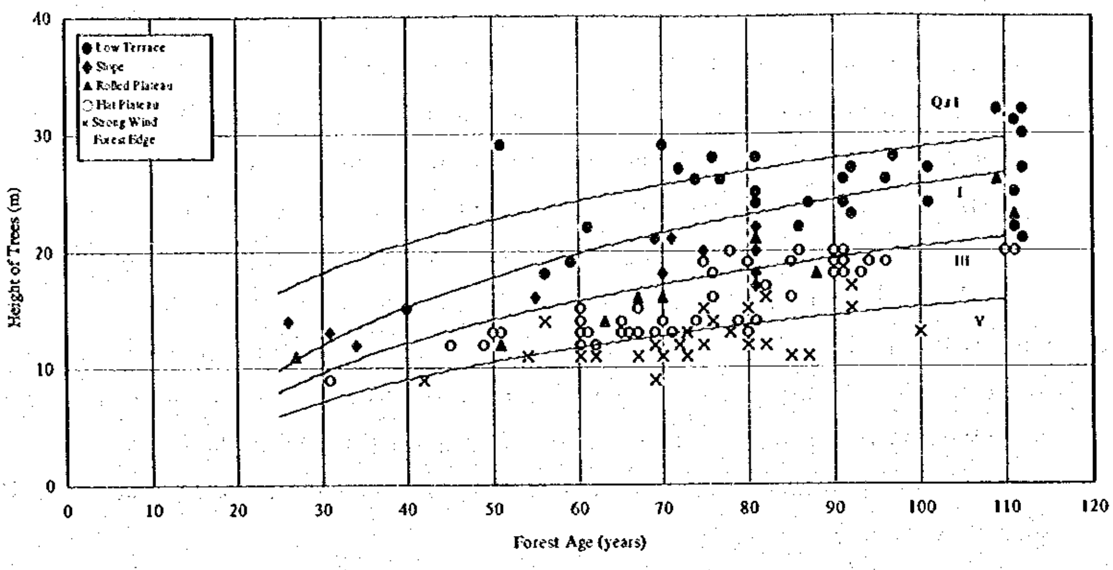


Fig.2-6-2 Relation between Forest Age and Height of Trees, Topography. Measured Points are Marked with Topology.

Analysis of the patterns shown on the graph and taking the observed facts during the survey into consideration leads to the following general conclusions.

Q. robur has the general character of a species in a wet temperature zone and Class I and Class II sites of *Q. robur* are distributed in areas with a so-called wet environment. To be more precise, such an environment consists of the existence of small pores as well as medium and coarse pores and the corresponding water environment (low terraces with a low groundwater level, etc.)

Class I and Class II *Q. frainetto* sites are also distributed in wet or semi-wet areas at low terraces along valleys and valley-type slopes. Under the same topographical and geological environment, the growth of *Q. robur* is better than that of *Q. frainetto* and *Q. cerris* in wet areas.

Class III, Class IV and Class V *Q. frainetto* sites are all stands located at middle to high terraces (plateaus). Under this environment, no growth of *Q. robur* is observed. As described earlier, it is necessary for forest trees to extend their root system in a compact soil formation to maintain their growth under these land conditions. As *Q. robur* lacks such property, it presumably could not adapt to these sites. There are many flat areas at the tableland, most of which are have a site index of Class IV, even though Class III sites appear in places with good drainage and air permeability such as sloping land, places with minor undulations and forest edges with a swollen and soft A horizon due to the absence of trampling by livestock, etc. In contrast, Class V sites are distributed in places near forest edges exposed to strong wind and forest edges where the A horizon is compacted due to trampling by livestock, etc. (poor drainage and air permeability; many are located in the SW direction). Treeless land is also observed as slightly concave sites with poor drainage.

(3) Declined Stands and Environment

Fig. 2-6-3 classifies the measurement points based on the grade of decline using the stand age-tree height diagram. When this graph is compared to Fig. 2-6-2, the following general tendencies can be observed.

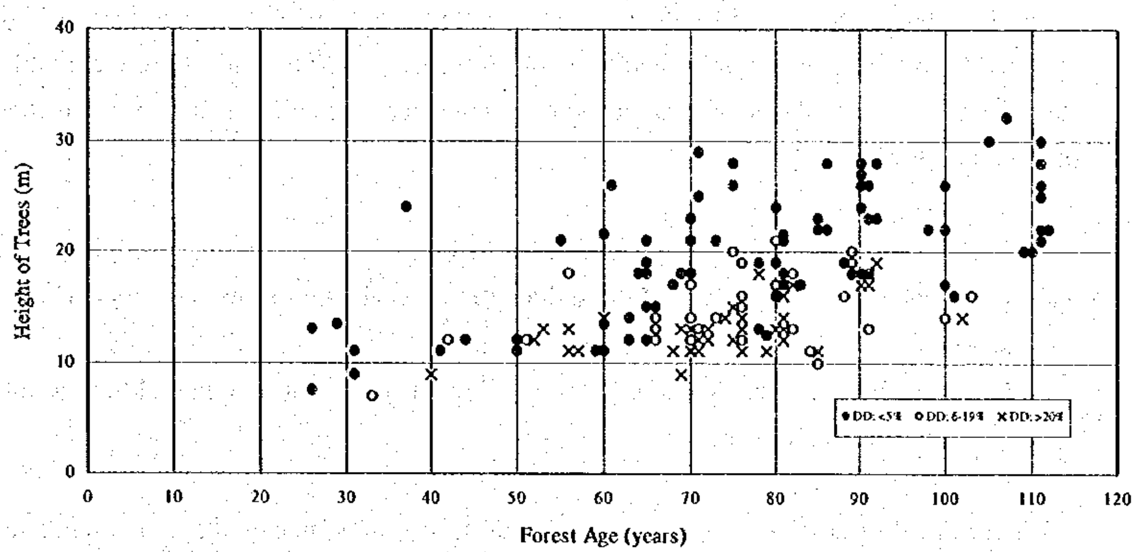


Fig.2-6-3 Relation between Forest Age and Height of trees, Forest Decline. Measured Points are Marked with Degree of Damaged Volume.

In the case of *Quercus* spp., the most noticeably damaged stands with a decline grade (ratio of the declined tree volume in the stand volume) of 20% or higher, are found at site index Class V sites with some others being found at Class IV sites. Sites with medium damage (6 - 19%) are mostly observed at Class IV sites.

The damage is less apparent in sloping places with good drainage and air permeability. The exceptions are narrow tableland with poor infiltration conditions due to erosion and trampling, etc. Despite good drainage and air permeability, however, forest decline originating from a water shortage in the sedimentation layer occurs in these places. Damage is rare at low terraces and valley-type slopes.

Sudden drought damage to forests mostly occurs when forest trees which usually show favourable growth with a rich water environment face a sudden water shortage. In this case, a substantial moisture gap causes their decline or even death. Even though declined forests of this kind are observed in the Study Area, it is believed that most declined forests were already in a poor state (poor site quality) when they experienced a decisive decline due to low precipitation.

Fig. 2-6-4 is a graph which classifies the measurement points based on the grade of decline using the tree height-relative stance diagramme while Fig. 2-6-5 shows the relationship between the relative stance and grade of decline (ratio of declined tree volume in stand volume). A large relative stance in a stand with the same tree height indicates a large stance between the forest trees, meaning an open stand. In particular, when the relative stance is 30% or more, the crown tends to be open regardless of high site quality. Such a stand is described as a sparse stand. Checking against the yield table, stands with a relative stance of 26% or more are considered to be more sparse stands than the standard level.

Analysis of the pattern on the graph after the removal of low terraces with high quality and low damage and a tree height of more than 20 m reveals the following tendencies.

- A larger relative stance tends to cause a higher grade of decline although this correlation is not very clear.

- The removal of artificial open stands, such as seed stands, makes the above tendency slightly clearer. This time, the survey data arbitrarily includes artificial open stands. However, a random survey will presumably show the tendency for a larger relative stance, i.e. a more open stand, or lower site quality to make a stand more liable to damage.

Fig. 2-6-6 is a graph which classifies the measurement points based on the existence or non-existence of damage using the correlation between the pre-damage crown coverage ratio (estimated value) and post-damage crown coverage ratio. It is shown here that closed stands with a crown coverage of 70% or more sustain hardly any damage while stands with a pre-damage crown coverage of 50 - 80% show a mixture of damaged and undamaged stands. Decline appears to frequently occur at stands of which the pre-damage crown coverage is 50% or less.

Fifty-seven plots are stands with a tree height of less than 20 m and a relative stance of 26% or more while 45 plots are stands with a crown coverage of 50% or less. Most of these are declined forests. Although these findings do not necessarily form a strong basis for the argument because of the non-random sampling survey, they still suggest that many open stands existed before direct damage and that these stands further declined because of damage. It is inferred that forests showing a chronic declining trend emerged for one reason or another and that their poor conditions resulted in the significant decline observed today. As declined forests indicate a slightly localised feature because of their ratio of 10%, the possible causes of the decline were further investigated. As a result, the extraordinary compactness of the surface soil layer was found as described later.

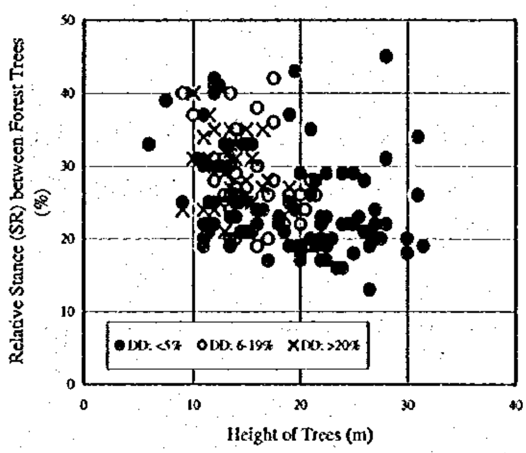


Fig.2-6-4 Degree of Damage on the Relation between Height of Trees and Relative Stance (SR)

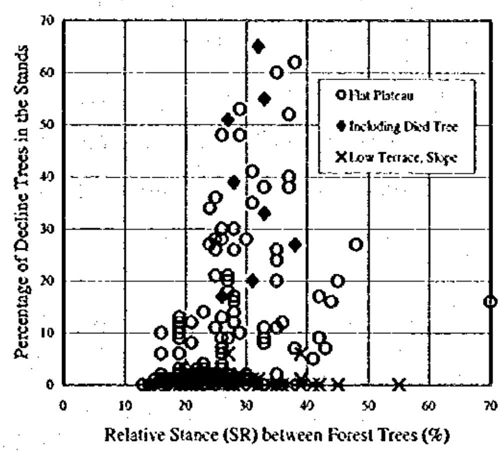


Fig.2-6-5 Relation between Relative Stance (SR) and Degree of Decline (DD) on the Forest Stands

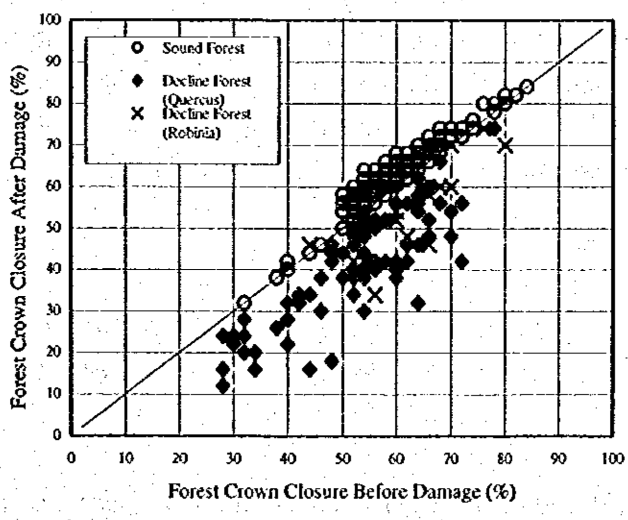


Fig.2-6-6 Relation of Crown Closure between after and before Damage

(4) Morphological Characteristics of Declined Forests - Crown Coverage and Decline

The characteristics of declined forests mentioned above are schematically shown in Fig. 2-6-7.

As the decline of *Quercus* spp. occurred at middle and high terraces, the description of the land conditions is restricted to terraces here.

- Fig. 2-6-7-(1) Undamaged Forests

Decline of the crown is rarely observed at stands which have a swollen and soft soil formation (A horizon: 20 cm), has minute undulations and is sloping with excellent drainage, infiltration and air permeability. Health crown closure is maintained at these stands. Many have a crown cover age of 70% (65%) or more.

- Fig. 2-6-7-(2) Declined forests with a mixture of healthy trees and dead trees do not exist.

Forest trees growing in an environment in which dead trees exist usually show significant decline of varying degrees. Decline caused by competition between forest trees usually shows a distinctive difference between healthy trees and declined trees and it is not unusual for healthy and dead trees to be found side by side. The decline in the Study Area, however, spreads over a wide area because of the environmental conditions and there is no uniformity of the state of trees. For example, a dead tree with zero crown coverage can be observed next to a declined tree of which the crown size has been reduced to 30% or 60%. In conclusion, the grade of decline cannot be expressed by the dead tree ratio.

Of the 74 plots with declined stands in the latest survey, only seven plots showed conspicuous death. In most cases, forest decline occurred in the form of crown size reduction.

- Fig. 2-6-7-(3) Judgement on declined trees is made on the basis of crown size reduction as a result of die back.

As the phenomenon of decline in 1992 and 1993 was not confirmed by the survey, only the tree form showing the after-effects of damage in these years can be used for inference purposes. Fortunately, those forest trees undergoing harsh decline experienced not only defoliation but also the die-back of young branches, making it possible to use the degree of die-back as an important decline index for single trees. The symptoms observed at the time was predominantly defoliation and it is believed that trees with severe defoliation equally experienced severe die-back. As a result, die-back rather than defoliation is emphasised as a phenomenon of tree decline accompanied by after-effects. As the dead branches are no longer expected to produce leaves, the damage can be measured in terms of reduction of the crown size. Conversely, measurement of the present crown diameter should enable a judgement on the degree of decline. As there is a mixture of trees with different degrees of crown reduction at declined stands, a general judgement on the degree of decline can be made based on the crown coverage.

The latest survey, however, found that the stoppage of crown growth was also an unusual phenomenon and was not necessarily caused by a severe environment. Consequently, judgement on the degree of decline based on the crown coverage should not only consider the damage in 1992 and 1993 but also the chronic decline upto that point.

When the crown coverage by stand age was inferred using the existing yield tables prepared in Romania, even normal stands at *Q. frainetto* and *Q. cerris* Class V sites had a crown coverage of around 50%, indicating forest management with a low crown density. It may be concluded that many stands at Class V sites are in an environment causing chronic decline.

- Fig. 2-6-7-(4) The degree of stand decline is judged by the crown coverage.

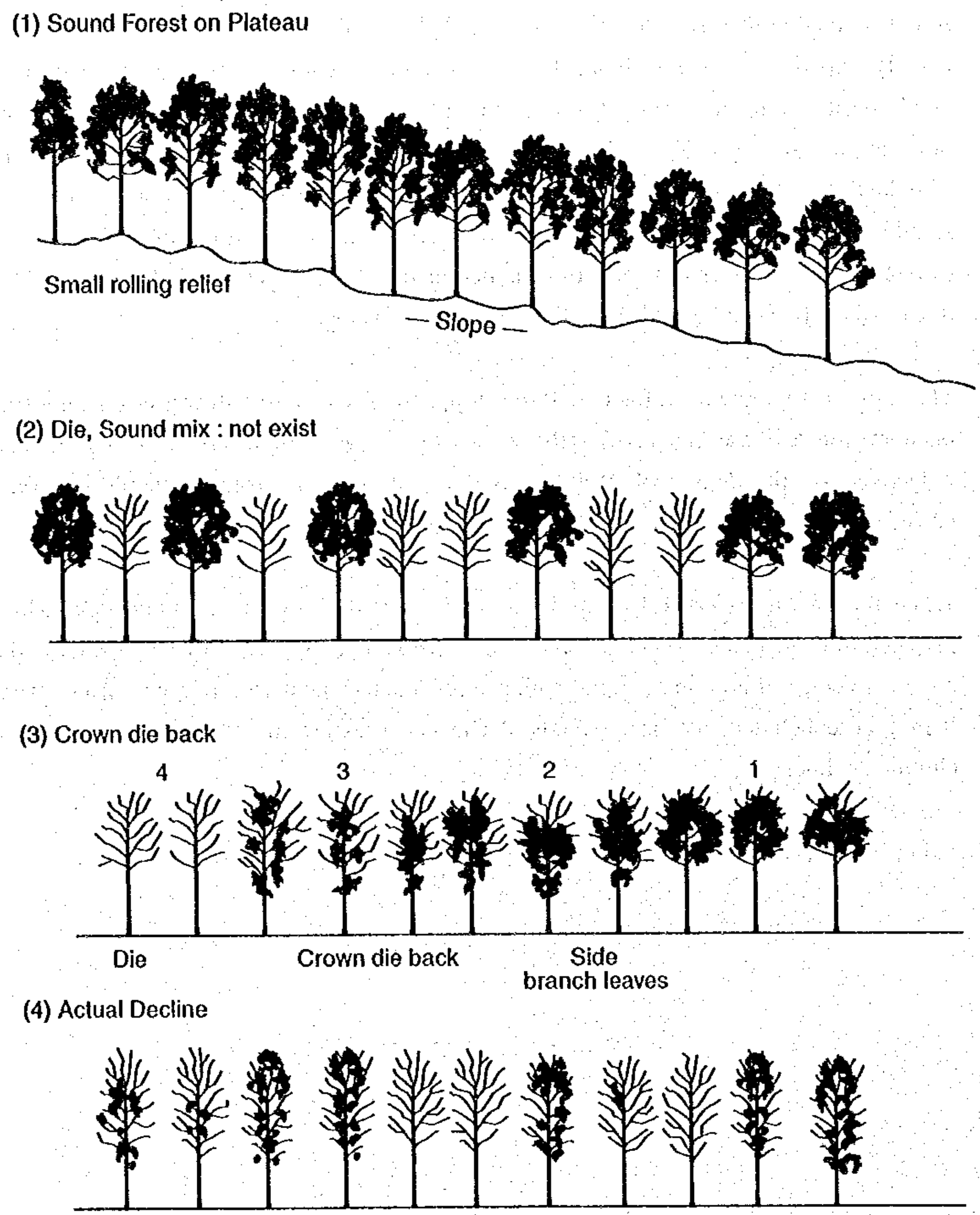


Fig. 2-6-7 Pattern of Forest Decline

It will be possible to alleviate or prevent the future decline of newly planted trees in damaged forests as well as existing trees in remaining areas and prevention forests by means of implementing the various measures put forward by the Plan. Fig. 2-6-8 schematically shows the expected increase of the stand volume with or without the implementation of such measures. Here, the normal growth of a normal forest is indicated by a crown coverage of 80% while dead trees or forests are indicated by a crown coverage of 0%. Assuming a current crown coverage of 50% for a damaged forest, the implementation of various measures will ensure its future growth similar to that of a stand with a crown coverage of 80%. The difference between the two curves represents the expected increase of the stand volume by the implementation of various measures.

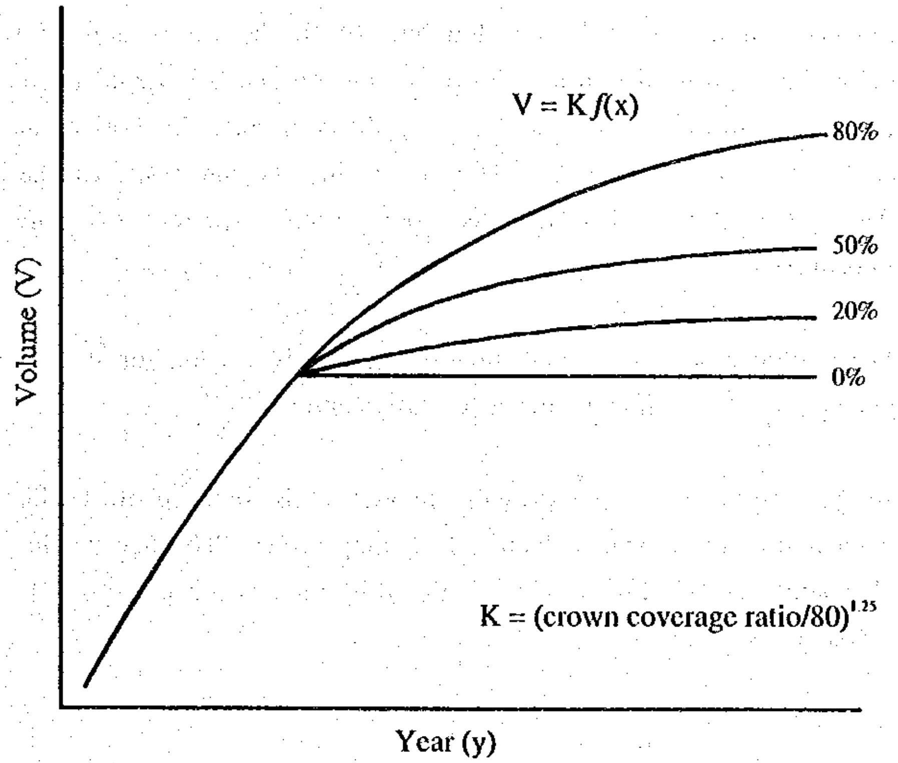


Fig. 2-6-8 Expected Stand Volume Increase Based on Crown Coverage

(5) Soil Characteristics of Declined Stands

1) Composition of A Horizon and B Horizon in Top Layer

Normal forest soil usually has soft and porous A and B horizons which fulfill multiple functions, such as percolation, infiltration, drainage and air permeation. At noticeably declined stands, however, it was found that soft A and B horizons were absent. Although a concrete reasons for this absence are not identified, it is inferred that the top soil layer was compacted due to trampling by livestock raised in the forest edges and was then lost through erosion. In reality a number of areas were observed where repeated trampling by grazing livestock has led to soil compaction.

Fig. 2-6-9-(1) and Fig. 2-6-9-(2) schematically show the normal top soil layer and compacted layer respectively together with the hardness index and porosity by depth. Comparison between (1) and (2) clearly shows the following facts.

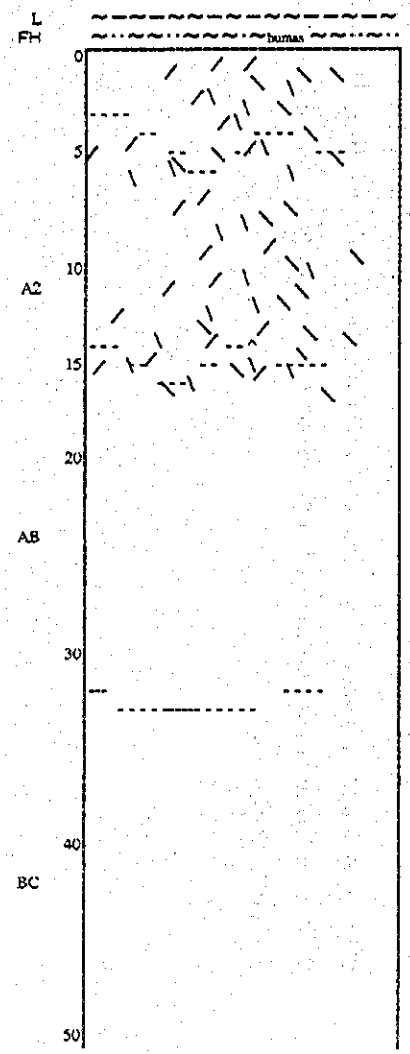
- The compacted top soil layer has a considerably reduced ratio of large pores responsible for infiltration, drainage and air permeability.

- In regard to soil subject to trampling, the top soil layer (upper A horizon) has retained some softness due to ploughing by the hooves of animals while soil below 10 cm from the surface (lower A horizon and B horizon) is considerably compacted. In the case of Fig. 2-6-9-(2), the compacted AB horizon becomes an aquifer vis-a-vis the soft A horizon, producing stagnant water (in the horizon). Air permeability is lost and the root system experiences a physiological impediment.

- When such a stagnant water situation frequently occurs, forest trees begin to decline, if not die, showing the state of ill health.

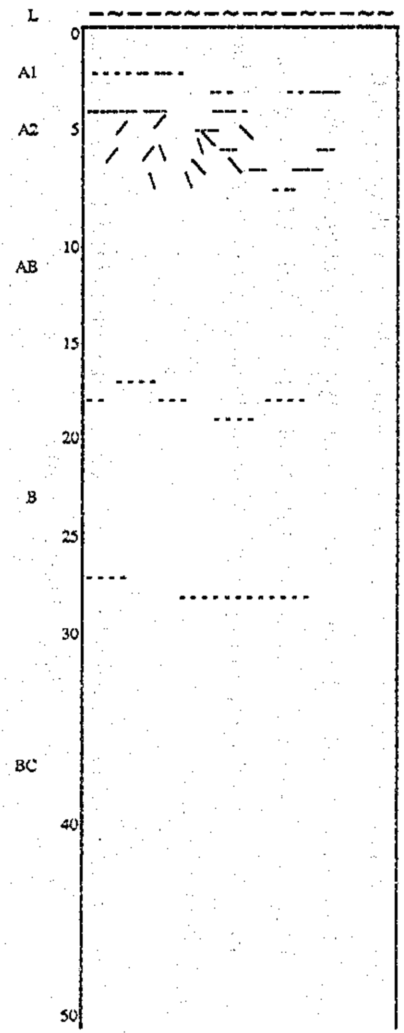
- Judging from the actual growth situation, this state of ill health hampers extension of the crown, reducing thickening growth. The tree height growth is also hampered (see Fig. 2-6-1) although this is not as conspicuous as the reduced thickening growth.

(1) Normal Forest Soil



Index of Hardness (mm)	Soil Porosity (%) Large Pore	Middle Pore	Small Pore	Fine Pore
5 (3~8)	8~15	14~18	12~14	20 ~26
8				
11 (8~12)	5~8	12~14	10~12	26~28
13 (9~16)	3~7	9~14	8~12	28~30
16 (12~20)	2~4	6~12	6~11	26~30
20 (18~21)	2~3	6~8	7~8	24~30
22 (20~24)	1~2	4~6	4~7	22~26
20 (18~25)	1~2	4~6	4~6	22~25
23 (20~26)	1~2	3~6	4~7	22~26

(2) Stamped (Pressed) Forest Soil



Index of Hardness (mm)	Soil Porosity (%) Large Pore	Middle Pore	Small Pore	Fine Pore
7 (5~11)	4~6	8~12	12~14	26~30
14 (12~18)	2~4	4~8	10~14	28~32
21 (17~25)	0~2	2~5	6~12	24~30
22 (19~26)	0~2	2~4	6~10	22~30
24 (22~27)	0~1	2~3	5~9	23~28
26 (24~30)	0~2	1~2	2~7	22~24
26 (22~28)	0~1	1~2	3~8	23~26
27 (24~29)	0~1	1~2	2~7	22~24
28 (26~29)	0~1	1~2	2~5	22~24

Fig. 2-6-9 Porosity of Soil

2) Distribution of Fine Roots in Top Layer

The distribution of fine roots in the top layer was surveyed for the purpose of inferring the absorption activity within the compacted layer and the concrete symptoms of decline. The survey results are schematically shown in Fig. 2-6-10.

- Fig. 2-6-10-(1) Shallow Distribution of Compacted Layer with Localised Concave Areas

Infiltrated water tends to stay above the compacted layer. Some of the water gathers and remains in concave areas. The root system does not develop in the soft layer and is mainly distributed in the compacted layer where stagnant water is unlikely to occur. Even though the compacted layer does not provide a favourable environment for fine roots, it appears to provide a more stable growth environment than areas of stagnant water.

- Fig. 2-6-10-(2) Slightly Deep Location of Compacted Layer with Continuous Buried Ditch Nearby

Because of the slightly thick soft layer, the distribution of highly frequent stagnant water areas is restricted to the bottom of the soft layer. As a result, fine roots mainly spread in the middle and top sections of the soft layer. When a buried ditch exists nearby, it acts as a drainage ditch, encouraging the spread of fine roots at the bottom of the soft layer as well as the sedimentation layer inside the ditch. In the case of localised concave areas instead of a ditch, the drainage function is weak, restricting the spread of fine roots.

- Fig. 2-6-10-(3) Adequately Thick and Sloping Soft Layer

The gentle slope of only 2 - 3 degrees provides drainage, reducing the impediment caused by stagnant water. The thick soft layer has an excellent infiltration function with a resulting small outflow of water resources. Fine roots spread in both the soft and compact layers.

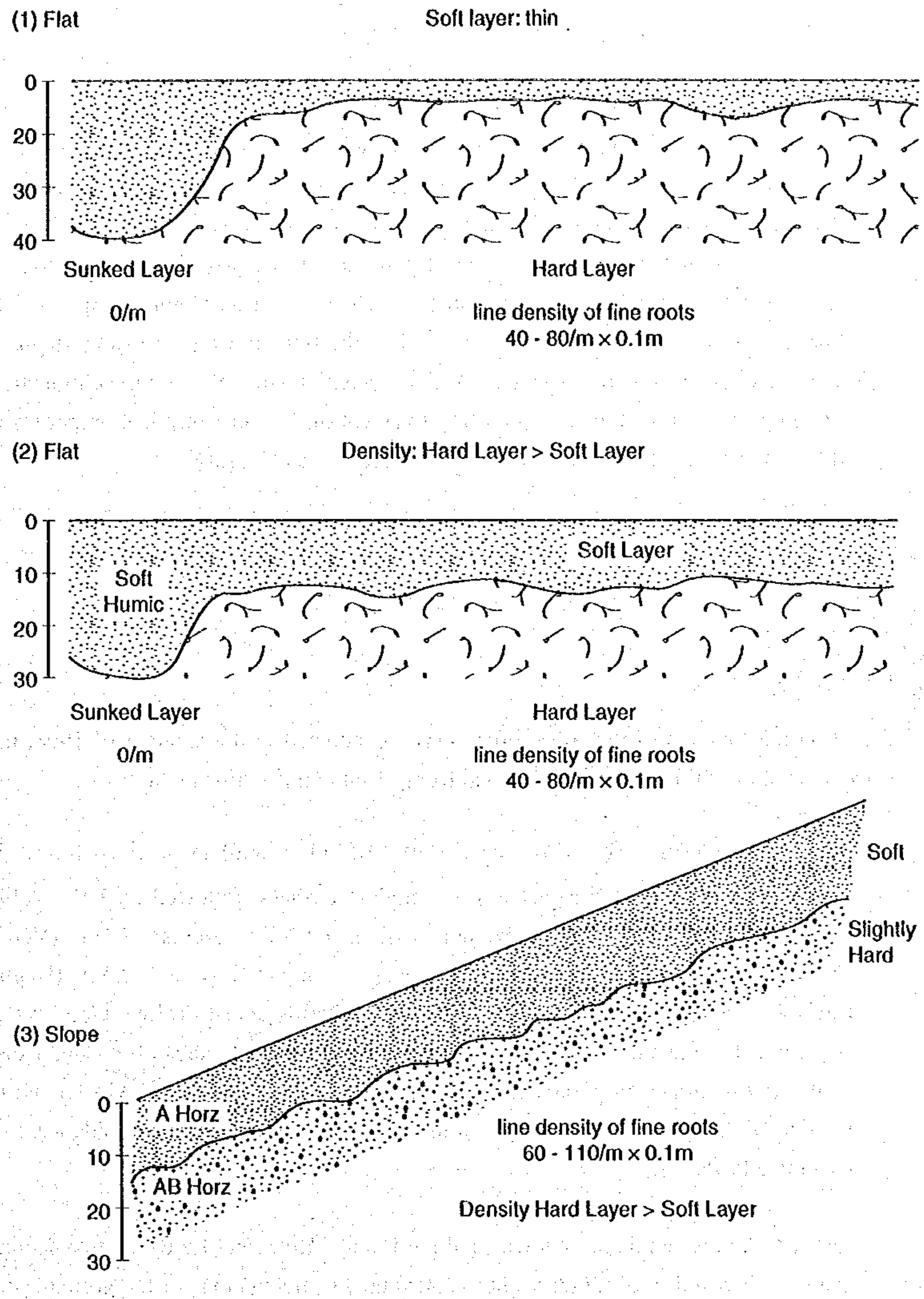


Fig. 2-6-10 Line Deisities of Fine Roots in Surface Soils

- Necessity for Drainage in Low Precipitation Areas

As infiltrated water is precious in low precipitation areas, its drainage may appear to be a contradictory requirement. However, the adverse impacts of stagnant water in the compacted top layer are truly severe, making the presence of water a disadvantage rather than an advantage. Normal natural soil enables the coexistence of water and air through the presence of pores of various sizes but compacted soil which has lost large pores does not allow such coexistence. Compaction of the B horizon in particular prevents the vertical infiltration of water, causing stagnant water. Even if the environmental conditions become favourable with the elimination of compacting in the future, natural improvement of the soil's physical properties is difficult, making artificial soil improvement measures necessary.

Reference Material: Keiji Takeshita and Junji Takagi, Study on Soil and Topography Regarding Water Conservation Environment at Forest Land in Temperature Zone, Review of Fukuoka Prefecture Forest Research and Extension Center No. 26, 1977.

(6) Links to Soil Factors

Based on the findings of the soil profile survey conducted in the summer of 1998, the causative relationship between the soil and forest decline is described below.

① The leading soil unit (based on the FAO/UNESCO system) of declined forests is LVx (Chromic Luvisols) at plateaus and middle terraces, followed by LVa (Albic Luvisols), CHk (Calcic Chernozems), PHl (Luvic Phaeozems), CMv (Vertic Cambisols) and PDj (Stagnic Podzoluvisols). Among Luvisols, LVh (Haplic Luvisols) and LVj (Stagnic Luvisols) are less linked to forest decline. Good water conditions have resulted in less forest decline in the case of CMe (Eutric Cambisols) at the lower slopes of mountains (plateaus) and FLc (Calcalic Fluvisols), GLm (Mollic Gleysols) and CMv (Vertic Cambisols) at low terraces and riverside terraces (riverside lowland).

At AR (Arenosols) dunes at lowland along Danube River and Jiu River, tree decline can be observed in some places but is attributed to fluctuations of the groundwater level and choice of species.

② As declined forests are often found with Luvisols or Chernozems, soil with a high clay content mainly causes tree decline.

③ High soil hardness (soil hardness measured by Yamanaka-Type hardness tester and penetrating resistance of soil measured by Hasegawa-Type penetration meter during the soil profile survey) is another characteristic of a declined forest (the compaction of the soil is accelerated by drought in the case of Luvisols and other types of soil which have a high clay content and which are prone to water content changes, resulting in high soil hardness). The soil hardness obtained is shown in App. B-5(1).

④ Compaction of the soil has reduced the amount of coarse pores, causing poor water permeability and poor water retention of the soil.

The soil survey results suggest a need to improve the physical properties of soil for forest restoration. Among the various possible measures, destruction of the compacted soil layer to increase the coarse pores in order to improve the water permeability and water retention of the soil will be particularly effective.

In order to gather comparative data, the soil improvement work sites at Letca forest which is marked by the conspicuous decline of *Q. frainetto* in the area managed by the Ghimpati Forest Range Office of the Giurgiu Forest Branch Office were surveyed as this forest land shows similar soil conditions, i.e. LVx (Chromic Luvisols), to the plains in Olt and Dolj Counties. The soil survey (penetrating resistance, etc.) results for those sites subject to soil improvement work (1: ditching by a scarificator, 2: reverse ploughing and crushing of large soil blocks and levelling by a disc harrow) and subsequent planting show a decreased soil hardness (compaction), increase of the coarse pores and increase of the soil's water content (increased water retention and increased effective water content) compared to forests where soil improvement has not been conducted. The measured soil compactness (penetrating resistance) is shown in App. B-5(2) and App. B-5(3).

As ground preparation work by means of soil improvement is very expensive, however, it will be necessary to examine less expensive soil improvement methods, including strip ripping by a ripper, a carry plough and a disc plough.

(7) Summary of Relationship Between Forest Tree Decline and Environment

The relationship between forest decline and the environment at middle and high diluvial upland where declining forests are frequently observed is summarised in the form of a flow chart (Fig. 2-6-11). Using the analysis results shown in the flow chart, the desirable direction for soil improvement is indicated as the basic issue for the Plan.

1) Quantity of Available Water

The sedimentation layer constituting the diluvial upland is compacted and hard but contains continuous fine pores (pF > 2.7). It can be reasonably inferred that a large quantity of water is stored in the fine pores of this thick sedimentation layer, providing a supply source to replenish the water in the top soil layer at the time of drought. As a result, despite the severe dry weather, an absolute shortage of water has not been manifest in the Study Area and most forest trees have maintained their growth without experiencing decline.

2) Root System

Water in the fine pores is retained by strong capillary tension. A root system with strong water absorption capability is required in order to use this water. Decline has occurred in the case of forest trees of which the root system has only weak water absorption capability.

3) Soil

Most forest trees growing in a regularly dry environment enjoy strong water absorption capacity and maintain their growth using the water in fine pores in an effective manner under drought conditions. In contrast, the root system of forest trees which formerly grew under a favourable water environment lacks such strong water absorption capability and these trees have decline even though their number is relatively small.

Apart from the water environment, many cases of tree decline are observed at sites where the A2 and B horizons immediately below the surface layer (A1 horizon) have been compacted by stamping. This is because of the fact that these A2 and B horizons have become impermeable layers, causing standing water in the top soil layer and weakening the root system. The insufficient water absorption capability of the weakened root system then leads to the decline of forest trees.

4) Conclusion

As shown in Fig.2-6-12(1), soil where healthy trees grow is composed of the A horizon (15 - 20 cm thick) with many pores and the B horizon (15 - 45 cm thick) which is located below the A horizon and which has large pores of several percent in volume despite its compactness. This type of soil simultaneously shows water permeability and air permeability. As the compacted soil layer with low porosity where many declined forests are observed has not been properly addressed, the reforestation of this type of forest runs a high risk of recurring forest decline. It is, therefore, essential for the physical properties of the soil to be improved.

To be more precise, culverts [Fig. 2-6-12-(2)] and strips [Fig. 2-6-12-(3)] should be created together with ploughing of the top soil layer to improve the infiltration capacity of the B horizon.

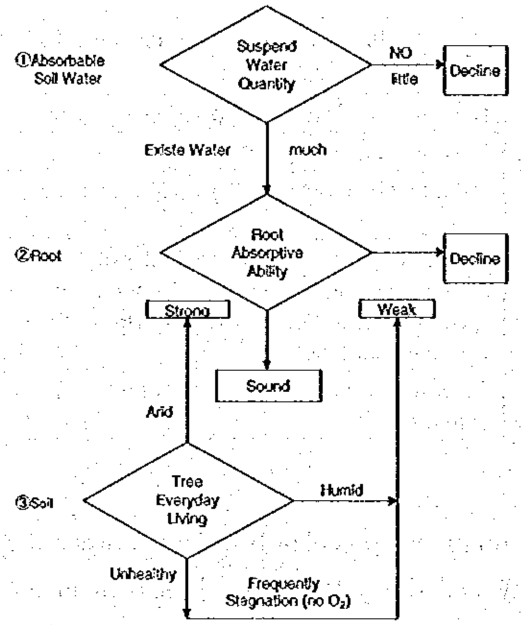


Fig. 2-6-11 Mechanism of Forest Decline

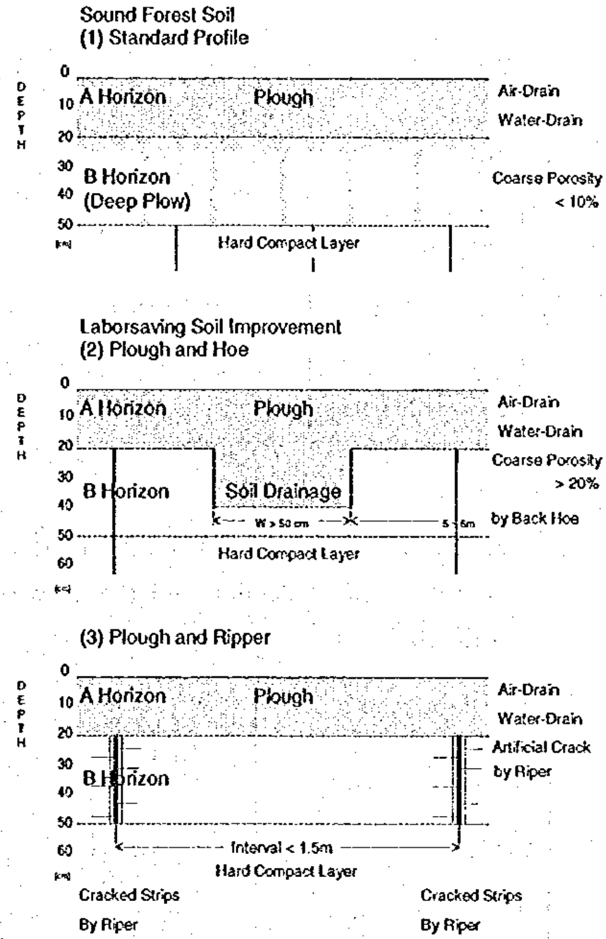


Fig. 2-6-12 Soil Improvement

2.6.2 Area of Declined Forests

(1) Interpretation of Aerial Photographs

The purpose of aerial photograph interpretation is to establish the location, area and degree of decline of forests and the causes of forest decline. Another purpose is to retrieve information to help specify the necessary forestry work to restore the health of declined forests. The aerial photographs used for the Study were those taken in July, 1998 by a local company subcontracted by the Study Team.

The required data on the aerial photographs is determined based on the relationship between information appearing on the near-infrared colour photographs and the results of the field survey on forest conditions. Information on the near-infrared colour photographs and the field survey results show the following correspondence.

Item	Field Survey Item	Factor Interpreted on Aerial Photographs
Location/Area	Confirmation on topographical map	Determined on photographs
Species	Actual observation	Determined by crown form and colour tone
Tree Height	Actual observation	Measured on photographs
Crown Density	Calculated after preparing a crown projection diagramme	Measured by crown density measuring plate
Decline Grade	Actual observation	Determined based on the crown density, ratio of declined trees, topography, location and species (refer to Forest Inventory Book of the RNP); colour tone
Causes of Decline	Confirmation on site	Refer to Forest Inventory Book of the RNP; colour tone

As described in 2.4.3-(2) and 2.6.1-(4), a close relationship is clearly found between the degree of stand decline and the crown density and this relationship is shown in the following table.

	Crown Coverage Ratio (Ground Survey)	Crown Density (Aerial Photographs)	Crown Diameter
Decline Grade Strong	Low 29%	36%	Small 3.5 m
Decline Grade Moderate	Medium 41%	51%	Medium 4.0 m
Decline Grade Weak	High 48%	60%	Large 5.0 m

Notes

1. The percentage figures for crown coverage ratio are based on the field survey results.
2. The crown diameter figures are average of 40 year old through 60 year old *Quercus* spp. stands

Based on the results of the above field survey and surveys featuring other study fields, the aerial photograph interpretation criteria of declining forests mainly due to drought were established as shown in Table 2-6-1. The use of the crown density and tree height as interpretation criteria was decided by the following reasons.

- The field survey found that a stand with a low crown density shows a high degree of decline.

- Many declining stands are stands of 40 - 80 years of age, indicating the importance of using a factor which reflects the stand age to determine the degree of decline. A factor which can be interpreted on the aerial photographs is the tree height.

The range of classes for each criterion, i.e. crown density and tree height, was determined in the following manner.

- Crown Density

A crown density measuring plate was used to measure the crown density by means of aerial photograph interpretation for the Study. While the minimum value of this plate which can be interpreted was 5%, the range of crown density classes was set at 10% in view of the scale of the aerial photographs used for the Study (1: 12,500).

- Tree Height

A parallax bar was used to measure tree height on the aerial photographs. While the tree height could measure in units of 1 m, 5 m was used for the height class range in view of the scale of the aerial photographs used for the Study (1: 12,500).

Table 2-6-1 Aerial Photograph Interpretation Criteria

Classification by Crown Density Class	I	39% or less
	II	40 - 49%
	III	50 - 59%
	IV	60% or more
Classification by Tree Height Class	A	4 m or less
	B	5 - 9 m
	C	10 - 14 m
	D	15 - 19 m
	E	20 m or more

(2) Forest Area Subject to the Plan

Forests subject to the Plan were classified on the basis of the general assessment results of the tree height and crown density class established by the aerial photograph interpretation, topographical analysis results using topographical maps and other survey results in the related fields.

A damaged forest is defined as a stand which meets all of the following conditions.

- Stand of *Quercus* spp., *Fraxinus excelsior* or another broad-leaved species with an age of from 10 to 100 years
- Stand of *Robinia pseudoacacia, Populus* spp. with an age of from 10 to 25 years
- Stand of which the proportion of standing trees with a decline grade of 2 or higher is 20% or more.
- Stand 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 ratio (crown coverage ratio = 0.8 x crown density)
- Stand of which a minimum area of 0.1 ha has declined

Prevention forest is defined as a stand which meets all of the following conditions.

- Stand at a middle or high terraces and adjacent to damaged forests
- *Quercus* spp. stand of mainly between 35 and 65 years of age
- Stand of which the soil is Chromic Luvisols (LVx), Vertic Luvisols (LVv), Albic Luvisols (LVa), Stagni-Vertic Luvisols (LVv-j), Haplic Luvisols (LVh), Vertic-Chromic Luvisols (LVx-v), Cambisols (CM), Chermozems (CH), Phaeozems (PH)
- Stand with trees of which the decline grade is less than 2 and which has an area of at least 0.1 ha
- Stand with an inclination of 3 degrees or less

The degree of damage to damaged forests was further classified as high, medium and low damage, mainly based on the crown density. The results of the above classification are summarised below.

Damaged Forests	Strong	Ratio of declined trees: 60% or more
	Moderate	Ratio of declined trees: 40 - 59%
	Weak	Ratio of declined trees: 20 - 39%
Prevention Forests	Minor Decline	*Quercus* spp. stands at Middle and High Terraces

1) Damaged Forests

For the purpose of the Study, forests to be restored are defined as damaged forests.

The total area subject to forest restoration by forest branch office and also by the geographical Part of the Study Area is shown in Table 2-6-2 and Table 2-6-3 respectively. The grand total area of damaged forests is 9,204 ha which accounts for 7.9% of the total national forest area of the Study Area. The corresponding figures for Olt County and Dolj County are 6.7% and 8.7% respectively.

The damage grade is weak in the case of stands located at flood plains or low terraces along Danube River, Olt River and Jiu River. The same is true in the case of stands at flood plains or low terraces along tributaries of the above major rivers where river water flows during normal times.

Those stands located at plains of middle and high terraces with a low groundwater level are often declining although the damage grade varies from one such stand to another depending on the micro-topography of the specific forest land. Stands along valleys with a better water environment generally show weak damage grade than those on flat land.

The relationship between the geographical Part/topography and the distribution of declining stands is outlined below.

Location of Declining Stand	Degree of Damage	Main Species
- Shoulder and top sections of hills in North Part	Weak	Qf, Qc, Qp
- Sloping sections of hills in North Part	Moderate	Rp
- Sloping sections of hills in North Part	Weak	Qf, Qc, Qp
- Foot section of hills in North Part	Minor	Qf, Qc, Qr, Fe
- Plain forests lying between Middle and North Parts	Weak	Qf, Qc, Qp
- Plain forests at middle and high terraces in Middle Part	Strong	Qf, Qc, Qp
- Plain forests at gently sloping sections of middle and high terraces in Middle Part	Weak	Qf, Qc, Qp
- Plain forests at low to middle terraces with sandy soil	Strong	Rp
- Plain forests at low terraces	Moderate	Qf, Qc, Fe

Table 2-6-2 Area of Damaged Forests by Damage Grade and Forest Range Office

(ha)
(%)

County	Forest Range Office	Forest Area	Damage Area			Total
			Strong	Moderate	Weak	
Olt	Bals	12,110.0	193.5	366.6	1,116.0	1,676.1
			1.6	3.0	9.2	13.8
	Caracal	4,934.0	125.4	65.6	28.6	219.6
			2.5	1.3	0.6	4.5
	(Corabia)	4,235.0		5.7	2.5	8.2
				0.1	0.1	0.2
	Slatina	9,825.0	74.5	335.8	327.4	737.7
			0.8	3.4	3.3	7.5
	(Draganesti-Olt)	4,629.0	41.8	102.9	52.2	196.9
			0.9	2.2	1.1	4.3
	Vulturesti	7,265.0	5.8	19.9	1.6	27.3
			0.1	0.3	0.0	0.4
Sub Total		42,998.0	441.0	896.5	1,528.3	2,865.8
			1.0	2.1	3.6	6.7
Dolj	Amaradia	10,722.0	44.5	355.5	63.0	463.0
			0.4	3.3	0.6	4.3
	Calafat	6,942.0	101.8	18.7		120.5
			1.5	0.3		1.7
	(Poiana Mare)	6,929.0	3.7			3.7
			0.1			0.1
	Craiova	11,667.0	519.9	598.7	202.1	1,320.7
			4.5	5.1	1.7	11.3
	Filiasi	9,163.0	49.0	177.3	231.1	457.4
			0.5	1.9	2.5	5.0
	Perisor	9,461.0	427.1	1,016.1	1,529.7	2,972.9
			4.5	10.7	16.2	31.4
	Sadova	6,356.0	12.8	9.9	17.9	40.6
			0.2	0.2	0.3	0.6
	(Apele Vii)	3,849.0	184.9	117.2	223.8	525.9
			4.8	3.0	5.8	13.7
	Segarcea	7,718.0	117.4	184.8	131.3	433.5
			1.5	2.4	1.7	5.6
Sub Total		72,807.0	1,461.1	2,478.2	2,398.9	6,338.2
			2.0	3.4	3.3	8.7
Total		115,805.0	1,902.1	3,374.7	3,927.2	9,204.0
			1.6	2.9	3.4	7.9

Table 2-6-3 Area of Damaged Forests by Damage Grade, Forest Range Office and Geographical Part

(ha)
(%)

	Forest Range Office	Forest Area	Damage Area			Total
			Strong	Moderate	Weak	
North Part	Vulturesti	7,265.0	5.8	19.9	1.6	27.3
			0.1	0.3	0.0	0.4
	Amaradia	10,722.0	44.5	355.5	63.0	463.0
			0.4	3.3	0.6	4.3
	Filiasi	9,163.0	49.0	177.3	231.1	457.4
			0.5	1.9	2.5	5.0
Sub Total		**27,150.0**	**99.3**	**552.7**	**295.7**	**947.7**
			0.4	**2.0**	**1.1**	**3.5**
Middle Part	Bals	12,110.0	193.5	366.6	1,116.0	1,676.1
			1.6	3.0	9.2	13.8
	Slatina	9,825.0	74.5	335.8	327.4	737.7
			0.8	3.4	3.3	7.5
	(Draganesti-Olt)	4,629.0	41.8	102.9	52.2	196.9
			0.9	2.2	1.1	4.3
	Craiova	11,667.0	519.9	598.7	202.1	1,320.7
			4.5	5.1	1.7	11.3
	Perisor	9,461.0	427.1	1,016.1	1,529.7	2,972.9
			4.5	10.7	16.2	31.4
Sub Total		**47,692.0**	**1,256.8**	**2,420.1**	**3,227.4**	**6,904.3**
			2.6	**5.1**	**6.8**	**14.5**
South Part	Caracal	4,934.0	125.4	65.6	28.6	219.6
			2.5	1.3	0.6	4.5
	(Corabia)	4,235.0		5.7	2.5	8.2
				0.1	0.1	0.2
	Calafat	6,942.0	101.8	18.7		120.5
			1.5	0.3		1.7
	(Poiana Mare)	6,929.0	3.7			3.7
			0.1			0.1
	Sadova	6,356.0	12.8	9.9	17.9	40.6
			0.2	0.2	0.3	0.6
	(Apele Vii)	3,849.0	184.9	117.2	223.8	525.9
			4.8	3.0	5.8	13.7
	Segarcea	7,718.0	117.4	184.8	131.3	433.5
			1.5	2.4	1.7	5.6
Sub Total		**40,963.0**	**546.0**	**401.9**	**404.1**	**1,352.0**
			1.3	**1.0**	**1.0**	**3.3**
Total		**115,805.0**	**1,902.1**	**3,374.7**	**3,927.2**	**9,204.0**
			1.6	**2.9**	**3.4**	**7.9**

2) Prevention Forests

For the purpose of the Study, forests of which the decline should be avoided are defined as prevention forests.

The total area of prevention forests by forest range office and also by the geographical Part of the Study Area is shown in Table 2-5-4 and Table 2-5-5 respectively. The grand total area of prevention forests is 4,074.3 ha.

Table 2-6-4 Area of Prevention Forest by Forest Range Office

County	Forest Range Office	Forest Area (ha)	Area (ha)	Rate (%)
Olt	Bals	12,110.0	837.3	6.9
	Caracal	4,934.0	292.6	5.9
	(Corabia)	4,235.0	2.6	0.1
	Slatina	9,825.0	438.9	4.5
	(Draganesti-Olt)	4,629.0	177.0	3.8
	Vulturesti	7,265.0	25.5	0.4
Sub-Total		42,998.0	1,773.9	4.1
Dolj	Amaradia	10,722.0	354.2	3.3
	Calafat	6,942.0	0.0	0.0
	(Poiana Mare)	6,929.0	0.0	0.0
	Craiova	11,667.0	705.4	6.0
	Filiasi	9,163.0	145.9	1.6
	Perisor	9,461.0	1,060.6	11.2
	Sadova	6,356.0	0.0	0.0
	(Apele Vii)	3,849.0	2.6	0.1
	Segarcea	7,718.0	223.0	2.9
Sub-Total		72,807.0	2,491.7	3.4
Total		115,805.0	4,265.6	3.7

Table 2-6-5 Area of Prevention Forest by Geographical Part

County	Forest Range Office	Forest Area (ha)	Area (ha)	Rate (%)
North Part	Vulturesti	7,265.0	25.5	0.4
	Amaradia	10,722.0	354.2	1.6
	Filiasi	9,163.0	145.9	1.6
Sub-Total		27,150.0	525.6	1.9
Middle Part	Bals	12,110.0	837.3	6.9
	Slatina	9,825.0	177.0	3.8
	(Draganesti-Olt)	4,629.0	438.9	4.5
	Craiova	11,667.0	705.4	6.0
	Perisor	9,461.0	1,060.6	11.2
Sub-Total		47,692.0	3,219.2	6.7
South Part	Caracal	4,934.0	292.6	5.9
	(Corabia)	4,235.0	2.6	0.1
	Calafat	6,942.0	0.0	0.0
	(Poiana Mare)	6,929.0	0.0	0.0
	Sadova	6,356.0	0.0	0.0
	(Apele Vii)	3,849.0	2.6	0.1
	Segarcea	7,718.0	223.0	2.9
Sub-Total		40,963.0	520.8	1.3
Total		115,805.0	4,265.6	3.7

(3) Accuracy of Aerial Photograph Interpretation

The photograph resolution power is determined by how many parallel lines with a uniform width can be discerned within a 1 mm long section on a photograph. The resolution power indicates the level of clarity of the photograph. The resolution of the negative film used for aerial photograph for the Study is 63 lines/mm (KODAK CIR 2443/Test object contrast: 1,000: 1). In general, the resolution power of positive film is 80% that of negative film.

Aerial photographs with a scale of 1:12,500 were used for the Study to interprete declined forests. With this scale, a canopy size of 5 m is reproduced as 0.4 mm on the photograph. Trebled images can be gained by stereoscopic binoculars. While it is impossible with a scale of 1:12,500 to interprete the dieback of a single tree, it is possible to interprete the crown density using a stand as the interpretation unit. For the Study, damaged forests and prevention forests were differentiated from mainly on the basis of the crown density interpreted on the aerial photographs. The correlation coefficient of the crown density values based on the ground survey and aerial photograph interpretation was calculated to be $R = 0.9397$. This result suggests that the interpretation accuracy of the crown density under the Study is adequate (Fig. 2-6-13).

Interpretation error of the crown density using aerial photographs tends to occur in the following manner.

o Incorrect interpretation of the crown density regarding old and high stands

- The crown density often appears to be sparser than the actual density.

o Incorrect interpretation of a stand with a large relative stem density

- The crown density often appears to be sparser than the actual density.

o Incorrect interpretation of a stand with a reduced crown due to dieback

- The crown density often appears to be sparser than the actual density.

o Incorrect interpretation of a stand with dense lower-story trees and shrubs

- The crown density often appears to be denser than the actual density.

o Incorrect interpretation of a stand with sparse lower-story trees and shrubs

- The crown density often appears to be sparser than the actual density.

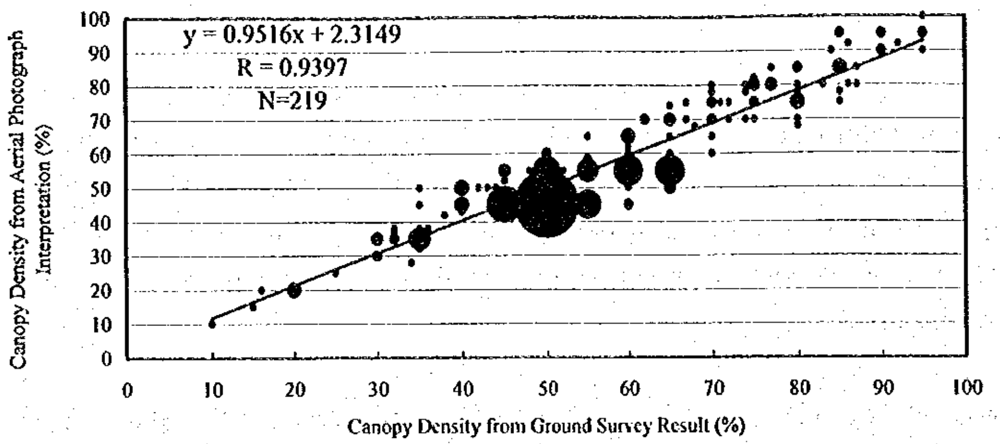


Fig.2-6-13 Aerial Photograph Interpretation Result
Remarks: Dot size indicates the number of data.

2.7 Initial Environmental Examination (IEE)

An IEE was conducted in Dolj County and Olt County to clarify the prospect of harmful influence on the environment through screening (Table 2-7-1).

Screening was conducted in regard to various social and natural environment aspects of the Plan which will be formulated based on the findings of the Study in a comprehensive manner. As the principal issue of the Study is the establishment of reforestation measures to restore decline forests, no problematic impacts on the environment are anticipated. Nevertheless, it is necessary to check whether any negative impacts on the environment will be caused if the implementation of forest restoration measures suggests the possibility of such impacts. There is concern in regard to negative impacts on the environment by chemical pesticides used for pest control. However, any environmental contamination due to insect control will be alleviated by the employment of a biological pest control method using a microbacterial pesticide to ensure the conservation of biological diversity.

The implementation of the Plan will facilitate the restoration of declining forests using species which are adapted to the local environment. In addition, the improved wind control function of forest belts will prevent surface soil drift from farmland, presumably increasing the yield of agricultural products. Moreover, the water yield function as well as landscape conservation function of forests will be improved.

The final assessment is that the realisation of the Plan will improve the value and positive effects of forests as environmental resources in addition to their being a pool of productive resources.

Table 2-7-1 IEE Screening Items

(1/2)

Primary Environmental Factor (Viewpoint)	Secondary Environmental Factor (Examples of Possible Environmental Impact)	Assessment Result	Remarks (Reasons for Assessment Result)
I. Social Environment 1. Social Life Possible impacts on existing aspects of local social life, including daily life, economic activities, transport, community, systems and customs, etc.	- Change of lifestyle - Conflict among people - Transfer of economic activity base - Bad influece on indigenous people, ethnic minorities and nomadic people - Population increase - Change of economic activities/unemployment - Sudden change of demographic structure - Widening of income gap - Readjustment of common rights to forest utilization - Reform of existing systems and customs - Change of social structure through grouping, etc.	None	Implementation of the Plan will enhance the environmental resources of forests in addition to productive resources, improving local social life. Careful examination of expansion of the forest land will be required.
2. Health and Hygiene Possible impacts on the state of health of local people and diseases related to forests	- Increased use of pesticide - Outbreak of local diseases - Spread of infectious diseases - Accumulation of residual agrochemicals - Increased household and human waste	None	Insect damage will be controlled by biological control, mitigating the adverse impacts of pesticide on the environment.
3. Historic Remains, Cultural Heritage and Landscape, etc. Presence of invaluable areas in terms of history, archaeology, landscape and science, etc. or areas of special social value	- Damage/destruction of historical remains and cultural heritage, etc. - Loss of rare landscape - Impacts on underground resources	None	Implementation of the Plan will enhance the conservation of the natural landscape.
II. Natural Environment 4. Rare Wildlife Habitat and Ecosystem Presence of areas of rare wildlife and ecosystem	- Vegetational changes - Invasion by and propagation of harmful living creatures - Decline or extinction of rare species and endemic flora and fauna - Disappearance of swamps and peat moors - Decline of biological diversity - Degradation of natural forests	None	Decline forests will be restored by right tree vis-a-vis the local environment, improving the forest ecosystem.

(2/2)

Primary Environmental Factor (Viewpoint)	Secondary Environmental Factor (Examples of Possible Environmental Impact)	Assessment Result	Remarks (Reasons for Assessment Result)
5. Soil and Land Likelihood of land devastation, soil erosion and soil contamination, etc.	- Decline of soil fertility - Soil erosion - Soil contamination - Land devastation (including desertification) - Occurrence of landslides - Decline of wind control function - Acidification of soil - Salinisation of soil	None	Implementation of the Plan will enhance the wind control and soil erosion prevention functions
6. Hydrology and Atmosphere, etc. Possible impacts on surface water, such as rivers and lakes, groundwater and the atmosphere, etc.	- Change of flow regime of surface water (water level) - Change of flow regime and groundwater level - Occurrence of drought or flooding - Lowering of riverbed - Sedimentation - Eutrophication - Water contamination and decline of water quality - Incursion of salt water - Impacts of ships - Air pollution - CO_2 generation - Microclimatic change - Occurrence of noise	None	Implementation of the Plan will increase the water infiltration capacity of the soil, improving the water resources conservation function
7. Sustainability of Forest Resources and Functions Destructive impacts on sustainability of forest resources and public benefit functions	- Discontinued sustainability of forest resources - Discontinued sustainability of environmental conservation function of forests	None	Implementation of the Plan will enhance various forest functions originating from environmental resources in addition to wood productive function
General Assessment		No need for special measures	