As for Olt County, there is a little augmenting trend of the vegetation stress in the northern forest area in the Study Area. As for the forest located in the northwestern Slatina and northeastern Caracal, the stress increased slightly from 1990 to 1997.

These spectral changes of vegetation can be seen on each false-color image.

The results from the analysis using LANDSAT/TM data were put to practical use to select vegetation survey areas and forest survey plots, and also used as some materials for the decision of soil survey area at the third field survey. The survey area selected by detecting areas with remarkable temporal change in the vegetation stress and by reviewing the information of the deteriorated forest distribution obtained from counterpart personnel.

In the third field survey, the relationship between the vegetation stress change and the extent of forest deterioration was confirmed by the Study Team. There was some distinguished vegetation stresses in the deteriorated forests. However, the correlation between the stresses and forest condition was not clear in areas with low stress. LANDSAT/TM was found to be useful, and the image analysis was effective when the Study Area is larger, as in the Study, to grasp overall distribution and condition of forests.

2.4.3 Forest Composition

(1) Forest Stand Composition and Forest Decline Fact-Finding

A belt-transect survey to classify forests into forest vegetation types was conducted at 32 survey plots in 19 forests shown in App. D-1 and App. D-2. App. D-3 shows the results of the belt transect survey for 11 forest vegetation types. At the same time, a forest decline fact-finding survey was conducted at the 22 plots shown in App.D-1 and App. D-6. A forest decline fact-finding survey was also conducted at the belt-transect survey plots using belt-transect survey stands.

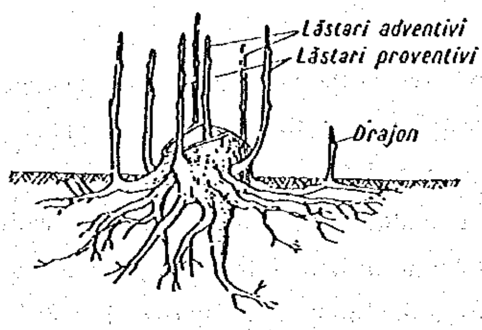
1) Stand Composition of Natural Forests

① Types of Natural Regeneration

Of the 32 survey plots where the belt-transect survey was conducted to classify forest vegetation types, 30 plots are natural forests with the exception of plantations of *Populus* spp. and *Robinia pseudoacacia.* These forests have been formed by natural regeneration and *Quercus* spp. is the main species. However, they can be classified as stands regenerated by seedlings and stands regenerated by coppicing. The former are the result of natural regeneration by seeding while the latter are further classified as those regenerated by coppice shoots and those regenerated by root suckers.

In Romania, coppicing is classified as coppice shoot (*Lastar*) and root sucker (*Drajon*) based on the section of coppicing and the types of coppicing for each *Quercus* species is identified as shown below.

Types of Coppicing



(by E.G. Negulescu)

Types of Coppicing by *Quercus* Species

Species	Lastar	Drajon
Q. cerris	O	△ X
Q. frainetto	O	O
Q. petraea	O	X
Q. robur	O	X
Q. pedunculiflora	O	X
Q. pubescens	O	△

Legend
O : abundant
△ : few
X : none

(Flora forestiera lemnoasa a romaniel, Victa Stanescu)

The relationship between the types of coppicing and forest decline is shown in Table 2-4-6. The survey sheets reveal that the degree of decline with root sucker is less than that with coppice shoots at Perisor UP III 57A and Craiova UP I 81B. However, no clear relationship between the difference in coppicing type and forest decline is established not only for *Q. frainetto* but also for *Q. cerris* and *Q. pubescens* at Vulturesti UP III 43D and Slatina UP V 32C.

Nevertheless, damage due to decaying bacilli was often found at trees regenerated by coppice shoot. In terms of species, the degree of decline of trees regenerated by coppice shoot is higher for *Q. frainetto* than *Q. cerris*. In short, it is judged that the general relationship between coppicing and forest decline is that trees regenerated by coppice shoot are more prone to decline that trees regenerated by root sucker.

The distinction between trees regenerated by root sucker and trees regenerated by natural seeding can be established for saplings but is difficult for mature trees. Table 2-4-7 shows the survey results for regenerated *Q. frainetto* saplings. According to this survey, the actual position of root sucker is within a 1.8 m radius of the mother tree.

Table 2-4-6 Relationship Between Each Regeneration and Its Declining Grade

(1) Perisor UP III ua.57A

Species	Coppice shoots						Seedlings/Root suckers						Total
	Decline grade					Sub total	Decline grade					Sub total	
	0	1	2	3	4		0	1	2	3	4		
Q.frainetto		1	2	2		5			1			1	6
Q.cerris	5	21	2		1	29							29
Q.pubescence			7			7			2	3		5	12
Q.pub.+Q.f.			4	1	1	6							6
Total	5	22	15	3	2	47	0	0	3	3	0	6	53

Note: *Q.pub+Q.f* means hybrid of *Q.pubescens* and *Q.frainetto*

(2) Craiova UP I ua.81B, Criva forest

Species	Coppice shoots						Seedlings/Root suckers						Total
	Decline grade					Sub total	Decline grade					Sub total	
	0	1	2	3	4		0	1	2	3	4		
Q.frainetto		6	12	3		21		4				4	25
Q.cerris		2				2							2
Total	0	8	12	3	0	23	0	4	0	0	0	4	27

(3) Vulturesti UP III ua.43D, Topana forest

Species	Coppice shoots						Seedlings/Root suckers						Total
	Decline grade					Sub total	Decline grade					Sub total	
	0	1	2	3	4		0	1	2	3	4		
Q.frainetto			6	2		8		4	13	7		24	32
Q.cerris		2	5	3		10		3	6	2		11	21
Total	0	2	11	5	0	18	0	7	19	9	0	35	53

(4) Slatina UP V ua.32C, Seaca Optasani forest

Species	Coppice shoots						Seedlings/Root suckers						Total
	Decline grade					Sub total	Decline grade					Sub total	
	0	1	2	3	4		0	1	2	3	4		
Q.frainetto		4	4	1		9		10	7	1		18	27

Table 2-4-7 Types of regeneration (Craiova UP I ua.68, Criva forest)

Plot	Number of regenerated trees	Distance from mother tree (m)	Height of regenerated trees (m)	Types of regeneration		
				Root (Drajon)	Stump (Lastar)	Seed
1	1	0.80	0.16	O		
	2	0.90	0.16	O		
	3	1.00	0.20	O		
	4	1.20	0.72	O		
	5	1.40	0.32	O		
	6	1.60	0.35	O		
	7	1.70	0.57	O		
	8	2.30	0.17			O
	9	3.00	0.24			O
	10	3.10	0.27			O
2	1	0.30	1.75		O	
	2	1.10	1.75			O
	3	1.20	0.80			O
	4	1.80	0.60			O
	5	2.40	1.80			O
	6	2.60	2.80			O
3	1	0.60	2.20	O		
4	1	0.70	0.90	O		
5	1	0.55	0.53	O		
	2	0.68	0.28	O		
	3	0.95	1.20	O		
	4	1.10	0.66	O		
6	1	0.40	2.40		O	
7	1	1.00	0.70	O		
8	1	0.30	0.90		O	
9	1	0.30	1.25		O	
10	1	1.80	0.50	O		
	2	1.80	0.50	O		
	3	1.80	0.50	O		
11	1~20	0.70	0.20~0.90	O		
	1~6	1.50	0.20~0.50	O		
	1~8	1.60	0.20~0.55	O		
12	1~12	1.20	0.10~0.43	O		

Note: *Q.frainetto*

② Formation of Natural Forests

Close observation of the 30 stands reveals that some have been created by seeding, some have been established by coppicing and some show a mixture of these two types of regeneration. The No. 13 belt-transect survey plot at Tarnava is an example of a mixed stand of *Q. cerris* and *Q. frainetto* regenerated by coppicing [Fig. 2-4-3-(1) and Table 2-4-8-(1)] while the No. 26 belt-transect survey plot at Vladila is an example of a *Q. pedunculiflora* stand regenerated by coppicing [Fig. 2-4-3-(2) and Table 2-4-8-(2)]. Broad-leaved species which are mixed with *Quercus* spp. are mainly *Fraxinus excelsior, F. ornus, Acer campestre, A. negundo, Ulmus minor, U. laevis, Tilla platyphyleos, T. argentea, Pyrus pyraster and Crataegus monogyna*. The results of the belt-transect survey suggest that the height of the trees observed at these plots ranges from 15 m to 35 m with a maximum dbh of 116 cm and a density per ha of 160 - 1,360 trees.

The number of regenerated seedlings by natural seeding found in the belt-transect survey plots is shown in App.D-4. At least 100,000 seedlings per ha at the initial stage of regeneration are required to expect the successful growth of a stand by means of regeneration by natural seeding with 30,000 - 40,000 seedlings per ha surviving after five years (Morio Imada, Study on Method to Produce Structural Timber from *Quercus mongolica* var. *grosseserrata*, 1972). *Quercus* spp. which produce the highest number of seedlings in the survey plots are *Q. cerris* and *Q. petraea*. The number of seedlings of *Q. frainetto* and *Q. robur* is a maximum of 10,000 - 20,000 per ha. Among broad-leaved trees other than *Quercus* spp., *Fraxinus excelsior* produces the highest number of seedlings, followed by *Acer campestre* and *Tilia argentea*.

Table 2-4-8 Observable Species and Summed Dominance Ratio of the Belt-transects
(1) Mixed forest *Q.cerris* and *Q.frainetto* by coppicing (No. 13, Tirnava forest)

Species	Number of trees		Tree height class (m)												Total height (m)	Total covered area (m²)	Summed dominance ratio (%)
	Number	%	2	3	4	6	8	9	10	15	16	17	18	20			
Quercus frainetto (Qf)	11 (5)	35.3	1 (1)	1 (1)	1 (1)	1 (1)	1		2 (1)		2		2		85	87.3	23.1
Quercus cerris (Qc)	11	5.9								4		1	5	1	187	166.7	47.5
Quercus pubscens (Qpub)	4 (1)	5.9											2	2 (1)	56	61.6	15.7
Euonymus europaeus (Ee)	1	35.3					1								8	12.8	2.8
Pyrus pyraster (Pp)	1	5.9				1									6	14.1	2.7
Crataegus monogyna (Cm)	1	5.9				1									6	14.4	2.7
Prunus spinosa (Ps)	1	5.9						1							9	32.3	5.5
Total	30 (6)	100.1	1 (1)	1 (1)	1 (1)	3 (1)	2	1	2 (1)	4	2	1	9	3 (1)	358	389.2	100.0

Note: Diameter of breast height (cm): 8-90

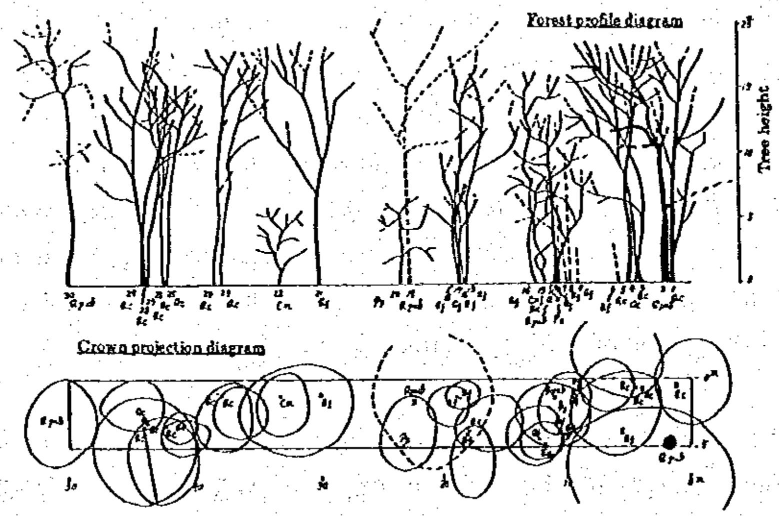


Fig. 2-4-3 Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(1) Mixed forest *Q.cerris* and *Q.frainetto* by coppicing (No. 13, Tirnava forest)

Table 2-4-8 Observable species and summed dominance ratio of the Belt-transects
(2) Regeneration by coppicing of *Q.pedunculiflora* (No. 26, Vladila forest)

Species	Number of trees		Tree height class (m)				Total height (m)	Total covered area (m²)	Summed dominance ratio (%)
	Number	%	13	15	16	17			
Quercus pedunculiflora (Qped)	14	100.0	4	1	4	5	216	285.6	100.0
Total	14	100.0	4	1	4	5	216	285.6	100.0

Note: Diameter of breast height (cm): 22-34

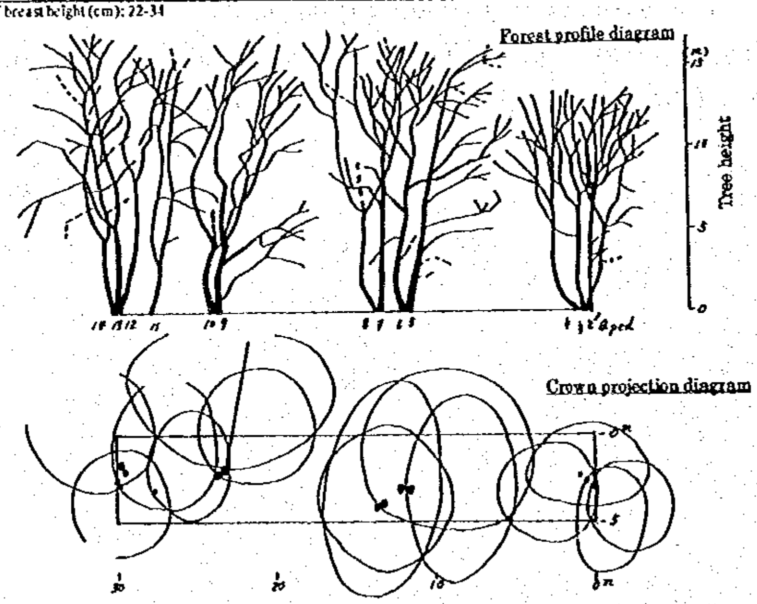


Fig. 2-4-3 Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(2) Regeneration by coppicing of *Q.pedunculiflora* (No. 26, Vladila forest)

③ Growth of Root System

A root system survey was conducted at a declined forest at Craiova UP I 81B and Craiova UP IV 142C (Table 2-4-9) to obtain information on the state of root system growth with a view to conducting drainage and infiltration work.

Table 2-4-9 Root Distribution

Forest name	Species	No.	Tree height (m)	DBH (cm)	Degree of decline	Lateral roots Number (1mx1m)	Lateral roots Thickness (cm)	Lateral roots Depth of distribution (cm)	Tap roots Depth (m)	Tap roots Thickness of 1m Depth (cm)	Vital activity of fine roots
Cosoveni	*Q.frainetto*	1	12	15	2~3	36	10.8	10~60	more than 2m	50	Low
		2	12	18	2~3	23	10.4	10~60	more than 1.5m	20	Low
Criva	*Q.frainetto*	1	12	18	2~3	24	33.7	10~60	more than 1m	19	Low
		2	11	20	1	29	33.4	10~60	more than 1m	24	Moderate
		3	10	16	2~3	22	25.9	10~60	more than 1m	35	Low
ICAS	*Q.robur*	1	25	26	0	35	15.5	10~60	more than 1.5m	-	High

The root system of the declined forest of *Q. frainetto* (tree height of 10 - 12 m; dbh of 16 - 20 cm) has a thick main root at deeper than 1.5 - 2 m. The lateral root density is 22 - 36 roots per m^2 of the soil profile and many are found at a depth of 10 - 60 cm. The surveyed tree of with a decline grade of 3 has less fine roots that the surveyed tree with a decline grade of 1, indicating a lower level of vigorousity.

Comparison between the state of root growth of the surveyed trees and that of a healthy *Q. robur* stand at the ICAS experimental forest found that the vigorousity of fine roots at the ICAS experimental forest was higher than that of the surveyed trees of declined forests, suggesting that the vigorousity of fine roots is affected by the degree of decline of standing trees.

The soil hardness at the root system survey sites is shown in Table 2-4-10. The hardness index measured by *Yamanaka's Soil Hardness Tester* at Criva and Cosoveni shows a high value of 26 - 28 mm below 30 cm of the soil profile. At these sites, the tight clayey soil maintained the moisture absorbed by the soil during the dry weather spell in the second half of the 1980's with the trees surviving this drought but that such moisture was spent at the time of the extremely abnormal dry weather in the early 1990's, making it impossible for the trees to survive.

When drainage and infiltration work is conducted, its distance of 1 - 1.5 m from a tree with a depth of 20 - 25 cm is believed to cause little damage to the root system.

Table 2-4-10 Soil Hardness on the Plots of Root Systems Survey

Forest name	Species	Soil hardness of each soil depth (mm)			
		10 cm	30 cm	50 cm	80 cm
Cosoveni	*Q.frainetto*	23	28	27	28
Criva	*Q.frainetto*	13	26	26	27
ICAS	*Q.robur*	21		25	25

Note: Measured by *Yamanaka's Soil Hardness Tester*

Hardness index (mm)	Root growrh
Less than 23	Easily
23~26	Possible
27~30	Difficult
31~40	Impossible

2) Composition of Artificial Stands

Quercus spp., the main species observed in Dolj and Olt Counties, mainly forms naturally regenerated stands. In the case of artificial stands created by artificial seeding or the planting of seedlings, many stands are noticeably young. Among these artificial stands, the survey was conducted on a planted *Q. robur* stand and directly seeded *Q. frainetto* stand.

Fig. 2-4-3-(3) and Table 2-4-8-(3) show the survey results for a 45 year old artificial stands mainly consisting of *Q. robur*. Of the accompanying species observed, *Q. frainetto* was regenerated by coppicing from the roots and *Q. petraea* was planted. The tree density of this stand is 1,180 trees per ha and the crown density is 85%. The average decline grade of the main species, i.e. *Q. robur*, is 1.7 although 35% of *Q. robur* show a decline grade of 2.0 - 4.0, illustrating the need for forest restoration. The tree height of the surveyed trees ranges from 6 m to 17 m and the relation between the tree height class and decline grade shows that most *Q. robur* and *Q. frainetto* trees in the lower story (6 m - 11 m class) show a high decline grade of 2.0 - 4.0. In contrast, the proportion of trees showing a high decline grade of 2.0 - 4.0 of 28.6% is not that high in the upper story (12 m - 17 m class).

Fig. 2-4-3-(4) and Table 2-4-8-(4) show data for a directly seeded 33 year old *Q. frainetto* stand. The number of trees per ha is 1,680 with a crown density of 72%.

The average decline grade of this stand is 1.7 with 29.3% of the trees showing a decline grade of 2.0 - 4.0. There is a strong correlation between the tree height class and decline grade as all of the trees in the lower story (5 - 6 m class) fall in the high decline grade range of 2.0 - 4.0. In the upper story (7 - 10 m class), many trees of low tree height class show a high decline grade. (Note: See 2-4-3 (1) 4) for a desription of average decline grade).

3) Non-*Quercus* spp. Artificial stands

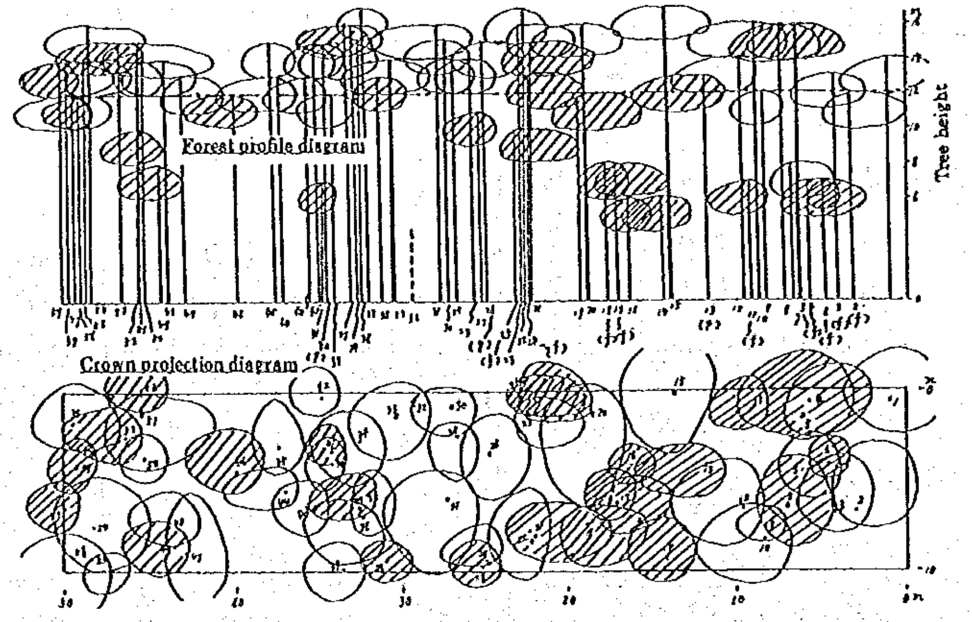
① *Robinia pseudoacacia* and *Populus* spp.

The main non-*Quercus* spp. artificial stands in Olt and Dolj Counties are huge artificial stands of *Robinia pseudoacacia* and *Populus* spp. *R. pseudoacacia* is imported from North America while *Populus euroamericana*, a mixed species between European and American species, is common in the case of *Populus* spp. stands. I-214 which is used as a breeding species is a clone which was developed in Italy and is a recommended species because of its excellent growth.

The No. 15 belt-transect survey plot is an example of *R. pseudoacacia* at Madona under the jurisdiction of the former Apele Vii Forest Range Office and has been established through regeneration by coppicing from planted *R. pseudoacacia* [Fig. 2-4-3-(5) and Table 2-4-8-(5)]. The original interval for the planted seedlings was 4 m between rows and 2 m between seedlings and the present tree height is in the 12 - 15 m class. Similarly, the No. 14 belt-transect survey plot is another example of *R. pseudoacacia* at Celaru, again in an area under the jurisdiction of the former Apele Vii Forest Range Office [Fig. 2-4-3-(6) and Table 2-4-8-(6)] and the height of the upper story trees of this stand is as high as 15 m - 20 m. These *R. pseudoacacia* stands are inland dune forests located far from the Danube River and, therefore, the water environment is believed to be poor. The grade of die back of these stands of 2.9 for the No. 15 survey plot and 3.0 for the No. 14 survey plot is high. Compared to these R. pseudoacacia stands in the Apele Vii area, the *R. pseudoacacia* coppice stands at Desa near the Danube River in areas under the jurisdiction of the former Poiana Mare Forest Range Office show excellent growth with a decline grade of 0.4. The No. 17 belt-transect survey plot at Desa is an example of a dune forest of *Populus euroamericana*. Compared to those planted at lowland, the *P. euroamericana* trees planted at the top of dunes show less favourable growth but most trees have reached a height of 30 m with a low decline grade of 0.3, constituting excellent stands [Fig. 2-4-3-(7) and Table 2-4-8-(7)].

Table 2-4-8　Observable Species and Summed Dominance Ratio of the Belt-transects
(3) Artificial stand of *Q.robur* and *Q.petraea* (UP V, ua.54J, Seaca Optasani)

Species	Number of trees	Height (m)	Diameter of breast height (cm)	Declining grade Average	Declining grade 0-1.9	Declining grade 2.0-4.0	Remarks
Quercus robur (Qr)	46	6-17	8-26	1.7	65.2	34.8	Planted main species
Quercus frainetto (Qf)	10	7-16	8-28	2.1	20.0	80.0	Copping tree, accampanied species
Quercus petraea (Qp)	3	13-15	12-20	1.3	67.0	33.0	Planted tree, accampanied species
Total	59	6-17	8-28	1.7	57.5	42.4	

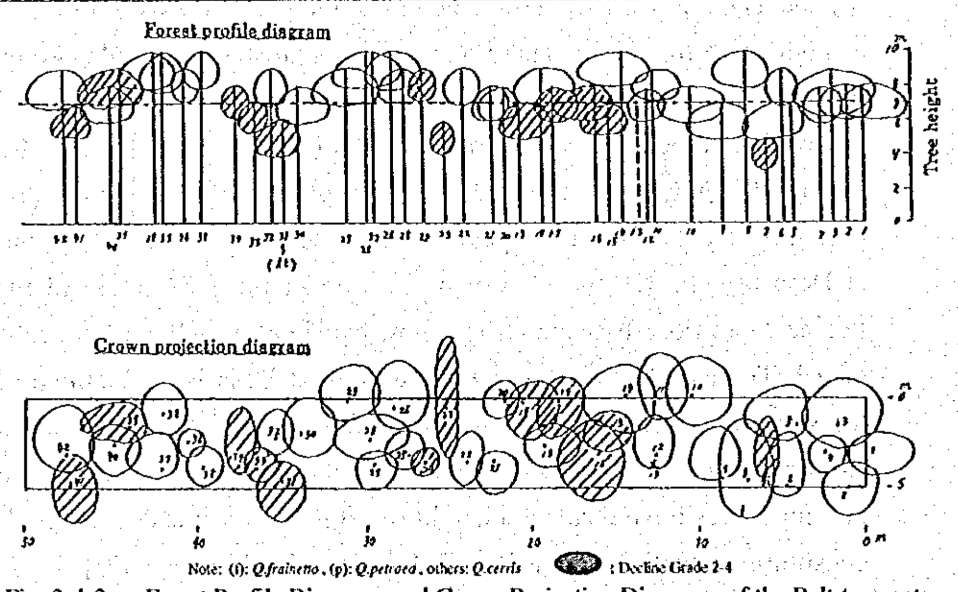


Note: (f): *Q.frainetto*, (p): *Q.petraea*, others: *Q.cerris* : Decline Grade 2-4

Fig. 2-4-3　Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(3) Artificial stand of *Q.robur* and *Q.petraea* (UP V, ua.54J, Seaca Optasani)

Table 2-4-8　Observable Species and Summed Dominance Ratio of the Belt-transects
(4) Artificial stand of *Q.frainetto* (UP II, ua.26B, Cerzeni, Caracal)

Species	Number of trees	Height (m)	Diameter of breast height (cm)	Declining grade Average	Declining grade 0-1.9	Declining grade 2.0-4.0	Remarks
Quercus frainetto (Qf)	41	5-10	10-22	1.7	70.7	29.3	Direct seeded main species
Acer tataricum (Ac)	1	6	8	2.0		100.0	accampanied species
Total	42	5-10	8-22	1.7	69.0	31.0	



Note: (f): *Q.frainetto*, (p): *Q.petraea*, others: *Q.cerris* : Decline Grade 2-4

Fig. 2-4-3　Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(4) Artificial stand of *Q.frainetto* (UP II, ua.26B, Cerzeni, Caracal)

Table 2-4-8 Observable Species and Summed Dominance Ratio of the Belt-transects
(5) Regeneration by coppicing of *Robinia pseudoacacia* (No. 15, Madona forest)

Species	Number of trees		Tree height class (m)										Total height (m)	Total covered area (m²)	Summed dominance ratio (%)
	Number	%	4	7	8	9	10	11	12	13	14	15			
Robinia pseudoacacia (Rp)	48 (5)	100.0	1	1	1	1	2	4 (3)	16 (1)	12 (1)	8	2	524	328.1	100.0
Total	48 (5)	100.0	1	1	1	1	2	4 (3)	16 (1)	12 (1)	8	2	524	328.1	100.0

Note: (3), (5) - Dead tree Diameter of breast height (cm): 12-32

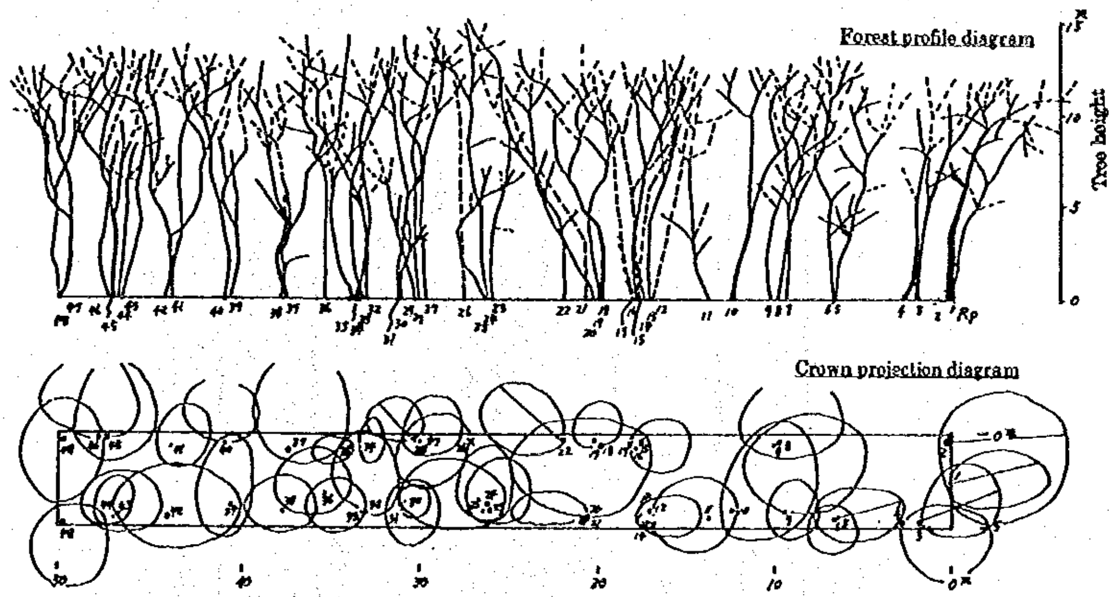


Fig. 2-4-3 Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(5) Regeneration by coppicing of *Robinia pseudoacacia* (No. 15, Madona forest)

Table 2-4-8 Observable Species and Summed Dominance Ratio of the Belt-transects
(6) Regeneration of *Robinia pseudoacacia* (No. 14, Celaru forest)

Species	Number of trees		Tree height class (m)									Total height (m)	Total covered area (m²)	Summed dominance ratio (%)
	Number	%	4	10	11	16	17	18	19	20	21			
Robinia pseudoacacia (Rp)	13 (3)	100.0	1 (1)	1	1	4 (1)	1	1	1	2 (1)	1	164	120.0	100.0
Total	13 (3)	100.0	1 (1)	1	1	4 (1)	1	1	1	2 (1)	1	164	120.0	100.0

Note: (3), (5) - Dead tree Diameter of breast height (cm): 16-34

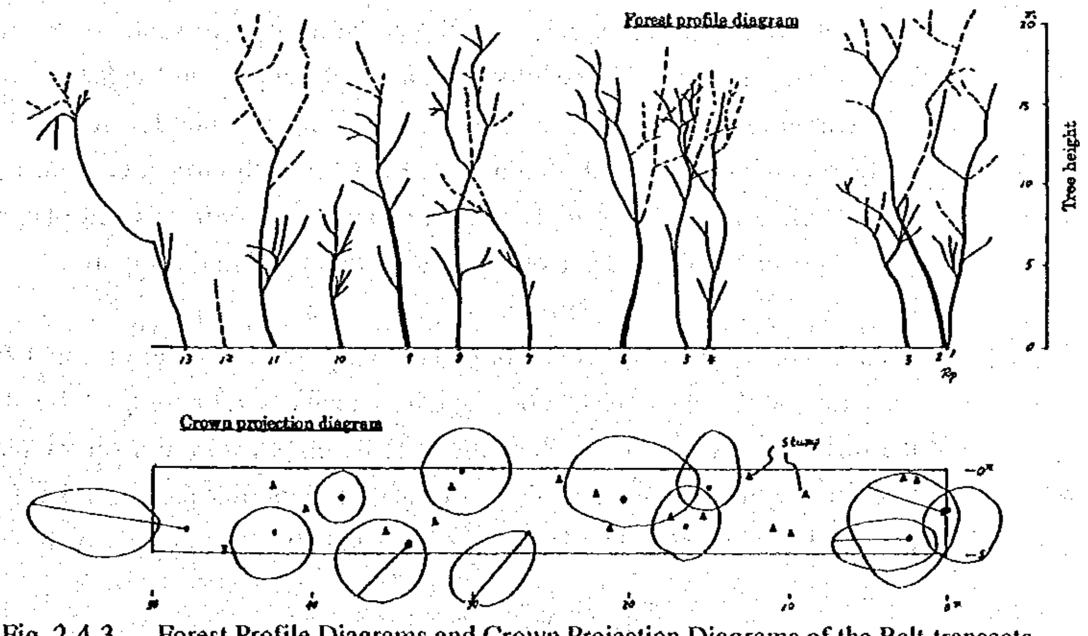


Fig. 2-4-3 Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(6) Regeneration of *Robinia pseudoacacia* (No. 14, Celaru forest)

Table 2-4-8 Observable Species and Summed Dominance Ratio of the Belt-transects

(7) Sand dune forest of *Populus euroamericana* (No. 17, Desa forest)

Species	Number of trees		Tree height class (m)					Total height (m)	Total covered area (m²)	Summed dominance ratio (%)
	Number	%	18	19	27	30	31			
Populus euroamericana (Pe)	9	100.0	1	1	2	1	4	245	310.4	100.0
Total	9	100.0	1	1	2	1	4	245	310.4	100.0

Note: Diameter of breast height (cm): 20-46

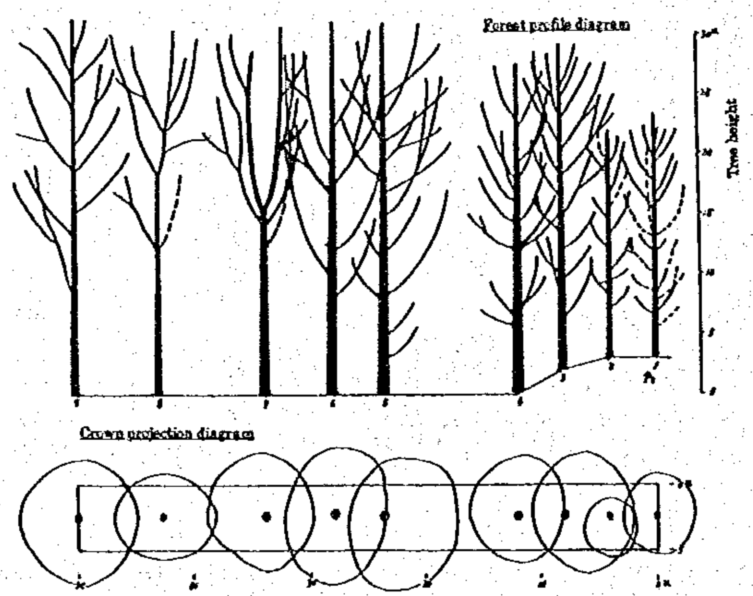


Fig. 2-4-3 Forest Profile Diagrams and Crown Projection Diagrams of the Belt-transects
(7) Sand dune forest of *Populus euroamericana* (No. 17, Desa forest)

② *Q. rubra*

Q. rubra is a species which was introduced from North America and is regarded as a promising species which can be adapted to southern Romania. This species has been successfully used as roadside trees in Bucharest and its excellent growth in artificial stand at the Retca experimental forest (stand age: 20 years) under the control of Ghimpati Forest Branch Office, Giurgiu Forest Range Office is well-known. The survey findings at a 40 year old plantation site at Perisor UP IV 99A in Dolj County are described in this report.

Such *Quercus* spp. as *Q. frainetto*, *Q. cerris* and *Q. robur* were planted at the same time at the above plantation site over an area of 7.7 ha. Fig. 2-4-4 shows the survey results on the tree height and DBH of *Q. rubra* at a survey plot of five lines x 50 m (line interval of 3 m and seedling distance of 1.5 m). The observed tree height and DBH are 15 - 17 m and 20 - 25 cm respectively.

Fig. 2-4-5 compares the tree height of *Q. rubra* with those of three other *Quercus* species planted at the same time. The height shown is 15 - 17 m for

Q. rubra, 12 - 14 m for *Q. cerris*, 9 - 11 m for *Q. robur* and 7 - 10 m for *Q. frainetto*.

As described above, the growing state of *Q. rubra* at the Perisor plantation site is far better than that of other *Quercus* spp. The growth of *Q. rubra* at this site must be continually monitored to examine its adaptability to Olt and Dolj Counties.

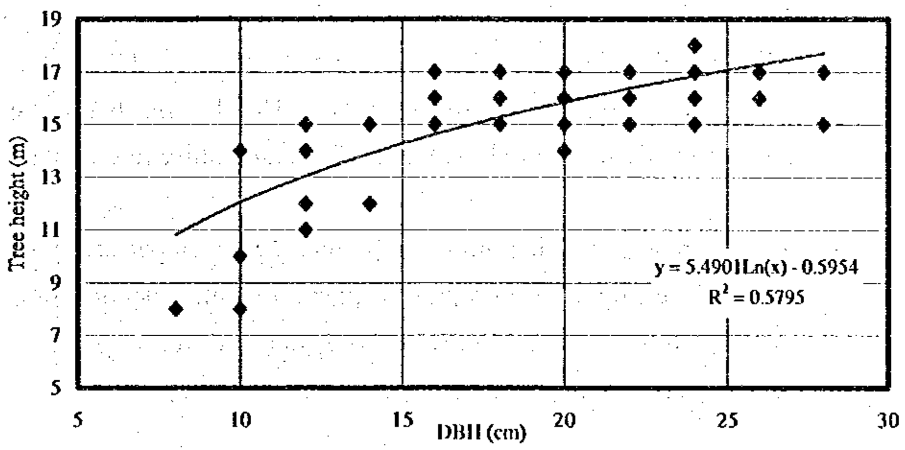


Fig. 2-4-4 Tree Height and DBH (*Q. rubra*)

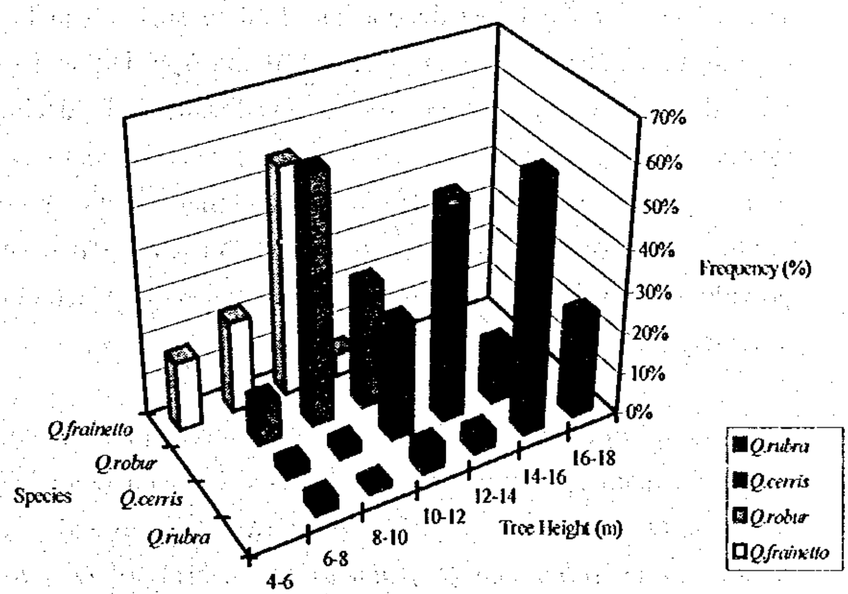


Fig. 2-4-5 Frequency of Numbers of Trees by Height of *Q. rubra* and Other *Quercus* Species

③ *Pinus nigra*

Pinus nigra is a local species in Romania and its introduction to Olt and Dolj Counties is hoped for because of the little presence of coniferous trees in these counties. Its value as a species for windbreak forests in southern dunes is described in detail in 2.4.6-(1). Here, the survey results on an old plantation site at Topana (Vulturesti UP III 52; stand age of 32 years) are described.

Pinus nigra has the disadvantage of being weak against snow damage. Although the plantation site at Topana shows a good state of growth with an average tree height of 12 m and DBH of 10 - 18 cm, its growth situation must be continually monitored to examine its adaptability to Olt and Dolj Counties.

Topographical consideration to protect *Pinus nigra* from snow damage is particularly important in regard to plantation site selection in order to achieve good planting results. *Pinus nigra* is also a candidate species for hillside regreening work in the future.

4) State of Forest Decline

① Forest Decline Fact-Finding Survey

The findings of the forest decline fact-finding survey can be found on the decline survey sheets [App. D-7-(1) - (22)] and App. D-8 and App. D-9 which show the decline grade ratio of the surveyed stands. The decline grade of the surveyed trees was determined as the average measurement results (scores) for four survey items, i.e. tree form, die back, defoliation ratio and branch and leaf density. Such survey items as leaf colour and leaf necrosis can be used to provide useful information on tree health by indicating whether or not trees are adversely affected by disease and pests.

The findings of the fact-finding survey at 22 survey plots are compiled in App. D-6. The main species of declined forests are such *Quercus* species as *Q. frainetto, Q. cerris, Q. petraea, Q. robur, Q. pubescens* and *Q. pedunculiflora*, hybrids of *Q. robur* and *Q. frainetto* and hybrids of *Q. pubescens* and *Q. frainetto*. Species other than *Quercus* spp. are *Fraxinus excelsior, Fraxinus ornus, Acer campestre* and *Acer negundo.* These broad-leaved species appear at the survey plots mixed with *Quercus* spp. App. D-6 also lists secondary species observed in declining stands, including those of *Quercus* spp. which are not considered to be the dominant species, *Ulmus minor, Malus sylvestris* and *Pyrus pyraster*. In the case of *R. pseudoacacia*, its state of decline was established based on the tree top death of the surveyed trees at the belt-transect survey plots as described in ② below.

The number of plots with a stand decline grade of 2 or higher is 12 out of 22, i.e. five out of 14 plots in Dolj County and seven out of eight plots in Olt County.

The degree of damage is affected by characteristics of the species. Out of the 22 survey plots, nine plots show a damage degree of "strong". Of these nine plots, *Q. frainetto* is the dominant species at seven plots. While *Q. frainetto* often appears mixed with *Q. cerris*, its degree of damage is always higher than that of *Q. cerris* which appears to be the least damaged among *Quercus* spp. A damage degree of "strong" was also observed at one plot each of *Q. petraea*, *Q. robur*, *Q. pubescens*, *Q. cerris* and a hybrid of *Q. pubescens* and *Q. frainetto*. All of these species are often mixed with other species.

Among broad-leaved species other than *Quercus* spp., *Fraxinus excelsior* has the highest appearance with a low degree of damage. This species is mixed with *Q. robur*, constituting stable stands with a high tree height.

Populus spp. tends to show an excellent state of growth with a low degree of damage.

② Die Back of Species Found at Belt-Transect Survey Plots

The findings on the die back of species found at the belt-transect survey plots in the forest vegetation survey are shown in App. D-10 while the ratio by decline grade at these plots as determined by the data on die back is shown in App.D-11.

App.D-10 indicates that *Quercus* spp. belts with a high stand decline grade are plots dominated by *Q. frainetto*. Among the *R. pseudoacacia* plots, those in the area of the former Apele Vii Forest Range Office show a high stand decline grade while those in the area of the former Poiana Mare Forest Range Office show an excellent state of growth with a low stand decline grade.

App. D-11 indicates that six *Quercus* spp. plots and four *Quercus* spp. plots have a damage degree of "strong" and "moderate" respectively. Six plots with a strong degree of damage consist of three plots of forest vegetation type 5 (dominated by *Q. frainetto* and *Q. cerris*) and one plot each of forest vegetation type 4 (dominated by *Q. petraea*), type 10 (dominated by *Q. robur* and *Q. pedunculiflora*) and type 11 (dominated by *Q. frainetto*). All four plots with a moderate degree of damage belong to type 5 (dominated by *Q. frainetto* and *Q. cerris*). Two *R. pseudoacacia* plots in the area of the former Apele Vii Forest Range Office both show a strong degree of damage.

5) State of Defoliation and Acorn Dropping of *Q. frainetto*

Seasonal observation of defoliation and acorn dropping was conducted at a *Q. frainetto*-dominated forest at Seaca Optasani and the results are shown in Fig. 2-4-6, Fig. 2-4-7, Table 2-4-11 and App. D-5. This observation used a circular litter trap (1 m^2 in size) placed below the crown and the trapped litter was measured every month during the period from July to October. The defoliation pattern of *Q. frainetto* in the growth period in 1998 was not particularly abnormal. The observation of dropped acorns which was conducted at the same time as the observation of defoliation showed only a small number of immature acorns among the collected samples, suggesting normal growth in 1998 as in the case of the defoliation rate.

Table 2-4-11 Data of Litter Trap Survey

(July-October 1998, *Q. frainetto* at Seaca-Optasani forest)

Trap	Leaves (g)				Acorn (g)				Branch (g)				Other components (g)			
number	Jul	Aug	Sep	Oct	Jul	Aug	Sep	Oct	Jul	Aug	Sep	Oct	Jul	Aug	Sep	Oct
1	2.0	2.1	44.5	36.8	3.9	4.8	60.0	10.0	7.2	0.5	10.0	15.0	5.0	2.5	2.6	2.2
2	1.3	1.8	54.0	128.1	2.4	0.6	27.2	7.0	3.5	2.0	15.4	24.3	3.7	1.4	1.3	0.8
3	2.7	1.7	125.1	95.1	2.4	0.2	10.0	5.0	21.2	3.4	17.5	7.2	4.4	0.8	2.0	1.2
4	0.8	2.4	88.4	108.6	3.7	1.2	8.5	6.9	2.2	-	20.1	18.0	3.6	0.4	4.3	1.8
5	5.5	2.2	84.0	202.0	1.3	1.1	11.7	8.2	9.6	1.0	40.2	10.6	4.8	1.5	3.8	2.1
6	3.2	1.3	103.2	211.1	2.5	1.6	55.0	15.0	12.4	0.8	35.2	18.0	5.4	2.1	5.0	3.8
7	6.2	1.8	111.0	150.0	1.8	-	19.1	5.4	11.8	0.5	16.6	16.2	3.6	2.0	2.4	2.4
8	3.1	1.8	110.1	192.8	-	-	9.0	3.0	28.4	0.5	47.0	17.1	5.3	3.0	3.8	2.6
9	3.2	11.6	106.1	203.5	0.8	-	12.0	2.8	2.2	2.5	22.8	29.1	3.1	1.7	5.1	2.1
10	2.7	5.0	90.0	154.0	3.7	0.3	5.2	3.4	11.0	1.2	25.6	19.2	6.0	2.8	3.8	4.2

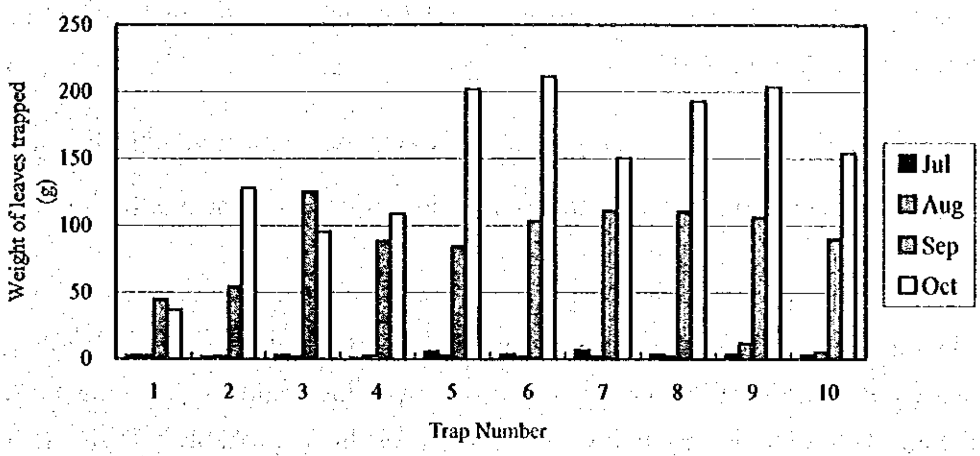


Fig. 2-4-6 Leaves Trapped from July to October 1998 in *Q. frainetto* Forest at UP V, Seaca Optasani, of Slatina Forest Range Office

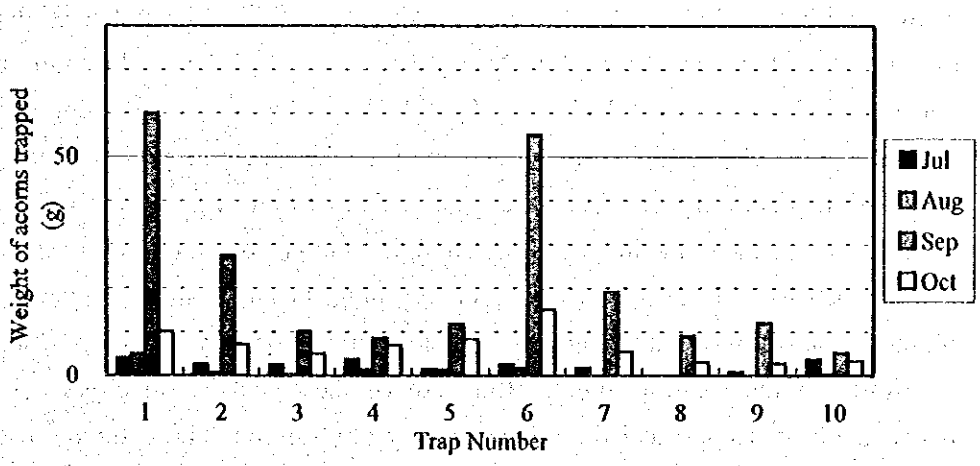


Fig. 2-4-7 Acorns Trapped from July to October 1998 in *Q. frainetto* forest at UP V, Seaca Optasani, of Slatina Forest Range Office

(2) Composition of Declined Forests

A ground conditions survey and forest conditions survey were conducted at damaged national forests (damaged forests) and forests subject to the avoidance of decline (prevention forests). The survey items were the tree species, tree height, dbh, crown density, decline grade, inclination and slope direction. There are 168 survey plots with a total survey area of 12.16 ha and 8,404 trees. The decline grade classification was conducted mainly featuring the state of dieback while referring to the decline grade evaluation method (Grade 0 through Grade 4) used in Romania for the forest monitoring of single trees [2-4-7-(2)]. The main characteristics of these forests are described below.

① Mixed stands of *Q. frainetto* and *Q. cerris* show a high decline grade for *Q. frainetto.* These stands are frequently observed in hill forests in the North Part and in plain forests in the Middle Part.

② Mixed stands of *Q. petraea, Q. frainetto* and *Q. cerris* show a high decline grade for *Q. petraea*. These stands are often observed in hill forests in the North Part.

③ The relationship between the crown density and decline grade in shown in Fig. 2-4-8. The ratio of declining trees with a decline grade of 2 or high increases as the crown density decreases. However, some plots show a low ratio of declining trees even though the crown density is low. The reason for this is probably that the damage is concentrated on certain species, leading to the removal of declining trees and a resulting decrease of the crown density. Fig. 2-4-9 compares the ratio of trees with a decline grade of 2 or higher with the degree of stand decline. In this figure, the ratio of trees with a decline grade of 4, i.e. dead trees, in the total number of declining trees is shown for each survey plot. Obviously, sound stands have a low ratio of trees which are judged to have a decline grade of 4. When the ratio of declining trees with a decline grade of 2 or higher increases, the ratio of trees with a decline grade of 3 or 4 among the declining trees becomes high. This fact indicates that the ratio of trees with a high decline grade increases with a higher ratio of declining trees. Stands with a crown density of 60% or more are generally judged to be healthy. However, stands of more than 100 years of age show a low crown density level because of the proximity to the rotation age. In the case of these stands, no close correlation between forest decline and the crown density is observed. These stands also show little damage due to drought. When the crown diameter of declining trees is compared with that of healthy trees, the crown diameter of the former is smaller under a similar stand density, resulting in a tendency towards a lower crown density at declining stands.

④ Declined forests are mainly observed in forests of 40 years of age or more. Young stands show rather little damage.

⑤ There is no distinct correlation between herbal undergrowth and forest decline. At those sites where the crown cover is opened up due to the disposal of damaged trees, however, herbs of *Gramineae* tend to become dominant, often preventing regeneration by natural seeding.

⑥ Trees with advanced decline at the crown are further suppressed by neighbouring healthy trees and, therefore, their height tends to be lower than that of healthy trees.

The results of the forest conditions survey are shown in App. D-13.

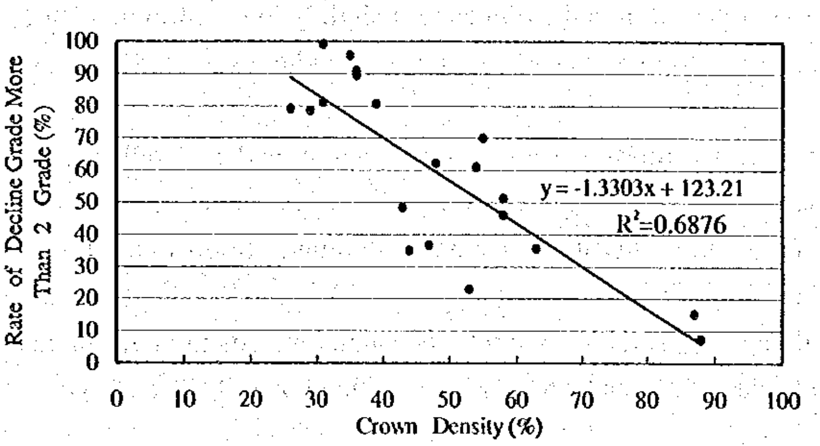


Fig. 2-4-8 Relationship Between Rate of Decline Grade 2 or Higher and Crown Density

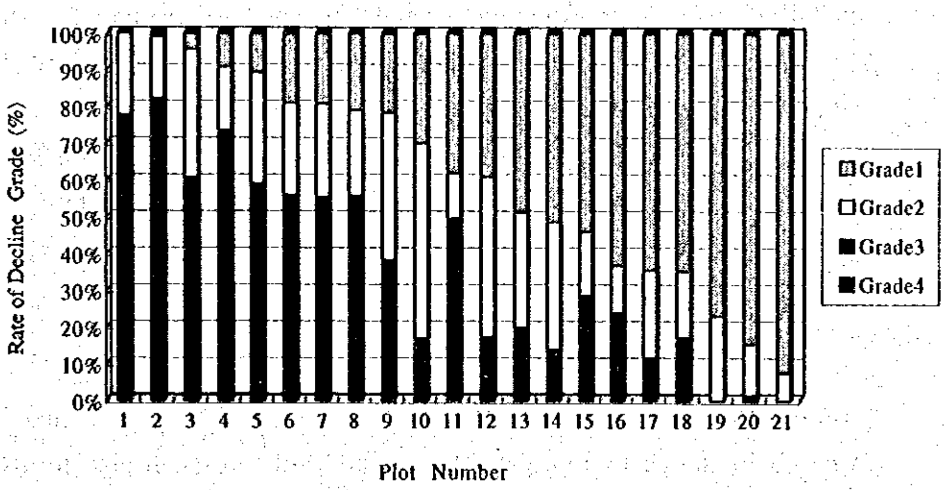


Fig. 2-4-9 Rate of Declining Trees by Survey Plots

Based on the above survey findings on the forest structure, the interpretation of declining stands on the aerial photographs was conducted and the interpretation results are described in 2.6.2.

(3) Growth of Main Species and Phenology

A general forest conditions survey, analysis of the collected reference materials and interviews with local forestry engineers were conducted to establish the picture of growth of the main species which is described next.

① *Quercus robur*

This species is suited to a climate of continental diversity. Its resistance to winter cold is fairly strong but due to its strong demand for a certain temperature during the growth period, it is distributed at a slightly lower altitude than *Q. petraea*. It is often distributed in areas with good water conditions, such as flood plains.

Quercus robur forms the upper story canopy and is a tall tree which eventually reaches a high of 30 - 35 m with a dbh of 1 - 2 m. Growth is at the maximum between 50 and 70 years of age and it continues to grow for 150 - 200 years. The expected life is as long as some 500 - 600 years. Provided that the soil and other growth conditions are favourable, the annual increment is 7.5 m^3 per ha for a stand of 100 years of age and 9 m^3 per ha for a stand of 120 years of age.

② *Quercus cerris*

(Forest and grassland forest) This species is found in steppe forests, plain forests and hill forests. Apart from pure stands, it tends to form mixed stands with *Q. frainetto*. It withstands hot weather, low precipitation and drought. It can reach a height of 35 m with a dbh of 1.5 m. Although the annual increment is lower than that of *Q. robur* and *Q. petraea*, it is higher than that of *Q. frainetto*. The average annual increment reaches 5 m^3 per ha at an age of approximately 100 years with favourable growth conditions.

③ *Quercus frainetto*

(Forest and grassland forest) While this species often forms mixed stands with *Q. cerris* in steppe forests, plain forests and hill forests, it also forms pure stands. The growth conditions and tree shape, etc. are very similar to those of *Q. cerris*. Its distribution area, however, tends to be at a higher altitude than that of *Q. cerris*. In general, it withstands compacted soil better than *Q. cerris* but its resistance to drought is lower than that of *Q. cerris*.

The growth performance of *Q. frainetto* is slightly inferior to that of *Q. cerris* and the most vigorous growth is observed at an age of around 100 years with an annual increment per ha of approximately 4.5 m^3 per ha with good growth conditions.

The existing natural stands have more often than not been generated by coppicing from the roots rather than ordinary coppicing and this is considered to be one reason for the poor seed bearing in recent years. *Q. frainetto* is the only *Quercus* species capable of regenerating by coppicing from the roots.

④ *Fraxinus excelsior*

This species is not particularly suited to compacted soil. It is often mixed with *Q. robur* and forms the upper story canopy together with *Q. robur* and *Tilia platyphyllos*. It is a tall tree reaching a height of some 40 m with a dbh of 1 m. The initial growth is larger than that of *Q. robur* and the maximum growth is achieved at an age of 30 - 40 years. Growth after 70 - 80 years of age is inferior to that of *Q. robur*. At the best of the experimental sites, the annual increment may reach 8 - 10 m^3 per ha. Special care is required during the tending stage of mixed stands because of the fast initial growth.

⑤ *Robinia pseudoacacia*

This species withstands drought better than *Q. frainetto* but is unsuited to compacted soil, preferring soil with a high porosity. It can reach a height of 25 - 30 m with a dbh of 80 - 100 cm. The initial growth is exceptionally large, reaching a height of 10 m in five years but the growth starts to decline after 15 - 20 years. The annual increment is around 15 - 17 m^3 per ha for a 20 year old stand.

⑥ *Populus euroamericana*

This species enjoys strong initial growth and the annual increment reaches a maximum of approximately 30 m^3 per ha at an age of 15 - 20 years. It eventually reaches a height of 40 - 50 m with a dbh of 2 m.

The phenological aspects such as flowering and seed bearing, etc. of the main species are shown in Table 2-4-12. Phenological information on flowering and seed bearing, etc. can constitute indices to judge the appropriate timing for various types of work for successful regeneration by natural seeding and nursing.

Table 2-4-12 Phenology of Main Species

Tree Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Q.frainetto (Garnita)		○		☆					◇△
Q. cerris (Cer)			○	☆					◇△
Q.robur (Stejar)		○		☆					◇△
Q. petraea (Gorun)		○	☆						◇△
Fraxinus excelsior (Frasin)	(△)		○☆					◇△	
Robinia pseudoacacia (Salcam)		○△		☆					←◇→
Cornus sanguinea (Sanger)		(△) ○		☆					◇△
Gleditschia triacanthos (Gladita)		△	○	☆					◇
Ligstrum vulgare (Lemn cainesc)			○	☆					◇△
Acer campestre (Jugastru)		○		☆				◇△	
Rosa canina (Maces)			☆○				△← ◇←	→△ →◇	
Crategus monogina (Paducel)		△ ○	☆				◇		
Purnus cerasifera (Corcodus)		☆	○	△←	———	→△	◇		

Note: ○: Foliation ☆: Flowering ◇: Seed Bearing (Harvesting) △: Sowing

2.4.4 Forest Land Productivity

(1) Forest Land Productivity

Tree growth is determined by the tree height and thickening growth while stand growth is determined by the stand density of forest trees. It has been theoretically established that thickening height is closely related to the stand density when a stand is stratified by tree height. Thickening growth is, therefore, a factor which must be taken into consideration when analysing the stand structure. As the stand structure is characterised by the type of forest work operation, thickening growth should be understood as a factor determined by the type of forest work operation. In contrast, as far as tree growth is concerned, the tree height tends to act as an independent variable, i.e. a factor less affected by the type of forest work operation. The site index is an index determined by this tree height as an independent variable. When considering the purpose of use (rotation age) and the height growth curve of *Quercus* spp., the main species in the Study Area, it is deemed appropriate to treat the height of 100 year old trees as the site index.

The height of such coniferous trees as *Picea* spp. and *Cedrus* spp. is closely linked to the water environment of the soil and is generally high along valleys and low along ridgelines in mountain areas. In comparison, such correspondence to the water environment is not so clearly shown by broad-leaved trees, forming the common opinion that the impacts of the water environment, i.e. topographical location in a valley or on a ridgeline, on them are small. However, a close relationship between topographical features and the water environment is observed in the case of *Quercus* spp. stands in the Study Area. The Study Area generally consists of terraced fans with a thick gravel layer and low annual precipitation of 500 - 700 mm. At relatively high middle terraces as well as high terraces, the deep groundwater level suggests that the soil is always dryish. Low terraces of which the relative height from the groundwater level is rather small, however, enjoy a comparatively wet environment.

The compact bed soil formation in the Study Area has been believed to be a negative factor for plant growth. Because of such compactness, however, a capillary system consisting of fine pores is well developed in this formation and it is assumed that a large quantity of water is stored in these fine pores. As the capillary tension of fine pores is strong, it is not easy for trees to use the water stored in the fine pores. Nevertheless, a poor but stable water environment is available for forest trees which are capable of extending their root systems in this compact formation. The survey results indicate that *Q. frainetto* and *Q. cerris* are species which can adapt to such a compact formation.

Meanwhile, areas with different site qualities can be found on the surface of terraces above the compact formation as their water storage, infiltration and drainage conditions reflect the existence or non-existence of A and B horizons with a different thickness as well as degree of swelling and softness (compactness) and also slight but still differing inclinations and undulations.

More detailed analysis reveals that Class I and Class II sites of *Q. robur* are located in an environment (low terraces, etc.) with abundant water stored in medium and fine pores (pF $\leq$ 2.7). In contrast, Class III through Class V sites where *Q. frainetto* and *Q. cerris* often grow present an environment where water stored in the fine pores in the compact base soil formation can be utilised. Using the site quality of *Q. frainetto* sites as a criterion, Class I *Q. robur* sites are above this criterion and Class II *Q. robur* sites closely resemble Class I *Q. frainetto* sites. The relationship between the site indices for *Q. frainetto* and *Q. cerris* and the land conditions is outlined in Table 2-4-13.

Table 2-4-13 Site Indices (Tree Height of 100 Year Old Stand) for *Q. frainetto* and *Q. cerris* and Land Conditions

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

Notes
Special I : Class I *Q. robur* site
Thickness of A horizon : healthy forest land = 15 - 20 cm; poor forest land = <15 cm
Depth of B horizon : healthy forest land = 25 - 30 cm; poor forest land = very compact below 5 - 15 cm

Analysis of the relationship between declined forests and site quality shows that conspicuously declined forests are overwhelmingly found at site index Class V sites, followed by Class IV and are rare at Class III sites. When the ground surface is compacted due to trampling, associated with stock raising, it loses large and medium pores, resulting in a considerable decline of the air permeability. In particular, if the B horizon is compacted, even the fine pore ratio is reduced, forming an impermeable layer. Under such circumstances, the water which infiltrates the A horizon loses the ability to coexist with air, becoming stagnant water lacking oxygen. As a result, the physiological activities of fine roots are hampered, resulting in root decay. At those sites where the surface soil is compacted, this obstruction occurs every time it rains, producing chronic poor forests. The latest phenomenon of decline occurred when such chronic poor forests reached the stage of decisive decline due to drought damage. At forest land of Class V site quality, there are some healthy stands despite their small increment. However, stands at Class V sites are often poor because of the very compact top soil layer.

(2) Site Index Distribution

The area of forests and damaged forests by site index and forest range office in each geographical area for *Quercus* spp. and *Robinia pseudoacacia* which are the main species in the Study Area is shown in Table 2-4-14. Meanwhile, the area of forests and damaged forests by site index and forest range office in each geographical area for all species is shown in App. E-2. As the area figures used in these tables are quoted from the

Table 2-4-14-(1) Area of Damaged Forests by Site Index and Forest Range Office in Each Geographical Area (*Quercus* spp.)

Area	Forest Range	Total Forest area					(ha)/(%)	Declined Forest Area					(ha)/(%)	Ratio					(%)
							Total						Total						Total
		I	II	III	IV	V		I	II	III	IV	V		I	II	III	IV	V	
North	Vulturesti	37.9	1,054.1	3,995.1	933.4	99.1	6,119.6		2.8	5.8	13.5	0.6	22.7						
Part		0.6	17.2	65.3	15.3	1.6	100.0	0.0	12.3	25.6	59.3	2.8	100.0	0.0	0.3	0.1	1.4	0.6	0.4
	Amaradia	2.7	75.7	6,655.0	1,946.2	269.6	8,949.2		1.8	268.2	103.5	47.7	421.1						
		0.0	0.8	74.4	21.7	3.0	100.0	0.0	0.4	63.7	24.6	11.3	100.0	0.0	2.4	4.0	5.3	17.7	4.7
	Filiasi	11.1	411.2	3,631.1	1,433.3	411.4	5,898.1	0.2	6.7	163.0	137.3	41.9	349.2						
		0.2	7.0	61.6	24.3	7.0	100.0	0.1	1.9	46.7	39.3	12.0	100.0	2.2	1.6	4.5	9.6	10.2	5.9
North Part Total (ha)		51.7	1,541.0	14,281.2	4,312.9	780.1	20,966.9	0.2	11.3	437.0	254.3	90.3	793.1						
North Part Total (%)		0.2	7.3	68.1	20.6	3.7	100.0	0.0	1.4	55.1	32.1	11.4	100.0	0.5	0.7	3.1	5.9	11.6	3.8
Middle	Bals	4.3	608.9	6,081.7	2,099.1	835.8	9,629.8	1.3	53.6	741.5	621.3	195.5	1,613.2						
Part		0.0	6.3	63.2	21.8	8.7	100.0	0.1	3.3	46.0	38.5	12.1	100.0	30.7	8.8	12.2	29.6	23.4	16.8
	Slatina	288.7	1,477.3	3,560.1	492.9	170.3	5,989.3		5.9	408.8	169.1	84.3	668.1						
		4.8	24.7	59.4	8.2	2.8	100.0	0.0	0.9	61.2	25.3	12.6	100.0	0.0	0.4	11.5	34.3	49.5	11.2
	(Draganesti-Olt)	94.7	246.6	973.3	303.3	42.5	1,660.4		35.4	120.3	22.7	4.4	182.8						
		5.7	14.9	58.6	18.3	2.6	100.0	0.0	19.4	65.8	12.4	2.4	100.0	0.0	14.4	12.4	7.5	10.4	11.0
	Craiova	28.1	310.3	3,752.6	2,789.8	918.8	7,799.6		5.9	498.5	552.2	206.3	1,262.9						
		0.4	4.0	48.1	35.8	11.8	100.0	0.0	0.5	39.5	43.7	16.3	100.0	0.0	1.9	13.3	19.8	22.5	16.2
	Perisor	10.9	355.8	3,666.3	2,554.3	1,109.3	7,696.6	0.2	99.9	1,035.9	1,156.4	559.4	2,851.7						
		0.1	4.6	47.6	33.2	14.4	100.0	0.0	3.5	36.3	40.6	19.6	100.0	1.4	28.1	28.3	45.3	50.4	37.1
Middle Part Total (ha)		426.7	2,998.9	18,034.0	8,239.4	3,076.7	32,775.7	1.5	200.7	2,804.9	2,521.7	1,049.9	6,578.7						
Middle Part Total (%)		1.3	9.1	55.0	25.1	9.4	100.0	0.0	3.1	42.6	38.3	16.0	100.0	0.3	6.7	15.6	30.6	34.1	20.1
South	Caracal	52.5	129.9	621.6	917.4	577.8	2,299.2	0.6	1.4	25.1	72.5	36.6	136.2						
Part		2.3	5.6	27.0	39.9	25.1	100.0	0.4	1.0	18.4	53.2	26.9	100.0	1.1	1.1	4.0	7.9	6.3	5.9
	(Corabia)	112.3	22.0	8.6	0.0	0.0	142.9	0.2		0.0			0.2						
		78.6	15.4	6.0	0.0	0.0	100.0	90.9	0.0	9.1	0.0	0.0	100.0	0.2	0.0	0.2			0.2
	Calafat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
	(Poiana Mare)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
	Sadova	2.9	65.4	606.8	172.5	114.9	962.5	0.0	0.0	0.0	0.0	0.0	0.0						
		0.3	6.8	63.0	17.9	11.9	100.0							0.0	0.0	0.0	0.0	0.0	0.0
	(Apele Vii)	7.1	4.3	62.0	74.4	1.3	149.1	0.6		40.5	69.3	0.5	110.9						
		4.8	2.9	41.6	49.9	0.9	100.0	0.5	0.0	36.5	62.5	0.5	100.0	8.5	0.0	65.3	93.2	40.0	74.4
	Segarcea	29.4	334.3	1,947.1	573.7	260.7	3,145.2	12.9	12.7	93.6	142.8	60.6	322.4						
		0.9	10.6	61.9	18.2	8.3	100.0	4.0	3.9	29.0	44.3	18.8	100.0	43.7	3.8	4.8	24.9	23.2	10.3
South Part Total (ha)		204.2	555.9	3,246.1	1,738.0	954.7	6,698.9	14.3	14.1	159.2	284.6	97.7	569.7						
South Part Total (%)		3.0	8.3	48.5	25.9	14.3	100.0	2.5	2.5	27.9	49.9	17.1	100.0	7.0	2.5	4.9	16.4	10.2	8.5
Total (ha)		682.6	5,095.8	35,561.3	14,290.3	4,811.5	60,441.5	16.0	226.1	3,401.1	3,060.5	1,237.8	7,941.5						
Total (%)		1.1	8.4	58.8	23.6	8.0	100.0	0.2	2.8	42.8	38.5	15.6	100.0	2.3	4.4	9.6	21.4	25.7	13.1

Table 2-4-14-(2) Area of Damaged Forests by Site Index and Forest Range Office in Each Geographical Area (*Robinia pseudoacacia*)

Area	Forest Range	Total Forest area (ha)/(%)						Declined Forest Area (ha)/(%)						Ratio (%)					
		I	II	III	IV	V	Total	I	II	III	IV	V	Total	I	II	III	IV	V	Total
North Part	Vulturesti	0.9	2.0	1,585.2	998.2	157.2	2,743.5	0.0	0.0	0.0	0.0	0.0	0.0						
		0.0	0.1	57.8	36.4	5.7	100.0							0.0	0.0	0.0	0.0	0.0	0.0
	Amaradia	0.0	0.0	70.2	371.0	195.2	636.4			7.5	21.9	7.0	36.3						
		0.0	0.0	11.0	58.3	30.7	100.0	0.0	0.0	20.6	60.2	19.2	100.0			10.7	5.9	3.6	5.7
	Filiasi	0.0	0.0	280.0	401.2	181.8	863.0			3.7	27.0	35.9	66.6						
		0.0	0.0	32.4	46.5	21.1	100.0	0.0	0.0	5.6	40.5	53.9	100.0			1.3	6.7	19.7	7.7
North Part Total (ha)		0.9	2.0	1,935.4	1,770.4	534.2	4,242.9	0.0	0.0	11.2	48.8	42.9	102.9						
North Part Total (%)		0.0	0.0	45.6	41.7	12.6	100.0	0.0	0.0	10.9	47.5	41.7	100.0	0.0	0.0	0.6	2.8	8.0	2.4
Middle Part	Bals	0.0	0.0	112.0	126.3	26.3	264.6				4.4	3.6	8.0						
		0.0	0.0	42.3	47.7	9.9	100.0	0.0	0.0	0.0	55.0	45.0	100.0			0.0	3.5	13.7	3.0
	Slatina	0.0	0.0	736.1	664.2	143.6	1,543.9			7.9	10.2	4.9	23.0						
		0.0	0.0	47.7	43.0	9.3	100.0	0.0	0.0	34.2	44.5	21.3	100.0			1.1	1.5	3.4	1.5
	(Draganesti-Olt)	0.0	2.3	727.3	209.9	62.0	1,001.5			10.7	0.1	0.8	11.6						
		0.0	0.2	72.6	21.0	6.2	100.0	0.0	0.0	92.5	0.5	7.0	100.0		0.0	1.5	0.0	1.3	1.2
	Craiova	0.0	0.0	280.2	378.1	128.3	786.6			0.2	3.9	1.1	5.2						
		0.0	0.0	35.6	48.1	16.3	100.0	0.0	0.0	4.6	74.9	20.5	100.0			0.1	1.0	0.8	0.7
	Perisor	0.0	28.6	619.9	188.5	52.8	889.8			33.1	3.0	10.1	46.2						
		0.0	3.2	69.7	21.2	5.9	100.0	0.0	0.0	71.6	6.5	21.9	100.0		0.0	5.3	1.6	19.1	5.2
Middle Part Total (ha)		0.0	30.9	2,475.5	1,567.0	413.0	4,486.4	0.0	0.0	51.9	21.6	20.5	94.0						
Middle Part Total (%)		0.0	0.7	55.2	34.9	9.2	100.0	0.0	0.0	1.2	0.5	0.5	100.0		0.0	2.1	1.4	5.0	2.1
South Part	Caracal	0.0	0.0	192.5	395.4	75.0	662.9			2.1	3.8		5.9						
		0.0	0.0	29.0	59.6	11.3	100.0	0.0	0.0	36.0	64.0	0.0	100.0			1.1	1.0	0.0	0.9
	(Corabia)	0.0	38.7	123.5	99.5	110.9	372.6		2.5	2.8			5.3						
		0.0	10.4	33.1	26.7	29.8	100.0	0.0	47.2	52.8	0.0	0.0	100.0		6.5	2.3	0.0	0.0	1.4
	Calafat	3.2	223.3	2,114.0	1,269.5	585.9	4,195.9		0.7	43.9	57.2	12.8	114.6						
		0.1	5.3	50.4	30.3	14.0	100.0	0.0	0.6	38.3	49.9	11.2	100.0	0.0	0.3	2.1	4.5	2.2	2.7
	(Poiana Mare)	0.5	52.9	3,144.7	711.6	406.6	4,316.3			3.2			3.2						
		0.0	1.2	72.9	16.5	9.4	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	0.1	0.0	0.0	0.1
	Sadova	0.0	3.7	335.1	514.6	92.6	946.0				27.8	12.8	40.6						
		0.0	0.4	35.4	54.4	9.8	100.0	0.0	0.0	0.0	68.5	31.5	100.0		0.0	0.0	5.4	13.8	4.3
	(Apele Vii)	0.0	735.7	2,869.2	1,445.9	374.1	5,424.9		43.9	246.5	80.9	32.4	403.7						
		0.0	13.6	52.9	26.7	6.9	100.0	0.0	10.9	61.1	20.0	8.0	100.0		6.0	8.6	5.6	8.7	7.4
	Segarcea			206.6	564.6	277.5	1,048.7			5.0	19.9	44.9	69.8						
		0.0	0.0	19.7	53.8	26.5	100.0	0.0	0.0	7.2	28.4	64.3	100.0			2.4	3.5	16.2	6.7
South Part Total (ha)		3.7	1,054.3	8,985.6	5,001.1	1,922.6	16,967.3	0.0	47.1	303.6	189.6	102.9	643.2						
South Part Total (%)		0.0	6.2	53.0	29.5	11.3	100.0	0.0	7.3	47.2	29.5	16.0	100.0	0.0	4.5	3.4	3.8	5.4	3.8
Total (ha)		4.6	1,087.2	13,396.5	8,338.5	2,869.8	25,696.6	0.0	47.1	366.8	260.0	166.3	840.1						
Total (%)		0.0	4.2	52.1	32.4	11.2	100.0	0.0	5.6	43.7	30.9	19.8	100.0	0.0	4.3	2.7	3.1	5.8	3.3

forest management book of each forest range office, they differ from those used in this report. The site index distribution by species as well as by geographical area is described next.

In the North Part, although the area of damaged forests is small, the proportion of damaged forests with low productivity (V) is high in the case of *Quercus* spp. forests. These forests are mainly located on slopes in hilly mountain foot areas.

In the Middle Part, damaged forests with low productivity cover a wide area. Many of these forests are plain forests which are dominated by *Quercus* spp. at middle and high terraces. Forests which are dominated by *Quercus* spp. and located on gentle slopes show a high proportion of medium productivity (III) forests.

In the South Part, the proportion of damaged forests with low productivity is slightly high. Many of these forests are located on dunes in the plain sections of low and middle terraces and are dominated by *Robinia pseudoacacia*. The forests at low terraces show a high proportion of forests with high productivity (I and II).

2.4.5 Yield Tables

The Study is characterised by the use of the crown coverage ratio, which can be interpreted on aerial photographs as the parameter. What are basically required to identify the forest mechanism and its secular changes and to predict its future are yield tables. The preparation of yield tables using the crown coverage ratio as the parameter is, therefore, essential for the financial and economic analyses for the Plan. As a highly accurate yield table was available for each species or variety in Romania, these tables were used as basic reference materials for the preparation of yield tables which use the crown coverage ratio as the parameter by means of their re-interpretation. The evaluation of declined forests also requires yield tables by decline grade. Accordingly, yield tables for declined forests using the crown coverage ratio as the parameter were prepared.

Re-interpretation of the yield tables was basically conducted using the growth analysis technique based on the crown form model. The decision on the parameter values was crucially important and, therefore, the trial and error process was repeated several times to decide these values while referring to the field survey data. As fine analysis was omitted, the results appear to slightly lack accuracy. Nevertheless, they are considered practically reliable without any contradictions.

A typical yield table example for *Q. frainetto* resulting from this exercise is shown in Table 2-4-15. The yield tables for the main species and the concrete analysis method are shown in App. E-3. Particularly important points are explained below.

- As the crown coverage ratio in the yield tables for Class V *Q. frainetto* and *Q. cerris* sites is roughly 50% with a relative stance (SR) of some 25%, the yield at these sites is evaluated as being similar to that of a crown coverage ratio with a damage degree of "weak". Although the tree density is restricted to low to mitigate competition for water at dry land, the relative stance of 25% is a figure which makes crown closure possible. Consequently, the low crown coverage ratio is assumed to be attributable to the site characteristics rather than forest management.

- In each site index area, the crown coverage ratio is maintained at the level of crown closure, i.e. 60% or higher, upto 100 years of age. Opening of the crown due to aging begins to appear between 100 years (low site index areas) and 120 years (high site index areas). The crown coverage ratio is low in the case of young forests of 50 years of age or less. As this is the period of most vigorous growth, the low crown coverage ratio is a contradictory result when compared with the normal state of crown growth, indicating problems in regard to the measurement and analysis methods used in compiling the yield table.

Reference material: Keiji Takeshita, Structural Analysis of Sugi (*Cryptomeria japonica*) Forest Using Parabolic Crown Form Model, Report on Experimental Forest of the Faculty of Agriculture, Kyushu University, 1985.

Table 2-4-15 Example of Yield Table of Declined Forest Using Crown Coverage as Parameter

(1) *Quercus Frainetto* Site III   Cc/(ΔV/ΔH2) = 80%/22   ΔH2 : ΔH + 0.2 (m)

Normal Forest / Declined Forest

Y	H	ΔH	D	N	Sr	f	V	ΔV	/ΔH2	v	V+v	ΔVt	/ΔH2	Cc	Cc:50% 13.75		Cc40% 11.00		Cc:30% 8.25		Cc20% 5.50
	m	m	cm	n/ha	%		m3	m3		m3	m3	m3		%	V	v	V	v	V	v	V
5	2.3	2.3	2.0	6000	56.1	-	2	2	0.8	-	2	2	0.8	36222	2	0	2	0	2	0	2
10	4.2	1.9	4.0	6000	30.7	-	17	15	7.1	0	17	15	7.1	25-26	17	0	17	0	17	0	16
15	5.7	1.5	5.3	5500	23.7	-	41	24	14.1	2	43	26	15.3	51-56	40	1	36	1	32	0	24
20	7.1	1.4	6.4	3914	36.0	0.648	63	22	13.8	8	70	27	16.9	50-61	62	7	56	5	46	4	33
25	8.4	1.3	8.1	2901	22.1	0.615	78	15	10.0	12	90	20	13.3	36-48	73	11	73	9	59	7	42
30	9.6	1.2	9.5	2296	21.7	0.594	93	15	10.7	14	107	17	12.1	39-44	92	12	88	10	71	8	50
35	10.7	1.1	10.8	1902	21.4	0.582	109	16	12.3	17	124	17	13.0	45-47	110	13	103	10	83	9	57
40	11.8	1.1	12.1	1626	21.8	0.571	126	17	13.0	15	131	17	13.0	47-47	128	13	117	11	94	9	64
45	12.9	1.1	13.4	1411	29.6	0.569	146	20	15.4	14	160	19	14.6	56-53	146	13	131	11	105	9	71
50	13.9	1.0	14.9	1227	20.5	0.568	167	21	17.5	14	181	21	17.5	64-64	163	13	145	10	116	9	78
55	14.9	1.0	16.1	1092	20.3	0.568	187	20	16.7	15	202	21	17.5	61-64	179	13	157	10	126	9	85
60	15.8	0.9	17.4	970	20.5	0.567	207	20	18.2	14	221	19	17.3	68-63	194	13	170	10	136	9	91
65	16.7	0.9	18.6	886	20.1	0.564	226	19	17.3	14	240	19	17.3	63-63	209	13	182	10	145	9	97
70	17.5	0.8	19.8	811	20.1	0.560	244	18	18.0	13	257	17	17.0	65-62	213	12	193	9	153	9	103
75	18.2	0.7	21.0	746	20.2	0.557	260	16	17.8	13	273	16	17.8	65-65	225	12	203	9	161	9	108
80	18.8	0.6	22.1	691	20.3	0.555	275	15	18.8	13	288	14	17.5	68-64	236	12	212	9	168	8	112
85	19.2	0.4	23.2	643	20.5	0.552	288	13	20.0	13	301	13	20.0	72-72	246	12	220	8	174	7	116
90	19.6	0.4	24.1	607	20.7	0.552	300	12	20.0	12	312	11	18.3	72-67	254	11	227	8	178	7	119
95	20.0	0.4	24.9	578	20.8	0.551	311	11	18.3	11	322	10	16.6	67-60	262	10	234	7	182	6	122
100	20.3	0.3	25.6	559	20.9	0.551	320	9	18.0	11	331	9	18.0	66-66	269	10	240	6	186	6	125
105	20.5	0.2	26.3	531	21.1	0.550	327	7	17.5	11	338	7	17.5	64-64	275	10	245	5	189	6	127
110	20.7	0.2	27.0	513	21.3	0.550	332	5	12.5	11	343	5	12.5	45-45	280	10	249	4	192	6	129
115	20.8	0.1	27.7	502	21.5	0.548	335	3	10.0	11	346	3	10.0	36-36	284	9	252	3	195	5	131
120	20.9	0.1	28.4	492	21.6	0.545	337	2	5.0	10	348	2	5.0	18-18	288	9	255	2	197	5	133

(2) *Quercus cerris* Site III   Cc/(ΔV/ΔH2) = 80%/22   ΔH2 : ΔH + 0.2 (m)

Normal Forest / Declined Forest

Y	H	ΔH	D	N	Sr	f	V	ΔV	/ΔH2	v	V+v	ΔVt	/ΔH2	Cc	Cc:50% 13.75		Cc40% 11.00		Cc:30% 8.25		Cc20% 5.50	
	m	m	cm	n/ha	%		m3	m3		m3	m3	m3		%	V	v	V	v	V	v	V	v
10	4.9	2.4	4.5	6000	26.3	-	43	23	8.8	0	43	23	8.8	32-32	38	0	34	0	28	0	24	0
15	7.1	2.2	6.8	3600	23.5	0.61	60	17	7.1	8	68	25	10.4	26-38	54	7	48	6	42	5	36	5
20	9.2	2.1	8.8	2393	23.2	0.58	78	18	7.8	15	93	25	10.9	28-40	72	14	64	13	56	12	48	9
25	10.7	1.5	10.6	1880	21.6	0.55	97	19	11.2	17	115	22	12.9	41-47	90	16	80	15	70	14	57	9
30	12.1	1.4	12.3	1546	21.0	0.52	116	19	11.9	19	135	20	12.5	43-45	107	18	97	16	83	14	66	9
35	13.3	1.2	13.9	1316	20.7	0.51	136	20	14.0	20	156	21	14.6	51-53	127	20	113	16	95	13	84	9
40	14.5	1.2	14.5	1156	20.3	0.50	156	20	14.3	20	176	20	14.3	51-52	146	20	128	16	106	12	92	8
45	15.6	1.1	16.9	1022	20.0	0.49	176	20	14.8	19	195	19	14.1	54-51	164	19	143	15	117	12	99	8
50	16.7	1.1	18.3	924	19.7	0.48	196	20	15.4	18	214	19	14.6	56-53	181	18	157	15	127	11	106	8
55	17.7	1.0	19.8	838	19.5	0.47	216	20	16.1	16	232	18	14.4	59-51	198	17	170	14	137	11	113	7
60	18.7	1.0	21.2	765	19.3	0.46	235	19	15.6	15	250	18	15.0	57-55	204	16	183	13	146	10	120	6
65	19.6	0.9	22.6	701	19.3	0.46	253	18	16.4	15	268	18	16.4	60-60	219	15	194	11	156	9	126	6
70	20.4	0.8	24.0	641	19.4	0.46	271	18	18.0	14	285	17	17.0	65-62	232	13	205	10	164	8	131	5
75	21.0	0.6	25.2	597	19.5	0.46	287	16	19.8	13	300	15	18.2	72-66	243	11	214	9	171	7	136	5
80	21.5	0.5	26.4	559	19.7	0.46	301	14	20.0	12	313	13	18.6	73-68	253	10	222	8	177	6	140	4
85	21.9	0.4	27.4	527	19.9	0.46	313	12	18.8	10	323	10	15.6	68-57	262	9	229	7	182	5	143	3
90	22.3	0.4	28.4	498	20.0	0.46	325	11	18.3	8	333	10	16.7	67-61	270	8	235	6	186	5	146	3
95	22.6	0.3	29.3	470	20.4	0.46	334	10	18.5	7	341	8	14.8	67-54	277	7	241	5	190	4	149	2
100	22.9	0.3	30.1	450	20.6	0.46	342	8	16.5	6	348	7	14.0	60-51	283	6	246	4	194	3	152	2
105	23.1	0.2	30.9	433	20.8	0.46	349	7	17.5	5	354	6	15.0	64-55	289	5	250	4	197	3	154	2
110	23.2	0.1	31.6	418	21.1	0.46	354	5	16.7	4	358	4	13.3	61-48	293	4	253	3	199	2	156	2

2.4.6 Environmental Conservation Functions of Forests

(1) Forest Functions

Forest functions are principally classified as functions of producing timber as a resource (resource production functions) and functions of conserving the natural environment (environmental conservation functions). The environmental conservation functions of forests are analysed here.

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

1) Water Source Conservation Function

The water infiltration performance of the top layer is crucial for the infiltration of rainwater into the ground and its subsequent storage in the soil and bedrock formations. That this infiltration rate is high in forests and low in other areas of land use is known to be a serious problem. With the advancement of forest exploitation to reduce the relative ratio of the forest area, the water source conservation function of forests declines. Therefore, when the ratio of forest area is high, it is judged that the water source conservation function of forests is strong.

Concrete analysis and evaluation of this function requires a flow rate survey on rivers and groundwater in the watershed. For the present study purposes, a rough estimate was made using data on the infiltration capacity of the top layer (0 - 5 cm), infiltration capacity at 25 cm below the ground surface and dam inflow.

Table 2-4-16 shows the infiltration capacity per minute (mm/min) of the top layer obtained by a simplified cylindrical infiltration gauge during the field survey. The numerical values shown in the table are real measurement values which are excessively large compared to the state of infiltration at the time of actual rain. The measured values are large because they reflect forced infiltration under pressure in a closed system. Empirically, such values are thought to be some 25 times higher than the real value. Following this line of thought, the infiltration capacity per hour is estimated to be some 2.4 times higher than the observed infiltration capacity per minute. As such, the measures values of the infiltration capacity are problematic but can still be effectively used as comparative values.

An infiltration structure consisting of medium and large pores is formed in natural forest soil by the vigorous ploughing activities of soil animals and others and an infiltration capacity of more than 60 - 70 mm/hr can be observed. This infiltration capacity level is high enough to infiltrate entire rainwater. However, when the measured values in the table are converted to the infiltration capacity per hour by multiplying them by 2.4, the minimum and maximum values fail to reach 10 mm/hr and 40 mm/hr respectively at many plots, indicating a low infiltration capacity. The infiltration capacity of the B horizon immediately below the top layer in particular is less than 10 mm/hr at all plots, indicating extremely unfavourable infiltration conditions. The major reason for such a low infiltration capacity is the fact that the subject soil formation is a clayey-silt formation under an almost semi-arid climate with low rainfall.

Table 2-4-16 Infiltration Capacity of Top Layer by Land Use and Soil Type

Site		Infiltration Capacity (mm/min)			
Land Use	Soil Type	Median	Min	Max	No.of Sites
Forest Land	LV	4.1	1.3	15.9	18
	FL	9.0	1.6	27.0	10
	CH	24.0	9.3	25.9	4
	PH	29.7	29.4	30.0	2
	CM	29.7	24.2	35.1	2
	GL	1.8	1.3	2.3	2
	AR	9.0	6.0	12.8	4
Farmland	LV	6.7	2.5	17.6	5
	FL	4.7	3.8	5.6	2
	CH	3.0	2.0	6.8	4
Grassland	LV	2.2	2.2	2.2	2
	FL	22.6	22.6	22.6	1

During the fifth field survey period, the infiltration capacity at 25 cm below the top layer was measured at 13 plots in typical forests in Olt and Dolj Counties to compare it with the infiltration capacity of the top layer and also to verify the suitability of the planned drainage and infiltration works. The measurement results are shown in Table 2-4-17. The infiltration capacity at 25 cm below the top layer is fairly small at some 15% of the infiltration capacity of the top layer. However, the range of values from several 10s to several 100s mm/hr suggests that the planned drainage and infiltration channels to be placed at this depth should sufficiently perform the intended function.

One important soil index in connection with water resources is the size of the water storage capacity of the soil formation. As the storage capacity is equivalent to the quantity of coarse pores (pF 0.6 - 2.7) in the soil formation, such a quantity within a 1 m deep soil formation is calculated. The water storage volume (Ss: mm) is expresed by an integral of porosity of pF 0.6 - 2.7 and the thickness of each horizon.

Table 2-4-17 Infiltration Capacity at 25 cm Below Top Layer at Forest Land

County	Location	Infiltration Capacity (mm/min)	Infiltration Capacity (mm/hr)	Soil Type	Soil Hardness *1 (mm)
Olt	Vulturesti UP III ua. 23D	0.19	12	LV	23
	Slatina UP V ua. 37A	0.53	32	LV	25
	Bals UP V ua. 150	1.88	113	LV	24
	Bals UP V ua. 161C	2.25	135	LV	15
	Caracal UP III ua. 52A	3.59	215	CM	24
Dolj	Craiova UP III ua. 95A	1.13	68	LV	27
	Craiova UP IV ua. 142C	0.52	31	LV	26
	Craiova UP I ua. 81B	1.56	94	LV	25
	Craiova UP II ua. 47	0.61	37	LV	22
	Perisor UP I ua. 119A	1.80	108	LV	24
	Perisor UP III ua. 57A	3.88	233	CH	18
	Perisor UP II ua. 27A	1.18	71	LV	18
	(ApeleVii) UP II ua. 75C	40.50	2,432	AR	1

Note: 1) The soil hardness was measured using Yamanaka's soil hardness meter.

$$\Theta i = \Theta(0.6) - \Theta(2.7)$$
$$S_s = \Sigma\, \Theta i \cdot Hi$$

Θi : porosity of pF0.6~2.7 (%)

Hi : thickness of each horizon (mm)

Table 2-4-18 shows the calculation results of the water storage volume per 100 cm of soil thickness using a horizon thickness of 15, 45 and 40 cm from the top layer to the lower horizon and the porosity of each layer (horizon). Soil porosity by survey point is indicated in App. A-7.

The storage capacity of coarse pores shown in the table ranges from 30 mm to 80 mm and is not particularly high. In fact, it is extremely low compared to the normal storage capacity of forest soil under a wet temperate climate at 200 mm/m or higher. As described in 2.2.4-(1) of the Study Findings, trees in the Study Area are inferred to be using water stored in not only coarse pores but also fine pores. The combined water storage capacity of coarse and fine pores is 200 - 400 mm/m, at last reaching the level of the expected water storage capacity under a wet temperate climate.

The porosity of forest soil linked to the water conservation function in the Study Area is rather poor as discussed so far but is still far better than the porosity of farmland, making it desirable to increase the forest area in order to improve the water resource situation in the Study Area. The ratio of forest area at highland and tableland of around 7% is low and the reality is that there is concern in regard to a further decline of the forest area. At tableland, groundwater is used as household water and farming water and its stable use poses an important task. Moreover, forest trees use water stored in the bed formation and the improvement as well as preservation of the water conservation function of forests is hoped for to ensure the smooth growth of forest trees. At tableland, it is possible to use underflow water from major rivers because of its being formed on top of a fan if boreholes of 100 - 150 m in depth are constructed. However, such boreholes pose technical as well as cost-related difficulties. It is, therefore, important to use shallow groundwater stored in the tableland itself. In short, improvement of the water conservation function of forests in the entire Study Area is highly desirable to achieve the stability and maintenance of shallow groundwater and water stored in the bed formation.

Table 2-4-18 Water Storage Capacity by Soil Type and Survey Plot

Site	Pore Ratio (%)		Thickness of Soil Horizon (mm)	Water Storage Capacity (mm)	
	Coarse Pores (pF0.7～2.7)	Fine Pores (pF2.7～4.0)		Coarse Pores (pF0.7～2.7)	Fine Pores (pF2.7～4.0)
O.S. Craiova UP I ua. 80	5.1	26.3	150 (0～150)	30.2	181.0
	2.6	16.6	450 (151～600)		
	2.7	16.7	400 (601～1,000)		
O.S. Craiova UP III ua. 46A	6.9	30.9	150 (0～150)	58.8	323.4
	6.4	32.5	450 (151～600)		
	4.9	32.7	400 (601～1,000)		
O.S. Craiova UP III ua. 95A	9.9	19.9	150 (0～150)	41.4	185.2
	2.6	18.6	450 (151～600)		
	3.7	17.9	400 (601～1,000)		
O.S. Craiova UP VI ua. 81B	4.0	39.9	150 (0～150)	65.7	312.5
	7.3	30.8	450 (151～600)		
	6.7	28.5	400 (601～1,000)		
O.S. Perisor UP I ua. 114A	8.3	26.7	150 (0～150)	46.1	221.9
	4.1	21.3	450 (151～600)		
	3.8	21.5	400 (601～1,000)		
O.S. Perisor UP III ua. 57A	5.4	32.5	150 (0～150)	39.0	209.8
	2.6	17.2	450 (151～600)		
	4.8	20.9	400 (601～1,000)		
(O.S. Poiana Mare) UP III ua. 15A	11.4	20.0	500 (0～500)	84.5	230.5
	5.5	26.1	500 (501～1,000)		

2) Windbreak Function

① Preservation of Wind Conditions

According to statistical data on the wind direction and velocity (Climatological Atlas; statistics for 15 year period from 1941 to 1955), areas exposed to strong wind are the southern part of Olt County from Caracal to Corabia, and the central and southern parts of Dolj County including Craiova. During the farming period from spring to autumn, these counties are exposed to strong wind of 3 - 6 m/sec on average (based on statistics for the 30 year period from 1967 to 1997; see 2.2.1). The prevailing winds are the western and eastern winds throughout the year. An area of which the average wind velocity exceeds 3 m/sec is usually said to require windbreak forests for farming purposes.

Even in the case of gently sloping terraces or highland topography with ridge-like convex slopes, it is known that the wind velocity reaches its maximum at such convex slopes, particularly sites of high exposure. As far as high terraces and highland areas are concerned, therefore, the establishment of forests, particularly on ridge-like gentle slopes, is important to ensure gentle wind conditions.

It is often the case that the frequency of wind in a certain direction is especially high in some areas. If a specific wind direction prevails, valleys or passes parallel to this direction are subject to particularly strong wind. A wide forest spreading from a valley to overhanging slopes is required to break this kind of strong wind.

② Necessity for Windbreak Forests

In general, wind faster than 3 m/sec is said to be harmful to the growth of agricultural crops. A strong spring wind not only causes wind erosion by blowing away the top soil of farmland but also blows away or damaged the sown seeds and transplanted seedlings. According to a report published by the Sand Crop Research Institute located in Dabuleni in the South Part of Dolj County, the roots of crops are exposed due to wind erosion and leaves suffer mechanical damage in areas subject to strong wind. The same report states that the loss of top soil is particularly severe in spring and that a flying sand volume of 10 tons per ha can be observed. Meanwhile, the Slatina Forest Range Office reports that as much as 500 ha of farmland was once damaged by wind in the South Part of Olt County. There has also been a report urging the future creation of a windbreak tree belt in the strong wind zone extending from Sadova in the South Part of Dolj County. The mean annual wind velocity in the South Part of Olt County is 3.2 m/sec with a western prevailing wind during the farming period and an eastern prevailing wind in winter. In areas where wind with a mean velocity of 3 m/sec or more prevails, local forests are expected to perform the function of a windbreak. The interview survey discovered a case where the productivity of farmland which had been converted from forest land declined due to wind damage resulting from the loss of trees. In another case, an irrigated farming system using irrigation channels was forced to recreate a forest (windbreak forest) as its productivity had declined due to wind damage resulting from the construction of irrigation channels by cutting forest trees.

③ Types of Windbreak Forests

According to the Forest Planning formulated by the former Corabia Forest Range Office in Olt County, windbreak forests in Olt and Dolj Counties can be classified into the following six types based on their function and objective.

Type 1 : Main tree belt - windbreak tree belt with a width of 7.5 m and an interval of 280 m to prevent wind damage to farmland

Type 2 : Supplementary tree belt - tree belt of 7.5 m in width to protect an irrigation channel from flying sand

Type 3 : Main water channel protection tree belt - tree belt of 8 - 20 m in width to protect slopes along a main water channel

Type 4 : Settlement protection forest - tree belt of 10 - 30 m in width to protect a settlement from strong wind

Type 5 : Road protection forest - tree belt of 10 - 20 m in width to protect a road from strong wind and flying sand

Type 6 : 50 m wide tree belt - 50 m wide tree belt to protect an irrigation system

Examples of these six types of windbreak forests in Corabia located in the South Part of Olt County show that Type 1 forests to protect farmland account for more than half of the total windbreak forest area (99 ha out of 194.5 ha), followed by Type 4 forests (30 ha) and Type 3 forests (26 ha). The main species of these windbreak forests are *R. pseudoacacia* and *P. euroamericana*.

④ Windbreak Forest Fact-Finding Survey

There is a well-developed network of windbreak forests in Sadova in the South Part of Dolj County, a neighbouring area of Corabia in the South Part of Olt County. The total area of windbreak forests under the jurisdiction of the Sadova Forest Range Office is 793.5 ha and *R. pseudoacacia* and *P. euroamericana* are the two main species. In addition, *Pinus nigra* is planted as a coniferous species. A windbreak forest fact-finding survey was conducted on these three species.

a) *Populus euroamericana* Windbreak Forests

The local standard specifications for a windbreak forest to protect farmland are a width of 7.5 m and an interval of 280 m between tree belts. At the relevant survey plot, *Populus* spp. is planted in two lines with a 4 m interval between the lines and a 3 m interval between the trees. Two lines of *Elaeagnus angustifolia* are planted along the edge of one side. The *P. euroamericana* trees at the survey plot are approximately 27 years of age with a tree height of 25 - 27 m and a dbh of 40 - 50 cm and their state of growth is fairly good. Although the decline grade of the planted trees of around 1 is low, damage due to defoliators can be observed [Fig. 2-4-10-(1) and Table 2-4-19-(1)].

Elaeagnus angustifolia which is planted at the edges of *P. euroamericana* stands forms a bush with a height of 3 - 4 m, preventing ground wind. The standard distance of 280 m between windbreak tree belts is approximately ten times the height of *P. euroamericana* and coincides with the maximum distance of windbreaking effect.

b) *Robinia pseudoacacia* Windbreak Forests

The *R. pseudoacacia* windbreak tree belt in question protects experimental farmland of the Sand Crop Research Institute in Dabuleni, an area under the jurisdiction of the Sadova Forest Range Office. The tree belt consists of four lines of trees with a distance of 1.5 m between the lines and 1.5 m between the trees. In addition, two lines of *Elaeagnus angustifolia* are planted along the forest edge. Many *R. pseudoacacia* trees have been generated by coppicing and the stand age survey using an increment borer suggests a stand age of approximately 25 years. The tree height ranges from 5 m to 10 m while the DBH ranges from 10 cm to 40 cm, showing a large growth discrepancy between individual trees. The decline grade is 2 and many declined trees have already been felled [Fig. 2-4-10-(2) and Table 2-4-19-(2)].

c) *Pinus nigra* Windbreak Forests

P. nigra is an indigenous species found in the West Part of the county neighbouring Dolj County. The environment of this habitat is sub-alpine with gravelly soil and this species is used for revegetation to restore landslide sites in the area. The surveyed tree belt constitutes a windbreak forest to protect the experimental farmland of the Sand Crop Research Institute at Dabuleni. *P. nigra* is densely planted in four lines with a distance of 1.5 m between the lines and 1 m between the trees. Along the windward edge of this *P. nigra* tree belt, *Elaeagnus angustifolia* is planted. Many of the *P. nigra* trees grow in the 5 - 8 m tree height class, showing a decline grade of 1 or 2 [Fig. 2-4-10-(3) and Table 2-4-19-(3)]. This *P. nigra* tree belt is believed to constitute a silviculture indicator for the future introduction of coniferous species in the Study Area.

Table 2-4-19 Structure of the Windbreaks

(1) Windbreaks of *Populus euroamericana*, Sadova

Row number	Number of trees	Average tree height (m)	Average diameter at breast height (cm)	Average declining grade of tree form
1	8	26.3	48.4	1.1
2	9	24.6	45.6	1.0
Total	17	25.5	47.0	1.1

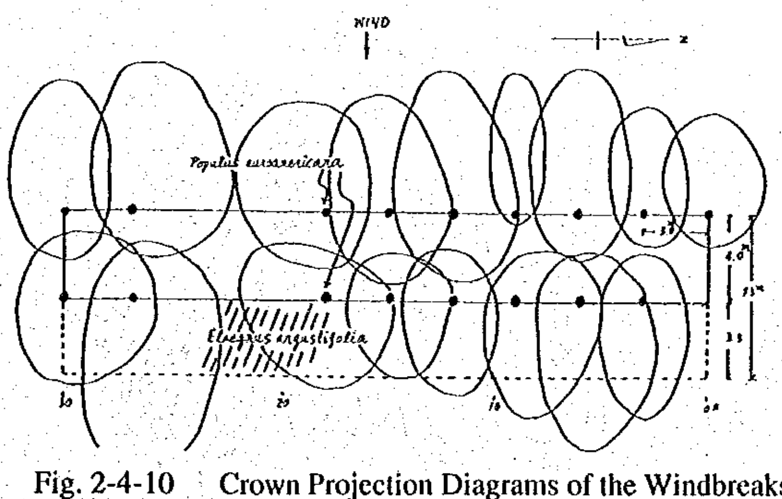


Fig. 2-4-10 Crown Projection Diagrams of the Windbreaks

(1) Windbreaks of *Populus euroamericana*, Sadova

Table 2-4-19 Structure of the Windbreaks
(2) Windbreaks of *Robinia pseudoacacia*, Dabuleni

Row number	Number of trees	Average tree height (m)	Average diameter at breast height (cm)	Average grade of declining	
				Die back	Tree form
1	7	8.6	18.1	1.7	1.6
2	4	9.3	22.8	3.0	2.8
3	3	9.0	18.7	3.0	3.0
4	9	9.3	26.0	2.6	2.3
Total	23	9.1	21.4	2.6	2.4

Note: Surveyed only existence tree

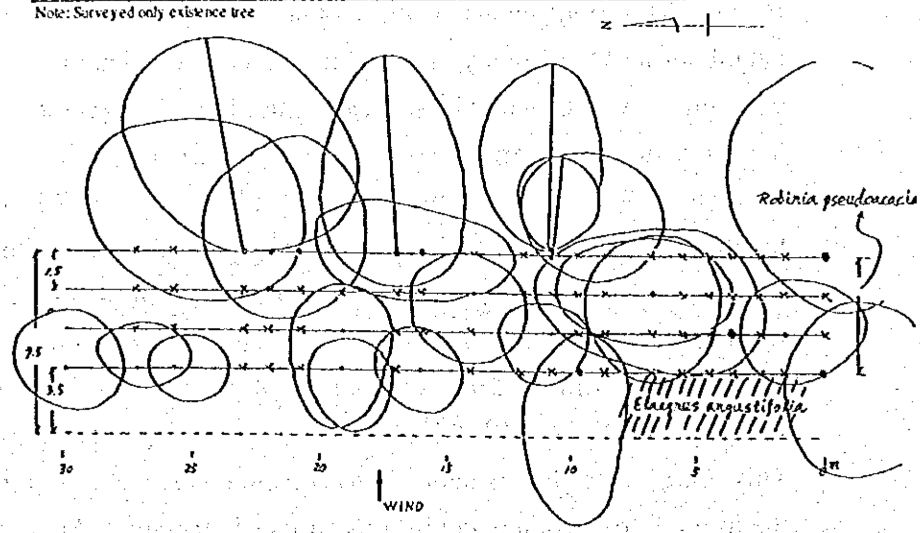


Fig. 2-4-10 Crown Projection Diagrams of the Windbreaks
(2) Windbreaks of *Robinia pseudoacacia*, Dabuleni

Table 2-4-19 Structure of the Windbreaks
(3) Windbreaks of *Pinus nigra*, Dabuleni

Row number	Number of trees	Average tree height (m)	Average diameter at breast height (cm)	Average declining grade of tree form
1	25	6.8	14.5	1.6
2	20	7.6	11.6	1.5
3	26	6.7	12.0	1.7
4	12	5.6	12.0	2.0
Total	83	25.5	12.6	1.7

Note: Surveyed only existence tree

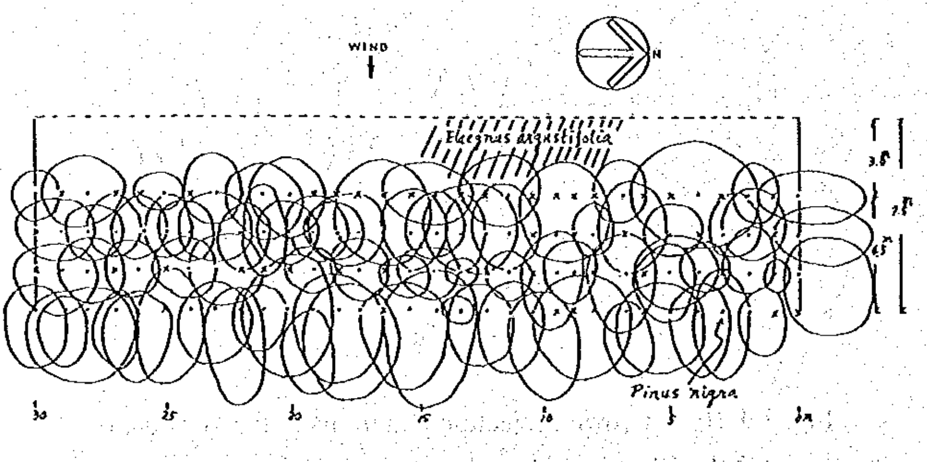


Fig. 2-4-10 Crown Projection Diagrams of the Windbreaks
(3) Windbreaks of *Pinus nigra*, Dabuleni

3) Soil Conservation Function

Surface flow and soil erosion occur at places with a low infiltration capacity. As in the case of the water conservation function described earlier, soil erosion is small in watershed with a high forest area ratio and a low ratio of farmland area. In the opposite case, soil erosion is judged to be large. It is, therefore, necessary to locate forests with a high infiltration capacity at sites where eroded soil is discharged to a river in order to prevent turbid water.

In those places where a river is carving mid to high terraces, steep slopes of more than 35° (terrace scarps) are formed, causing landslides (watershed of Scorburoaia River and Dejasca River, both tributaries of Olt River). As terrace scarps lack a bedrock layer, their conditions slightly differ from ordinary mountain land. If the slopes of these terrace scarps are covered by forests, it is believed that landslides are less likely to occur. As the use of steep slopes for purposes other than forest land is difficult, the conservation of steep slopes as forest land to prevent slope failure is required.

4) Climate Mitigation Function (Preservation of Living Environment)

Forests contribute to the conservation of the living environment for humans. Many villages (Cosoveni and Criva, etc.) in the Study Area are adjacent to forests and local forests function as a shield vis-a-vis emission gas from factories and automobiles. Any progress of forest decline damages this forest function. Sound forests must, therefore, be preserved or restored.

5) Wildlife Protection and Preservation Function

Forests provide a much richer habitat for wildlife than such other types of vegetation as grassland and farmland. The existence of forests with diverse species and a high forest area ratio means rich flora and fauna, preserving a complicated food chain which includes natural enemies.

Many forests were felled in Western Europe from the 18th century to the early 19th century to expand farmland and grazing land. As a result, there was a great population explosion of field mice and other pests. Learning from this experience, the restoration of forests earnestly commenced in the late 19th century, achieving a forest area ratio of more than 15%, even on plains, in the 20th century. However, the forest area ratio in the Study Area is still as low as some 10%, making at least the maintenance of the present forest area necessary in order to allow forests to function adequately.

6) Recreational Use and Landscape Maintenance Function

Landscape is something which is aesthetically evaluated by humans. Forests, which are harmonious from the viewpoint of natural science, present an excellent landscape. As such, a forest group (defined in terms of the composition of species, area size and forest layout) which maintains harmony with the natural ecosystem, a forest group with an excellent water resource conservation function and a forest group with an excellent windbreak function, etc. are also highly evaluated as landscape forests. These forests must, therefore, be preserved or restored.

7) CO_2 Fixation

The CO_2 fixation by forests and wood is attracting much attention in recent years from the viewpoint of preventing global warming. The problems associated with CO_2 emission pose an unavoidable challenge for advanced manufacturing, mining and other industries and strong interest is expressed in forest creation as a measure to reduce the adverse impacts of CO_2 emission. To be more precise, planning is in progress to design and create forests with these industries bearing part of the cost. In an age when funding for afforestation poses a stiff challenge for forestry which is in a difficult financial situation, such planning is a welcome trend to be exploited for the extension of forests. Forests designed to produce durable timber not only fix CO_2 during their growth period but also maintain CO_2 fixation in the form of harvested wood. As such, wood is considered an advantageous material to deal with the problem of CO_2 emission.

Among existing forests in Olt and Dolj Counties, the area by site quality and damage grade was established for conspicuously damaged *Quercus* spp. forests and *Robinia pseudoacacia* forests to calculate the CO_2 fixation volume. In addition, the volume of CO_2 fixation at existing forests and declined forests (converted based on the volume at final cutting) was calculated to roughly estimate the monetary value. The calculation results are shown in Table 2-4-20. The line of thinking for CO_2 fixation calculation is explained in App. E-5.

The CO_2 fixation volume of forests consisting of fast growing species where harvesting and regeneration are frequently conducted is not necessarily high. These forests may be disadvantageous unless they can show high profitability as every regeneration incurs an expense. In this context, *Quercus* forests, particularly healthy forests of Class IV or higher, can be valued as having a good CO_2 fixation function as well as being profitable.

Table 2-4-20 Quatitative Fixation Ability in Existing Forests and Declined Forests

Kinds of Forest	Forest Area	On Standard Cutting Age				On Standard Cutting Age				Annual Fixed Quantity of Carbon	
		Unit Stock	Forest Stocks	Carbon in Forests	Evaluation	Unit Stock	Forest Stocks	Carbon in Forests	Evaluation	Fixed Carbon	Evaluation
	ha	m^3/ha	10^3m^3	10^3tC (A)	10^6\$	m^3/ha	10^3m^3	10^3tC (B)	10^6\$ (Be)	10^3tC	10^3\$
Quercus Forest		(100 years old)				(50 years old)				B/50y	Be/50y
Whole Forest	77,317.0	309	23,891.0	7,768.10	310.72	170	13,143.9	4,266.04	170.64	85.32	3,413
Declined Forest											
before damage	8,334.5	284	2,370.5	767.10	30.69	156	1,301.8	422.52	16.90	8.45	338
after damage	5,504.8	299	1,644.8	532.50	21.30	164	905.5	293.89	11.76	5.88	235
damaged ammount	2,829.7	260	735.7	233.60	9.39	143	369.3	128.63	5.15	2.57	103
Robinia Forest		(30 years old)				(15 years old)				B/15y	Be/15y
Whole Forest	25,696.6	163	4,188.5	1,268.40	50.74	99	2,544.0	768.02	30.72	51.20	2,048
Declined Forest											
before damage	840.1	152	127.7	38.55	15.42	92	77.3	23.33	0.93	1.56	62
after damage	419.1	163	68.6	20.71	8.28	99	41.5	12.53	0.50	0.84	33
damaged ammount	421.0	140	59.1	17.84	7.14	85	35.8	10.80	0.43	0.72	29

tC*A*10^2: Quantability of carbon fixation in the existing forests

tC*a*10^2: Quantability of carbon fixation in the declined forests (before damage)

Σ(f*tC*a)*10^2: Quantability of carbon fixation in the declined forests (after damage)

(2) Forest Function Groups in Romania

Forest functions are classified into several groups in Romania as shown in Table 2-4-21.

Table 2-4-21 Forest Function Groups in Romania

Group	Sub-Group	Name	Description	Remarks
1: Forest with Special Protection Function				
	1) Forests with water conservation function		Forests located near sources of drinking and industrial water, etc.	1a - 1i
	2) Forests with soil and land conservation function		Forests at devastated land, flying sand zones and swamps, etc.	2a - 2l
	3) Forests with protection function vis-a-vis climatic factors and industrial pollution, etc.		Forests protecting farmland and roads, etc. and forests in areas of air pollution, etc.	3a - 3k
	4) Forests with recreational function		Forests with forest park and recreation function, forest to protect and develop hunting resources	4a - 4k
	5) Forests with scientific function vis-a-vis genetic and environmental sources		National park, natural park and forests to protect genetic and ecological resources	5a - 5 l
2: Forests with Protection and Production Functions				2.0a - 2.0c

Source: Norme technica pentru amenajamentul silvice (1986)

Of the two groups shown in Table 2-4-21, Group 1 consists of forests which are expected to perform the environmental conservation function while Group 2 consists of forests which are expected to perform the resources production function in harmony with the environmental conservation function. As the environmental conservation function is further classified into sub-functions (sub-groups), the designated functions of forests in the Study Area were listed and certain functions were combined based on their similarity. Accordingly, the use of the groups shown in Table 2-4-22 is deemed appropriate to establish the forestry activity (forest management method) and to conduct the functional evaluation of forests for the Plan formulation purposes.

Table 2-4-23 shows the area of forests, area of damaged forests and ratio of damaged forests by forest function category in Olt and Dolj Counties based on the above functional categories. In this table, a large damaged area can be observed with *Quercus* forests in hilly areas (1.3C), timber production forests (2.0B) and windbreak forests (1.2G), etc. while a high proportion of damaged forest area in the total forest area can be observed with *Quercus* forests in hilly areas (1.3C), windbreak forests (1.3K), recreation forests (1.4I) and seed forests (1.5H), indicating the importance of *Quercus* forests in hilly areas in the Study Area.

Table 2-4-22 Grouping of Forest Function for Formulation of Forest Restoration Plan

Forest Function Under the Plan	Forest Function Group in Romania[1]		
	Group	Description	Operation Standards[2]
1. Wood Production	2.0a	Wood production. Large diameter trees to produce high quality timber for furniture and musical instruments, etc.	V
	2.0b	Wood production. High quality large diameter trees and ordinary quality large diameter trees	VI
	2.0c	Wood production. Small to medium diameter trees for chipping materials and ordinary building timber	VI
2. Water Source Conservation	1.1a	Conservation forests to provide sources of drinking and industrial water	II
	1.1b	Hill forests around reservoirs or natural lakes	III
	1.1c	Forests around mountain rivers; forests supplying water to a lake within a radius of 15 - 30 km of the lake	IV
	1.1d	Belt-like forests along rivers in the Danube delta and other rivers	IV
	1.1e	Forests adjacent to lakes; forests protecting riversides, including those in mountain areas	III
	1.1g	Forests developed in fans or at the large sedimentation sites of torrents	III
	1.1h	Forests above water sources supplying nutrition for the culture of trout and forests along valleys providing habitat for trout; minimum area of 100 ha	II
3. Soil Conservation	1.1f	Forests located on scoured slopes at the riverside	IV
	1.2a	Forests at eroded sites	II
	1.2b	Forests adjoining public roads or railway lines in areas with unique undulations Artificial stands at devastated land	II
	1.2c	Forests at landslide sites	II
	1.2h	Forests in swamp areas	II
	1.2i	Forests at and around open cast mines and liable to erosion	II
	1.2j	Forests at vulnerable land to erosion and landslides	II
	1.2l		II
4. Windbreak (Protection of Farmland)	1.2g	Forests in flying sand areas	III
	1.3c	Forests protecting farmland and roads, etc.	II
	1.3k	Forest edges of plain forests or low hill forests (minimum width of 20 m)	II
5. Climate Mitigation (Protection of Livelihood)	1.3a	Forests in the steppe zone	III
	1.3d	Forests around basins with lakes	II
	1.3g	Scattered forests of 100 ha in size or small in the hill zone	III
	1.3h	Forests moderately affected by the falling of air pollutants	II
	1.3i	Forests weakly affected by the falling of air pollutants	III
	1.3j	Forests adjacent to disposal areas of industrial waste, etc.	II
6. *Quercus* Forests in Hill Areas	1.3c	*Quercus* forests in hill areas	II
7. Recreational Use and Landscape Maintenance	1.4a	Forests with forest park and recreational functions	II
	1.4b	Forests near settlements (including the function of supplying forest products)	III
	1.4c	Forests with valuable landscape and located around cultural remains	II
	1.4f	Forest belts around hotels in tourist areas	II
	1.4g	Forests around agricultural complexes or workshops for agricultural machinery Forests adjacent to settlements at hills or valleys	II
	1.4h	Forests along access roads to tourist areas	IV
	1.4i	Forests protecting special objects	II
	1.4k	Landscape conservation forests containing beautiful plant communities or topographical features	II
	1.5e		I
8. Hunting	1.4j	Forests protecting, developing and receiving the benefits of hunting	IV
9. Wildlife Protection and Preservation	1.5c	Nature conservation forests preserving the living environment for the entire species of a forest ecosystem	I
	1.5d	Nature reserves for scientific research and genetic resources conservation forests Endangered flora and fauna protection forests; giant tree protection forests	I
	1.5f	Experimental forests	I
	1.5g	Seed collecting stands; tree genetic resources conservation forests	II
	1.5i	Animal colony protection forests	II
	1.5j	Old-age forests of special value; forests with rare species	II
10. Seed Stands	1.5h	Seed stand; tree genetic resources conservation forest	II

Note: 1) As only forest functions relevant to Olt and Dolj Counties are listed here, this table is not an exhaustive list of forest functions regulated by RNP.

2) The following operation standards by forest function apply in Romania.

I. Forests with special environmental conservation functions
Cutting is prohibited in these forests without a permit issued by the competent organization under the Environmental Protection Law (trees may be cut and used for research purposes as an exception).

II. Forests with special environmental conservation functions
These forests are located in places characterised by ecological difficulty and cutting is not allowed under ordinary regulations. Special conservation work is conducted in these forests in accordance with the instructions clearly given by the Romanian Forests Planning. (The only permitted activities are 1) special forest conservation work in response to the specific conditions of forests to improve the environmental conditions and protection function and 2) cutting to control damage by diseases and pests.)

III. Forests with special protection functions (functional categories of 1.1B, 1.1G, 1.3I, 1.4B, 1.4D, 1.5B and 1.5I)
Intensive management, selective cutting and/or semi-selective cutting are permitted in these forests depending on the inclination of the forest land. If the inclination is 25° (30°) or more, special conservation work is conducted.

IV. Forests with special protection functions
Other types of operation may apply under a certain regulatory regime at these forests and selective cutting or semi-selective cutting is permitted.

V. Forests with special protection functions as well as production function
These forests supply high quality wood and selective cutting, semi-selective cutting or group selective cutting is applied.

VI. Forests with special protection functions as well as production function
All types of operation may apply at these forests, taking the ecological conditions, socioeconomic conditions and management conditions in that order into consideration.

Table 2-4-23 Area of Forests, Area of Damaged Forests and Ratio of Damaged Forests by Forest Function Category

Forest Function Under the Plan	Current Functional Category Used by RNP	All Forests *1			Damaged Forests			Ratio		
		Olt (ha)	Dolj (ha)	Total (ha)	Olt (ha)	Dolj (ha)	Total (ha)	Olt (%)	Dolj (%)	Total (%)
1 Wood Production	2.0 A									
	2.0 B	16,647.5	18,444.8	35,092.3	2,176.7	954.0	3,130.7	13.1	5.2	8.9
	2.0 C	1,642.0	1,162.3	2,804.3	30.9	79.4	110.3	1.9	6.8	3.9
		18,289.5	19,607.1	37,896.6	2,207.6	1,033.4	3,241.0			
2 Water Source Conservation	1.1 A									
	1.1 B	4,043.1		4,043.1	25.4		25.4	0.6		0.6
	1.1 C	2,038.1		2,038.1						
	1.1 D	2,648.2	2,163.9	4,812.1						
	1.1 E	305.3	744.4	1,049.7		2.1	2.1		0.3	0.2
	1.1 G									
	1.1 H									
		9,034.7	2,908.3	11,943.0	25.4	2.1	27.5			
3 Soil Conservation	1.1 F	1,243.0	4,409.7	5,652.7						
	1.2 A	670.9	294.0	964.9	10.1	26.3	36.4	1.5	8.9	3.8
	1.2 B	39.0	61.5	100.5						
	1.2 E	628.8	2,863.9	3,492.7		91.6	91.6		3.2	2.6
	1.2 H		40.3	40.3						
	1.2 I	15.6	92.2	107.8						
	1.2 J									
	1.2 L	1,629.4	739.4	2,368.8	1.7	42.5	44.2	0.1	5.7	1.9
		4,226.7	8,501.0	12,727.7	11.8	160.4	172.2			
4 Windbreak (Protection of Farmland)	1.2 G		14,897.7	14,897.7		595.9	595.9		4.0	4.0
	1.3 E	187.0	1,511.2	1,698.2						
	1.3 K	35.3	3.2	38.5	9.7		9.7	27.5		25.2
		222.3	16,412.1	16,634.4	9.7	595.9	605.6			
5 Climate Mitigation (Protection of Livelihood)	1.3 A	825.4	2,003.3	2,828.7	27.4	86.6	114.0	3.3	4.3	4.0
	1.3 D	29.9	44.2	74.1						
	1.3 G	1,695.4	678.9	2,374.3	62.2	137.2	199.4	3.7	20.2	8.4
	1.3 H									
	1.3 I		72.3	72.3						
	1.3 J	1.2	127.1	128.3						
		2,551.9	2,925.8	5,477.7	89.6	223.8	313.4			
6 *Quercus* Forests in Hill Areas	1.3 C	1,760.4	17,347.3	19,107.7	1.8	4,132.3	4,134.1	0.1	23.8	21.6
		1,760.4	17,347.3	19,107.7	1.8	4,132.3	4,134.1			
7 Recreational Use and Landscape Maintenance	1.4 A	71.4		71.4						
	1.4 B	331.3	1,166.5	1,497.8	117.4	43.2	160.6	35.4	3.7	10.7
	1.4 E									
	1.4 F	55.1	32.0	87.1	4.9		4.9	8.9		5.6
	1.4 G									
	1.4 H	191.9		191.9	12.3		12.3	6.4		6.4
	1.4 I	194.4	380.9	575.3	63.2	22.8	86.0	32.5	6.0	14.9
	1.4 K		162.7	162.7						
	1.5 B		15.0	15.0						
		844.1	1,757.1	2,601.2	197.8	66.0	263.8			
8 Hunting	1.4 J	3,637.5	202.1	3,839.6	322.1		322.1	8.9		8.4
		3,637.5	202.1	3,839.6	322.1		322.1			
9 Wildlife Protection and Preservation	1.5 C	146.7		146.7						
	1.5 D	136.8		136.8						
	1.5 F	54.3		54.3						
	1.5 G		325.6	325.6						
	1.5 I	45.8		45.8						
	1.5 J	2.7		2.7						
		386.3	325.6	711.9						
10 Seed Stand	1.5 H	398.0	733.8	1,131.8		124.3	124.3		16.9	11.0
		398.0	733.8	1,131.8		124.3	124.3			
Total		41,351.4	70,720.2	112,071.6	2,865.8	6,338.2	9,204.0	6.9	9.0	8.2

Note: The figures for All Forests differ from those used in the present Report as these are the figures given in the forest management plans for the forest range offices.

(3) Positive Effects of Forest Functions Other Than Wood Production

The field survey in the first year found such functions other than wood production, including fuelwood, in the Study Area as the harvesting of forest by-products, provision of hunting grounds and sites for apiculture, windbreaking, water source conservation, soil conservation and the preservation of forest landscape, etc. The current conditions of these functions were surveyed together with a socioeconomic survey through interviews with field staff of the RNP, village heads and representatives of farmers. The results of these interviews in the North, Middle and South Parts are summarised in App. C-2. Of these functions, those providing direct revenue for the RNP are listed in Table 2-4-24.

Table 2-4-24 Income of RNP from Forest Functions Other Than Wood Production

(1,000US$)

	Year	1980	1985	1990	1993	1996	1997	1998
Forest by-products	Olt	133	82	141	76	115	252	56
	Dolj	144	47	68	20	24	59	36
Hunting	Olt	61	12	73	169	75	54	91
	Dolj	111	82	182	104	92	87	116
Fisheries	Olt	0	0	23	1	4	9	11
	Dolj	22	29	23	8	14	21	17
Apiculture	Olt	56	71	18	31	12	26	42
	Dolj	39	112	5	3	0	0	0

Source: RNP

Forest by-products include the small fruit of shrubs, medicinal herbs, mushrooms and fodder grass, all of which grow naturally in forests. The RNP employs local people on a daily wage basis to collect and sell these by-products to earn revenue. Local people are permitted to collect small quantities of these by-products for their own consumption. Therefore, forest by-products benefit local communities by means of providing waged labour and supplying household needs. Of the RNP's sales income of approximately US$ 92,000 in 1998, some US$ 68,000 was paid to local people in the form of wages.

Hunting is conducted in almost all forest areas and surrounding fields. The RNP and the General Association of Hunting and Fishery (AGVPS) conduct surveys on wild birds and animals and activities to assist breeding through feeding and to protect them. They make financial gains by collecting a fee from hunters for hunting permits and selling the meat of the wild animals received from hunters. The estimated income of the RNP and AGVPS in 1998 was some US$ 207,000 and US$ 187,000 respectively.

The RNP and AGVPS also charge a fee for fishing in inland waters. Another source of income is the culture of such fish as trout. These fishery activities are possible because of the contribution of forests to a stable supply and the purification of river water which must be counted as one of the conservation effects of forests. The estimated income of the RNP and AGVPS in 1998 from fisheries was some US$ 28,000 and US$ 14,000 respectively.

Apiculture relies on honey bees which are attracted to the flowers of various trees, shrubs and herbs growing in forests. *R. pseudoacacia* and *Tilia platyphyllos* are particularly useful species. The figures shown in the above table indicate the direct revenue of the RNP from apiculture. In addition, the Apiculture Association alone has more than 3,000 local members. In the case of *R. pseudoacacia* and *Tilia platyphyllos* forests, 4 - 5 beehives can be installed per hectare with each beehive producing some 19 kg of honey in spring. In summer, apiculture is conducted in sunflower fields with each beehive producing some 40 - 50 kg of honey. The producer price of honey in 1998 was approximately US$ 1.8/kg. The honey production value of the RNP in 1998 was US$ 42,000 which was earned by the former Slatina Forest Branch Office. The total production value of private apiculturists was some US$ 1,037,000, the spring production value of which accounted for some US$ 438,000, indicating the relatively large economic effect of local apiculture.

Even though the RNP earns income from various sources, the large costs of each activity has reduced the profitability. Consequently, the RNP is planning to transfer the production of forest by-products and honey, craftwork and fish culture, etc. to the private sector so that it can concentrate mainly on forest management, such as wood production and the control of wild birds and animals.

The windbreaking effect of forests on farmland, etc. is strongly recognised by farmers in the southern areas of both counties. The spread of sandy soil from the riversides of the Danube to low tableland areas and the dry climate mean that strong wind causes flying sand, damaging not only crops but also the farmland itself. In view of the importance of windbreaks, more than 16,000 ha of windbreak forest belts have already been established using *P. pseudoacacia* and *Populus* spp., contributing to farming activities together with the remaining forests in the form of consolidation. Farmland between these forest belts mainly produce wheat, maize, sunflowers, melons and grapes. The fact that none of these can be cultivated without windbreak forests due to strong wind and flying sand shows the important windbreaking effect of forests.

The water source conservation function of forests is not well recognised by local people, because of the fact that most of the Study Area is flat. The supply of domestic water for such key cities as Craiova and Slatina originates from artificial dams constructed in the Carpathian Mountains, and clean water produced by local forests is hardly used except for watering domestic vegetable gardens in some villages. Local people living near forests use well water to meet their daily water needs. While wells in and around forests show little fluctuation of the water level even in a year of drought, those located far from forests have dried up in the past, making their users understand the water retention function of forests.

The soil conservation function of forests is also not well recognised by local people, because of the generally flat terrain of the Study Area. However, this function is recognised by people living near specific areas where landslides have occurred in the past, or where the land has been devastated. People living along such large rivers as Danube River and Olt River are aware of this function, because of their past experience of soil erosion at the time of flooding and also because of their observation of the mitigation of soil erosion by the riverside forests. In areas of sandy soil in the south, people are aware of the windbreaking as well as soil conservation effects of forests, because forests prevent flying sand caused by strong wind. In some areas, *R. pseudoacacia*, *Elaeagnus angustifolia*, *Populus* spp. and *Quercus* spp. have been planted to benefit from these forest functions.

There is an increasing trend of utilizing beautiful forest landscape for recreational purposes as well as for tourism as shown in Table 2-3-1. While local people have been the main visitors to forests so far to enjoy picnics, the development of the road network in the Middle Part due to advancement of the motorization of Romanian society has prompted an increased number of visitors to forests for recreational purposes. There is a good prospect of the emergence of commercial activities on the green tourism, making the best use of the natural combination of rivers, lakes, forests, ranches and farms, and also agro-tourism through which tourists can experience farming in the future.

2.4.7 Forestry Work and Forest Management

(1) Past and Present Measures

1) Forest Decline Improvement Measures

Annual survey guidelines have been established in Europe to evaluate forest conditions using five grades (0 to 4) based on the degree of defoliation and discolouration. These guidelines were first introduced in Germany in 1983 and are now accepted by many European countries. Romania is one such country using the guidelines for judgement of the state of forest decline and decisions on pest control measures and the cutting of declined trees. In addition to the application of these guidelines, the occurrence rate of damaged trees in stands is surveyed with a view to classifying the damage in each stand in one of four grades.

Efforts to deal with declined forests so far have concentrated on the cutting of damaged trees and planting at felling sites. These two activities have been employed for stands where the ratio of damaged trees is 65% or more. Unfortunately, however, the subsequent growth of the planted trees has not been very favourable due to the increasingly dry climate and soil, etc.

The RNP has been experimenting with various planting methods. A typical attempt can be seen at Letea in the area under the jurisdiction of the Ghimpati Forest Range Office of the Giurgiu Forest Branch Office where the following methods are being used under a joint research project with the ICAS.

① Direct seeding at felling sites of damaged trees in stands

② Clear cutting of damaged stands, followed by deep ploughing and seeding in planting holes

③ Clear cutting of damaged stands, followed by removal of the stumps by tractor, deep ploughing and straight line seeding

④ Clear cutting of damaged stands, followed by removal of the stumps by tractor, deep ploughing and planting of seedlings

⑤ Clear cutting of damaged stands, followed by removal of the stumps by tractor, deep ploughing and planting of seedlings after use of the land for farming for one year

Of these sites, those where methods ④ and ⑤ are used show favourable growth of the planted trees. Deep ploughing has increased the porosity of the soil, improving the permeability. However, deep ploughing is very expensive and further research is in progress to develop new methods. The conditions of the soil at planting sites where method ④ is employed are discussed further in 2.6.1.