REPUBLIC OF CROATIA
COASTAL FOREST RECONSTRUCTION AND PROTECTION PROJECT

ANNEX J.
ECONOMIC ANALYSIS

I. INTRODUCTION

1. This Annex presents the results of the economic analysis for the proposed Coastal Forest Reconstruction and Protection Project in the Republic of Croatia. The main objective of the project is to restore and protect forest land in the coastal zone of Croatia in order to enhance landscape and recreation values of the region and thereby contribute to restore tourism to its pre-war level. Other objectives related to the project's main objective are to (i) restore the environmental role of coastal forests destroyed by the war, in protecting soils and waters, and initiate the restoration of the natural vegetation; (ii) address the problem of forest fire that is a crucial threat to coastal areas; and (iii) develop the knowledge base for improved management and protection of coastal forests.

2. In the Bank Group's Country Assistance Strategy, this project is envisaged as part of a long-term program to restore and maintain favorable ecological conditions in coastal areas in support of tourism. Other projects which address environmental problems in areas of strong tourist significance are also being prepared or implemented. The environment plays a particularly important role in Croatia's coastal areas because of its close links to the performance of the tourism sector.

3. The project, to be implemented over 5 years, would include the following 3 components:

(a) *reconstruction of coastal forests* destroyed by war activities including the reconstruction of about 5,800 ha of forests, and the reconstruction of one nursery and one arboretum;

(b) *forest fire management* in coastal areas including a comprehensive package of prevention, pre-suppression, and suppression measures; and

(c) *support services* including research in coastal forestry, testing new methods to combat forest fires, and training and technical assistance to Hrvatske Sume (HS) and the Ministry of Interior (MoI).

The economic analysis presented in this paper focuses on the two investment components of the project: the reconstruction component and the forest fire management component.

4. Economic analysis was an integral part of project preparation. Numerous alternatives were fully evaluated before the final project design was arrived at. Even prior to this stage, however, economic principles were taken into consideration in project design. Reforestation activities, for example, are undertaken primarily in areas where there has been little or no natural regeneration, while cheaper silvicultural interventions are carried out where natural regeneration has been strong. Measures designed to help prevent forest fires are targeted in areas most at risk and where the damage from fires would be greatest.

II. BENEFITS PROVIDED BY COASTAL FORESTS IN CROATIA

5. Forests provide many benefits. Historically, timber production has been the primary benefit considered. In recent years, however, there has been increasing awareness that the non-timber benefits provided by forests can be very significant. This is definitely the case in the island and coastal areas of Croatia, where timber production provides only a very small part of total forest benefits. The primary benefit of coastal forests results from their contribution to the landscape. Evidence shows that forested landscapes significantly increase the attractiveness of resort areas. Tourists are less likely to come to areas without such landscapes, or will only come if prices are significantly lower.

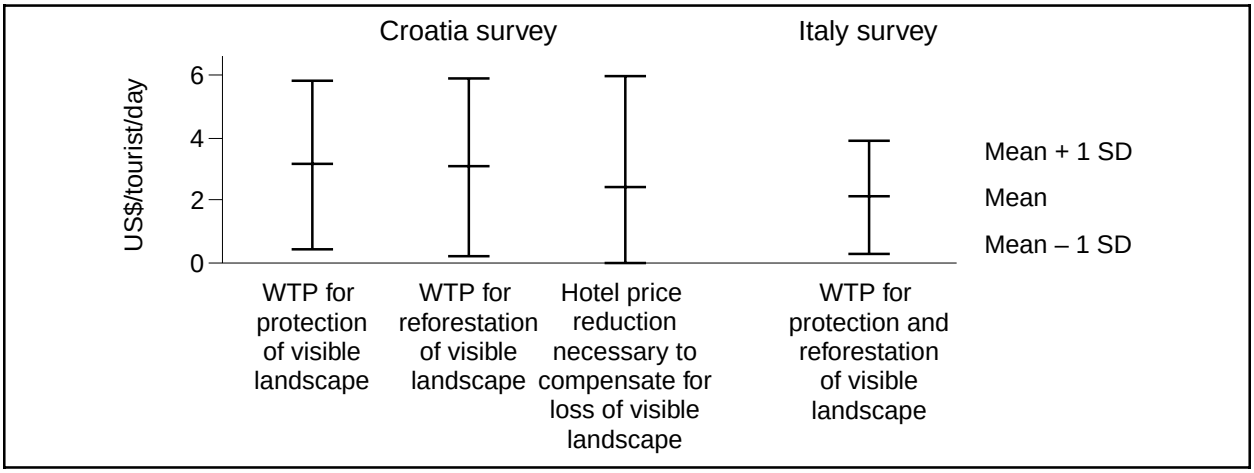
6. **Landscape benefits**. Forested landscapes are an important aspect of the Dalmatian coast's attractiveness. In order to quantify the benefits of attractive, forested landscapes, two contingent valuation studies of tourist willingness to pay for forest landscapes were conducted during the summer of 1995. Contingent valuation is a commonly-used technique to obtain monetary values for goods and services for which markets do not exist. Survey respondents are asked for their willingness to pay (WTP) or for their willingness to accept compensation (WTA) for specified increases of decreases in the level of the service.

(a) The Institute for Tourism Zagreb conducted a contingent valuation study of tourist willingness to pay for forest protection and reconstruction. Tourists were shown pictures of resort areas in Croatia before and after fires had destroyed forests in their vicinity. They were then asked how much they would be willing to pay, in the form of a surcharge to their hotel bills, for protection and reconstruction of forest landscapes visible from the resort they were staying in. Very similar results were obtained irrespective of the way in which the question was posed. Tourists were also asked how much hotel prices would have to decline to induce them to return if the landscape was marred by fire. The results of this survey show that tourists have a strong preference for forested landscapes, and are willing to pay about 3 US$/tourist/day to preserve or restore them, as shown in Figure J.1.

(b) Because of the possibility that fighting in Croatia in the spring of 1995 affected the tourist season and may have resulted in a non-representative tourist population, a parallel study was carried out among foreign tourists in two competing tourist destinations in Italy. A very similar questionnaire and the same photographs were used. The results of the survey conducted in Italy were broadly similar to that carried out in Croatia, as also shown in Figure J.1. However, willingness to pay for forest improvements was lower, with only about one-third of the sample being willing to pay more than 2 US$/tourist/day.

Although both surveys gave broadly similar results, both contained substantial variance, as can be seen in Figure J.1. Information from these surveys is consistent with data obtained from other sources. An analysis of hotel room prices by the Institute for Tourism Zagreb, for example, found that double rooms in hotels in areas with attractive forest landscapes tended to cost about 5–10 DEM/day (3–6 US$/day) more than rooms in hotels in areas with little forest landscape. (These estimates should be interpreted cautiously, however, since sufficient data were not available to allow for other differences in hotel amenities which might also influence the price.) Interviews with hotel managers indicate that most consider forest landscaping an important aspect of their attractiveness and believe attendance would fall sharply if the surrounding forest landscapes were destroyed. They estimate they would have to reduce room prices by as much as 24-32% to remain competitive. Although the magnitude and the degree of confidence of each of these estimates differs, all point in the same direction. In the calculations, a conservative value of willingness to pay for forest landscapes in tourist areas of 1.50 US$/tourist/day is used.

FIGURE J.1: ESTIMATES OF WILLINGNESS TO PAY (WTP) FOR VISIBLE FOREST LANDSCAPES BY TOURISTS IN CROATIA AND ITALY



7. The total benefits derived from forest landscapes depend on the total size of the local tourist population. Attractive forest landscapes are public goods, which can be enjoyed by many people without detracting from the enjoyment of others. At present, the tourist population is well below the pre-war level of about 60 million overnights a year. Rebuilding to pre-war levels will take time, given the damage suffered by tourist infrastructure and lingering tourist uneasiness over the prospects of peace holding. It is assumed that the tourist population will recover from its current level of about 20 million overnights to its pre-war level of 60 million overnights in five years. This rate of recovery is consistent with the recovery that was observed in the northern county of Istria, which was less affected by the war, during 1992-1994. In each year, the tourist population is assumed to be distributed throughout the coastal zone in accordance with the pre-war distribution (Table J.1).

8. **Regional forest landscapes.** Visible forests provide a direct benefits to tourists who can see them. In addition to willingness to pay for loss of visible forest landscapes, tourists were also surveyed on their willingness to pay for protection of all forests in the coastal region. This estimate reflects the value tourists place on the existence of coastal forests rather than on their amenity value. A conservative value of 0.75 US$/tourist/day is adopted for the calculations.

9. **Wood production.** Although the coastal areas are not important wood production areas, some local wood is used for pulp and some for sawlogs. Pulp production is currently suspended, since the factory in Bosnia is inaccessible, but is likely to resume soon as the peace process progresses. In any case, likely future wood shortages in Europe will make the wood from Croatia's coastal forests increasingly valuable.

10. **Hunting.** In addition to the amenity value derived from their contribution to the landscape, forests also provide recreational opportunities for foreign tourists in the form of hunting activities. The benefit of these activities can be quantified by using the values derived from the lease of hunting rights to foreign hunters. The hunting value of the sites differs, based partly on inherent site characteristics, but especially because of differences in accessibility. Areas near tourist destinations provide particularly attractive hunting venues because of their accessibility and the possibility of combining hunting with other activities in a single vacation. On good hunting lands, these leases generally cost about 30 DEM/ha, or about 20 US$/ha, with a range of 50 DEM/ha (33 US$/ha) on very good hunting land to 10 DEM/ha (7 US$/ha) on marginal hunting land. About half the coastal forest areas are considered suitable for hunting.

TABLE J.1: ESTIMATED RECOVERY OF THE TOURIST POPULATION IN THE ISLAND AND COASTAL AREAS OF CROATIA
(million overnights)

		Year					
County	%	0	1	2	3	4	5+
Istria	35	6.9	9.7	12.5	15.3	18.0	20.8
Primorje & Gorski Kotar r.	22	4.5	6.3	8.1	9.9	11.7	13.5
Lika-Senj	2	0.4	0.6	0.8	0.9	1.1	1.3
Zadar-Knin	7	1.5	2.1	2.6	3.2	3.8	4.4
Sibenik	5	1.0	1.4	1.7	2.1	2.5	2.9
Split-Dalmatia	18	3.5	5.0	6.4	7.8	9.2	10.6
Dubrovnik & Neretva r.	11	2.2	3.0	3.9	4.8	5.6	6.5
Total	**100**	**20.0**	**29.0**	**38.0**	**47.0**	**56.0**	**60.0**

11. **Other benefits.** In addition, several other categories of benefits should be mentioned:

(a) **Non-timber forest products.** A variety of products can be and are harvested from forest areas, including fuelwood, fodder, fruit, and various medicinal and aromatic plants. Forest fires do not necessarily destroy these benefits, however, except perhaps in the very short term. In some cases, production of non-timber products might increase. Many medicinal and aromatic plants, for instance, prefer open areas such as those created by forest fires to the interior habitat of shaded high forest. Whether production of secondary non-timber products would rise or fall after forest fires is, therefore, uncertain.

(b) **Recreational value.** Forest areas also provide recreational benefits to local populations, especially where they are in close proximity to population concentrations. The social survey carried out during project preparation showed that local populations value forests for this purpose. No information is available, however, on the magnitude of recreational benefits.

(c) **Watershed protection.** In some areas, forests help protect dams or urban areas from erosion. As with recreational benefits, these benefits are potentially quite significant on specific sites but generally small on average. Improvements to hydrological conditions are similar but harder to quantify.

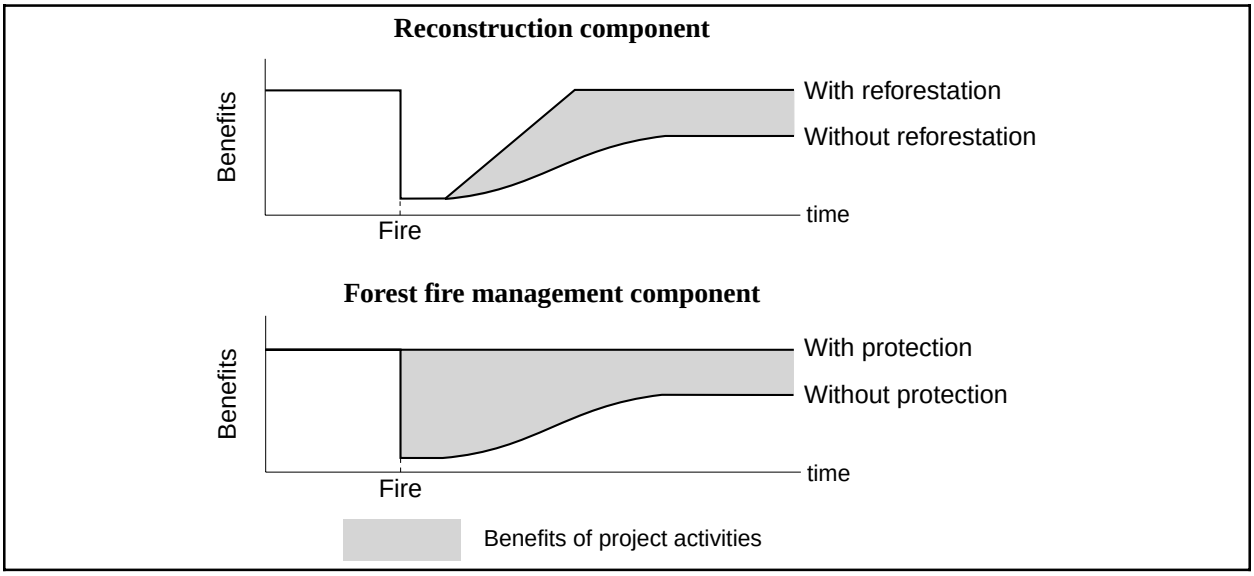
(d) **Microclimatic effects.** Forests can affect local microclimates by providing shade and windbreaks. This effect is generally unquantifiable.

The exclusion of these benefits, whether for lack of data or for other reasons, implies that the estimated value of forest benefits used in evaluating the benefits of the reforestation and protection activities of the project are conservative. Actual benefits, if they could be fully quantified, are likely to be larger than those assumed in the calculations.

12. **Computing benefits.** The same basic data are used to compute the benefits of both the reforestation component and the forest fire management component. Because of the difference in the nature of these activities, however, the data have to be used differently in each case.

(a) In the reconstruction component, activities are undertaken on specific, known sites to rebuild benefits which have been lost to fires. The appropriate measure of the benefits is the

FIGURE J.2: COMPARISON OF COMPUTATION OF BENEFITS IN THE RECONSTRUCTION AND FOREST FIRE MANAGEMENT COMPONENTS OF THE PROJECT



difference between the benefits that will be obtained by reforesting and those that would have been obtained otherwise. In the top panel of Figure J.2, this is shown as the shaded area between the flow of benefits with reforestation and those without.

(b) In the forest fire management component, the starting point is a forest area which is producing benefits. In the without project case, fire destroys these benefits, which may then rebuild over some time, perhaps only partially. If protection is successful, on the other hand, the loss of benefits will be averted. The averted loss of benefits, shown as the shaded area in the bottom panel of Figure J.2, is the appropriate measure of the benefits. An additional complication is that it is impossible to know, *ex ante*, which hectare of forest will burn. Since forests in different areas have different values, it matters which one would have burnt in the absence of protection. When estimating the benefits of protecting forest areas, therefore, a weighted average of the value of different parts of the forest must be used, with the probability that a given area will burn used as a weight.

IV. RECONSTRUCTION COMPONENT

Background

13. About 11,000 ha of forest in the island and coastal areas of Croatia were destroyed in 1991-92 by fires caused either directly by incendiary bombs and rocket attacks or indirectly by other war activities. Many of the forest areas affected are in important tourist areas. Rehabilitation of forest areas in tourist areas is crucial to the recovery of the tourist industry for two reasons. First, evidence shows that forested landscapes significantly increase the attractiveness of resort areas. Tourists are less likely to come to areas without such landscapes, or will only come if prices are significantly lower. Second, the persistence of devastated areas so close to tourist resorts undermines the country's ability to assure tourists that the threat hostilities is no longer a factor. The Project's reconstruction activities include the reconstruction of 5,000 ha of damaged forests. This section provides an economic analysis of this component.

TABLE J.2: WORK PLANS FOR THE PROPOSED REFORESTATION SITES
(ha)

County, Site	Site Clearing	Planting with ripping	Planting with manual soil preparation	Thinning coppice forests	Thinning plantations and natural regeneration	Comple-mentary planting	Area planted	Area thinned
Lika-Senj								
Jasenje-Bisernjakovica			161				161	0
Sibenik								
Brdo Sv Kate	80		24	64	142		24	206
Culisica brdo	50	80	25		80		105	80
Vlake	40	28	12				40	0
Zadar-Knin								
Musapstan-Zemunik	2,277	1,472	805				2,277	0
Novigrad	350	300	50				350	0
Split-Dalmatia								
Sinj-Peruca	50		50				50	0
Trogir		30	203				233	0
Dubrovnik & Neretva r.								
Slano	20		75		20		75	20
Podimoc	121	60	295	30			355	30
Rudine Ostrikovac	120	100	80		60		180	60
Brsecine	50		70		24		70	24
Petrinj			60		25		60	25
Srdj	32	20	100	97	135	110	120	342
Total							**4,100**	**787**

Note: Several sites at Trogir have been aggregated into a single site

14. The proposed forest reconstruction measures are described in detail in Annex G. Stands of burned trees would be cleared and—where natural regeneration has not taken hold—reforested, primarily with indigenous species. Reconstruction would also include silvicultural interventions in areas affected by war destruction: cleaning of young stands that have regenerated naturally and thinning of young stands that have survived. Rehabilitation activities would be carried out primarily in areas selected for their strong touristic and environmental significance, sometimes combined with other benefits such as erosion prevention or wood production potential.

15. Detailed rehabilitation plans were prepared by Hrvatske Sume (HS) for 14 sites, covering 4,100ha to be replanted and an additional 787ha to receive silvicultural treatments. The work plans for each of these sites is shown in Table J.2. This section provides a detailed economic analysis of the returns to reforestation on these sites. On the basis of this analysis, an initial list of sites to be reforested during the first part of the project was drawn up. The results of the analysis are then used to develop simple criteria for use in selecting additional sites to complete the planned reforestation program.

TABLE J.3: FINANCIAL AND ECONOMIC UNIT COSTS OF PROPOSED REFORESTATION ACTIVITIES
(US$/ha)

	Unit costs (financial)						Unit costs (economic)					
County, Site	Site Clearing	Planting with ripping	Planting with manual soil preparation	Thinning coppice forests	Thinning plantations and natural regeneration	Comple-mentary planting	Site Clearing	Planting with ripping	Planting with manual soil preparation	Thinning coppice forests	Thinning plantations and natural regeneration	Comple-mentary planting
Lika-Senj												
Jasenje-Bisernjakovica			1,186						859			
Sibenik												
Brdo Sv Kate	205		1,171	1,062	698		132		848	749	518	
Culisica brdo	361	1,175	1,171		698		232	924	848		518	
Vlake	349	1,175	1,171				224	924	848			
Zadar-Knin												
Musapstan-Zemunik	338	1,374	1,171				217	1,081	848			
Novigrad	381	1,374	1,171				245	1,081	848			
Split-Dalmatia												
Sinj-Peruca	674		1,802				434		1,304			
Trogir		1,374	1,171					1,037	807			
Dubrovnik & Neretva r.												
Slano	205		1,186		698		132		859		518	
Podimoc	240	1,175	1,186	1,062			154	924	859	749		
Rudine Ostrikovac	320	1,175	1,186		698		206	924	859		518	
Brsecine	205		1,186		698		132		859		518	
Petrinj			1,186		698				859		518	
Srdj	240	1,175	1,186	1,062	698	631	154	924	859	749	518	450
Proportion labor costs:	0.97	0.58	0.75	0.80	0.70	0.78						

Costs

16. Table J.3 shows the financial (private) and economic (social) unit costs of the activities planned for each of the proposed reforestation sites. The costs are based on detailed discussions with Hrvatske Sume personnel, and have been adjusted to reflect differences in the activities planned at each site (for example, differences in planting density) and site-specific characteristics (for example, slope).

17. Labor costs form the bulk of the reforestation costs. The financial costs assume daily casual labor costs of 182HRK (about 36US$). The economic costs adjust the labor portion of each activity's cost to remove taxes and other transfers. An economic cost of 115HRK per day of casual labor (23US$) is assumed (including the value of food and field allowances paid to workers). This represents a 15% increase over the level paid in 1995, reflecting the likelihood that employment opportunities will increase as tourism and construction activities recover following the end of hostilities.

18. Table J.4 shows the total cost of the proposed reforestation activities at each site, taking into account the area to be treated, the timing of treatments, and the site-specific unit costs.

TABLE J.4: TOTAL ECONOMIC COSTS OF PROPOSED REFORESTATION ACTIVITIES
(US$)

County, site	Site Clearing	Planting with ripping	Planting with manual soil preparation	Thinning coppice forests	Thinning plantations and natural regeneration	Comple-mentary planting	**Total**
Lika-Senj							
Jasenje-Bisernjakovica	0	0	121,403	0	0	0	**121,403**
Sibenik							
Brdo Sv Kate	10,544	0	20,345	47,951	70,277	0	**149,117**
Culisica brdo	10,550	61,099	17,514	0	37,768	0	**126,930**
Vlake	8,159	21,385	8,407	0	0	0	**37,951**
Zadar-Knin							
Musapstan-Zemunik	429,382	1,318,683	495,400	0	0	0	**2,243,466**
Novigrad	79,317	268,736	115,594	0	0	0	**463,647**
Split-Dalmatia							
Peruca	21,681	0	59,294	0	0	0	**80,975**
Trogir	0	31,098	142,285	0	0	0	**173,383**
Dubrovnik & Neretva r.							
Slano	2,636	0	56,054	0	9,421	0	**68,110**
Podimoc	17,817	50,406	203,058	22,477	0	0	**293,759**
Rudine Ostrikovac	23,551	80,956	59,602	0	31,088	0	**195,196**
Brsecine	6,590	0	56,196	0	12,435	0	**75,221**
Petrinj	0	0	49,952	0	12,953	0	**62,905**
Srdj	4,934	16,802	79,753	65,821	59,508	43,673	**270,492**

Benefits

19. Forests provide many benefits. Historically, timber production has been the primary benefit considered. In recent years, however, there has been increasing awareness that the non-timber benefits provided by forests can be very significant. This is definitely the case in the island and coastal areas of Croatia, where timber production provides only a very small part of total forest benefits. Table J.5 summarizes the main benefits expected to result from reforestation at each proposed reforestation site.

20. **Landscape.** As discussed above, a conservative value of willingness to pay for forest landscapes in tourist areas of 1.50 US$/tourist/day is used, with an additional value of 0.75 US$/tourist/day for forest landscapes in the entire region. These values are then multiplied by the expected number of tourists in each county to obtain an estimate of the total value of landscape benefits provided by forests at the county level. To obtain estimates of the benefits that would be obtained from reforestation, some additional steps are necessary.

(a) The county-level data must be disaggregated to reflect conditions at specific sites. The proportion of hotel beds at the site to total beds in the county is used to calculate the proportion of total benefits that are generated at the site. The area visible from each site is based on a semi-circle centered at the resort, the radius of which is based on the configuration and size of the site. Only half the area in the semi-circle is assumed to provide landscape benefits. The results are shown in Table J.6.

TABLE J.5: EXPECTED BENEFITS AT THE PROPOSED REFORESTATION SITES

County, Site	Visible landscape	Erosion protection	Hunting potential	Recreation	Mean wood yield (m^3/ha/yr)
Lika-Senj					
Jasenje-Bisernjakovica	Some	City	Good		0.6
Sibenik					
Brdo Sv Kate	Yes	Dam	Very good[a]		2.6[a]
Culisica brdo			Very good[a]		2.8[a]
Vlake			Very good[a]		3.4[a]
Zadar-Knin					
Musapstan-Zemunik			Very good	Yes	3.9
Novigrad	Yes		Very good		3.9
Split-Dalmatia					
Sinj-Peruca		Dam	Very good		3.1
Trogir	Yes	City	Good		3.1
Dubrovnik & Neretva r.					
Slano	Yes		Marginal		2.0
Podimoc			Very good		2.4
Rudine Ostrikovac			Very good		2.2
Brsecine	Yes		Marginal		2.9
Petrinj	Some		Marginal		1.9
Srdj	Yes		Very good[b]		2.1

Notes: (a) Hunting and wood production are both limited within the Krka National Park.
(b) Very good hunting potential on 80% of the area; none on the rest

(b) The resulting value is then multiplied by an adjustment factor to allow for site-specific conditions. Dubrovnik, for example, is visited by all tourists in Dubrovnik-Neretva County and also by tourists in neighboring counties. The landscape benefits provided by forest areas surrounding Dubrovnik (for example, at Srdj) will be much larger than suggested by the proportion of tourists who actually stay in Dubrovnik. Likewise, sites near the main road connecting Dubrovnik to neighboring resorts will be visible (albeit briefly) to many tourists. The estimated landscape benefits at Srdj, therefore, are given an adjustment factor of 2, while those at sites on the main road are given an adjustment factor of 1.5. Conversely, a large quarry mars the view at Trogir. Reforesting adjacent areas may not substantially improve the landscape, therefore. An adjustment factor of 0.5 is used. At Zadar, the very flat terrain means very little of the affected forest is visible.

Table J.6 shows the resulting per hectare forest landscape benefits at each site.

21. The way in which benefits recover with and without reforestation needs to be projected. Based on consultations with Croatian foresters and World Bank forestry experts, landscape benefits are assumed to recover in five years following the implementation of reforestation measures. Although it will take considerably longer for the forest areas to fully recover to their pre-fire condition, their *visual* condition will already have substantially recovered after this period.

TABLE J.6: VISIBLE LANDSCAPE BENEFITS AT EACH SITE

County, Site	Area Visible (ha)	Tourists at site (% county)	Tourist overnights at site (million) Year 0	1	2	3	4	5+	Adjust Factor	Forest landscape benefits (US$/ha) Year 0	1	2	3	4	5+
Lika-Senj															
Jasenje-Bisernjakovica	1,500	0.08	0.03	0.05	0.06	0.08	0.09	0.10	1.00	34	48	62	75	89	103
Zadar-Knin															
Musapstan-Zemunik	16,000	0.49	0.72	1.00	1.29	1.57	1.86	2.15	0.25	17	23	30	37	44	50
Novigrad	1,500	0.06	0.08	0.12	0.15	0.19	0.22	0.25	1.00	85	119	153	186	220	254
Split-Dalmatia															
Trogir	2,500	0.07	0.24	0.34	0.43	0.53	0.63	0.72	0.50	72	101	130	159	188	217
Dubrovnik & Neretva r.															
Slano	4,000	0.09	0.19	0.27	0.34	0.42	0.49	0.57	1.50	107	150	193	235	278	321
Brsecine	4,000	0.09	0.19	0.27	0.34	0.42	0.49	0.57	1.50	107	150	193	235	278	321
Petrinj	2,500	0.06	0.13	0.19	0.24	0.29	0.35	0.40	1.00	80	112	145	177	209	241
Srdj	20,000	0.80	1.73	2.42	3.11	3.80	4.49	5.18	2.00	259	363	466	570	674	777

Note: sites with no visible landscape benefits have been omitted

22. The no-project conditions differ depending on the extent of natural regeneration.

(a) In most cases, areas where planting is planned have little or no natural regeneration. Repeated fires on sites such as Trogir and Srdj have destroyed most seed sources. In these areas, therefore, the calculations are carried out under the assumption that there would not be any regeneration in the absence of intervention.

(b) On areas to be thinned, on the other hand, natural regeneration is often exuberant. Without silvicultural interventions, however, growth would remain stunted because of intense competition between plants. The recovery of landscape (and other) benefits under these conditions would be only partial. The net benefits of rehabilitation measures in these areas, therefore, are computed as the difference between the full flow of benefits and the partial flow that would occur on areas left untreated.

TABLE J.7: VISIBLE LANDSCAPE BENEFITS OF REFORESTATION IN THE FIRST YEAR OF THE PROJECT
(US$/ha)

County, Site	NPV	Year 0	1	2	3	4	5	6	7	8	9	10+
Lika-Senj												
Jasenje-Bisernjakovica	777	0	10	25	45	71	103	103	103	103	103	103
Zadar-Knin												
Musapstan-Zemunik	381	0	5	12	22	35	50	50	50	50	50	50
Novigrad	1,923	0	24	61	112	176	254	254	254	254	254	254
Split-Dalmatia												
Trogir	1,643	0	20	52	96	151	217	217	217	217	217	217
Dubrovnik & Neretva r.												
Slano	2,428	0	30	77	141	223	321	321	321	321	321	321
Brsecine	2,428	0	30	77	141	223	321	321	321	321	321	321
Petrinj	1,823	0	22	58	106	167	241	241	241	241	241	241
Srdj	5,883	0	73	187	342	539	777	777	777	777	777	777

Note: sites with no visible landscape benefits have been omitted

TABLE J.8: RECOVERY OF INCREMENTAL HUNTING BENEFITS FOLLOWING REFORESTATION
(US$/ha)

	Year										
Hunting potential:	0	1	2	3	4	5	6	7	8	9	10+
Very good	0.0	7.0	13.0	20.0	27.0	33.0	33.0	33.0	33.0	33.0	33.0
Good	0.0	4.0	8.0	12.0	16.0	20.0	20.0	20.0	20.0	20.0	20.0
Marginal	0.0	1.0	3.0	4.0	5.0	7.0	7.0	7.0	7.0	7.0	7.0

23. Table J.7 shows the resulting flow of benefits for areas reforested in the first year of the project. Areas reforested later will have a slightly higher flow of benefits, since there will be more tourists to enjoy the landscape, but these benefits will begin later.

24. **Hunting.** The benefits of hunting activities are quantified by using the values derived from the lease of hunting rights to foreign hunters. On good hunting lands, these leases generally cost about 30 DEM/ha, or about 20 US$/ha, with a range of 50 DEM/ha (33 US$/ha) on very good hunting land to 10 DEM/ha (7 US$/ha) on marginal hunting land. Table J.8 shows the time path of recovery of incremental hunting benefits following reforestation. The hunting potential of each site to be reforested was determined in consultation with Croatian foresters and World Bank forestry experts (see Table J.5).

25. **Wood production**. By the time trees planted on reforestation sites mature, their wood is likely to be quite valuable because of increasing wood shortages in Europe. The value of future wood production resulting from reforestation is estimated using the following assumptions:

(a) Only species with significant pulpwood or sawlog production potential are considered. These species include *Pinus halepensis, P. pinaster, P. nigra*, and *Cupressus sempervirens.* The proportion of these species included in the planting plans on each site are shown in Table J.9.

(b) The mean annual increments for each species are derived from yield tables supplied by Hrvatske Sume (see Table J.9). Only 58% of useful species are assumed to be harvested, so as not to interfere with recreational value.

(c) 10% of accumulated yield is harvested during thinning at 20 years, and 20% at 40 years. Harvest at 80 years assumes 30% of accumulated yield is used for pulp (except for *P. halepensis*, where 45% is used for pulp), and 15% of accumulated yield is used for sawlogs (except for *P. halepensis*, where none is used).

(d) The assumed stumpage fees are 10 US$/$m^3$ for pulpwood and 30 US$/$m^3$ for sawlogs.

The resulting estimates wood production benefits at each site are shown in Table J.10.

TABLE J.9: YIELD AND PROPORTION PLANTED OF DIFFERENT SPECIES ON THE PROPOSED REFORESTATION SITES

	Mean annual increment (m^3/ha)					Proportion of species planted				
County, Site	*Pinus halepensis*	*Pinus pinea*	*Pinus pinaster*	*Cupressus sempervirens*	*Pinus nigra*	*Pinus halepensis*	*Pinus pinea*	*Pinus pinaster*	*Cupressus sempervirens*	*Pinus nigra*
Lika-Senj										
Jasenje-Bisernjakovica					1.2					0.5
Sibenik										
Brdo Sv Kate	4.2	3.6	3.8	3.1	3.2		0.1	0.5	0.1	
Culisica brdo	4.2	3.6	3.8	3.1	3.2		0.2	0.4	0.1	0.1
Vlake	4.2	3.6	3.8	3.1	3.2	0.2	0.3	0.3	0.1	
Zadar-Knin										
Musapstan-Zemunik	6.0	5.0	5.2	3.8			0.5	0.2	0.2	
Novigrad	6.0	5.0	5.2	3.8			0.5	0.2	0.2	
Split-Dalmatia										
Sinj-Peruca					3.1					1.0
Trogir	3.5	3.2	3.3	3.0	3.2	0.5	0.2	0.1	0.2	0.0
Dubrovnik & Neretva r.										
Slano	3.2	2.8	2.8	3.0		0.2	0.2		0.3	
Podimoc	3.2	2.8	2.8	3.0		0.3	0.2		0.4	
Rudine Ostrikovac	3.2	2.8	2.8	3.0		0.1	0.2		0.4	
Brsecine	3.2	2.8	2.8	3.0		0.4	0.3		0.3	
Petrinj	3.2	2.8	2.8	3.0			0.2	0.1	0.4	
Srdj	3.2	2.8	2.8	3.0		0.2	0.2	0.1	0.3	

Note: proportions of species planted do not add to 1.0 because only timber-producing species are counted

TABLE J.10: ESTIMATED WOOD PRODUCTION BENEFITS ON THE PROPOSED REFORESTATION SITES

	Output (m^3/ha)				Value (US$/ha)				
	Pulpwood								
County, Site	20	40	80	Sawlogs	20	40	80	Sawlogs	**Total**
Lika-Senj									
Jasenje-Bisernjakovica	1.2	4.8	14.4	7.2	12	48	144	216	**420**
Sibenik									
Brdo Sv Kate	5.1	20.6	61.7	30.8	51	206	617	925	**1,799**
Culisica brdo	5.5	22.1	66.2	33.1	55	221	662	993	**1,931**
Vlake	6.7	27.0	91.0	30.4	67	270	910	911	**2,157**
Zadar-Knin									
Musapstan-Zemunik	7.7	30.9	92.6	46.3	77	309	926	1,390	**2,702**
Novigrad	7.7	30.9	92.6	46.3	77	309	926	1,390	**2,702**
Split-Dalmatia									
Sinj-Peruca	6.2	24.8	74.4	37.2	62	248	744	1,116	**2,170**
Trogir	6.3	25.1	95.5	17.6	370	1,480	5,531	3,382	**10,763**
Dubrovnik & Neretva r.									
Slano	3.9	15.6	54.5	15.7	39	156	545	472	**1,211**
Podimoc	4.8	19.4	67.7	19.4	48	194	677	583	**1,502**
Rudine Ostrikovac	4.4	17.6	57.8	21.4	44	176	578	642	**1,440**
Brsecine	5.7	23.0	84.2	19.1	57	230	842	572	**1,702**
Petrinj	3.8	15.2	45.6	22.8	38	152	456	684	**1,330**
Srdj	4.3	17.2	58.5	18.9	43	172	585	566	**1,365**

26. **Erosion protection.** At some sites, reforestation would help protect dams or urban areas from erosion. In general, Karst areas such as much of the coastal area of Croatia are not very susceptible to erosion. In some instances, however, even low levels of erosion can cause significant damage.

(a) At Trogir and Senj, erosion in areas destroyed by fires is causing damages in adjacent urban areas. Silt clogs drainage channels, causing flooding and increasing cleaning costs. Estimates of the additional costs due to erosion are available from Trogir. Damages can be as high as 45,000US$ in a bad year, but are usually about 20,000US$/year. This does not include damage to roads, but the extent of this damage is minor. If the hillsides above town were reforested, these damages could be essentially eliminated. The per hectare benefits depend on the size of the area assumed necessary to achieve this reduction in damage. At Trogir, the area required to be reforested is about 200ha, so per hectare benefits are 695 US$/ha (assuming it would take 5 years for ground cover to be sufficient to stop erosion). Similar calculations can be made for Senj.

(b) At Brdo sv Kate and Peruca, reforestation sites are immediately above hydroelectric installations. Reforestation would help protect these installations from sedimentation. However, no information is available is available on the extent of damage from sedimentation.

(c) At Novigrad, erosion threatens oyster beds in the Novigrad Lagoon. Reforestation of the slopes above the city would help reduce damage to these fisheries. However, no information is available is available on the extent of damage.

27. **Other benefits.** In addition, several other categories of benefits should be mentioned:

(a) **Non-timber forest products.** Reforestation would not necessarily increase production of non-timber products. Many medicinal and aromatic plants, for instance, prefer open areas such as those created by forest fires to the interior habitat of shaded high forest. Whether production of secondary non-timber products would rise or fall after reforestation is, therefore, uncertain.

(b) **Recreational value.** Among the proposed reforestation sites, recreation is particularly likely to provide a substantial part of the benefits at Musapstan-Zemunik, because of its proximity to Zadar's large urban population. However, no information is available on the magnitude of recreational benefits.

(c) **Microclimatic effects.** Reforestation will probably help improve local microclimates by providing shade and windbreaks. This effect cannot be quantified, however.

The exclusion of these benefits, whether for lack of data or for other reasons, implies that the estimated value of benefits from reforestation used in evaluating the rehabilitation component of the project are conservative. Actual benefits, if they could be fully quantified, are likely to be larger than those assumed in the calculations.

TABLE J.11: TOTAL ECONOMIC BENEFITS OF REFORESTATION AT THE PROPOSED SITES
(US$)

County, site	Visible landscape	Regional landscape	Hunting	Wood production	Erosion protection	**Total**
Lika-Senj						
Jasenje-Bisernjakovica	112,699	27,320	22,457	427	97,639	260,542
Zadar-Knin						
Musapstan-Zemunik	708,355	346,673	471,707	35,063	0	1,561,799
Novigrad	760,997	74,288	101,057	7,481	0	943,823
Split-Dalmatia						
Peruca	0	8,798	11,966	709	0	21,473
Trogir	346,904	39,871	32,773	19,031	142,492	581,072
Dubrovnik & Neretva r.						
Slano	183,704	14,183	4,025	724	0	202,636
Podimoc	0	58,938	80,184	3,699	0	142,820
Rudine Ostrikovac	0	36,160	49,184	2,062	0	87,406
Brsecine	190,516	15,020	4,262	1,107	0	210,905
Petrinj	161,988	13,728	3,895	676	0	180,286
Srdj	1,458,259	44,394	52,886	2,804	0	1,558,343

28. **Summary.** Table J.11 shows the estimated total economic benefits of the proposed reforestation activities at each site, taking into account the area to be treated, the timing of treatments, and the site-specific value of the various benefits.

Results

29. The results of the economic analysis are shown in Table J.12. This table omits the sites which are mostly in the Krka National Park (Brdo sv Kate, Cusilica Brdo, and Vlake in Sibenik county). These sites are discussed separately below.

30. The analysis shows that reforestation would definitely be profitable at several sites. In every case, landscape considerations are paramount and by themselves justify reforestation. In all cases, all other benefits combined would not be sufficient to justify reforestation.

(a) **Srdj.** This site is by far the most profitable. Its location immediately above the city of Dubrovnik makes it extremely visible to a large number of tourists. Repairing the damage caused by forest fires, which have left the slopes above the city essentially denuded, would greatly improve the view from both the city and numerous observation points around it. The area also has very good hunting potential, especially because of its accessibility, even though hunting in the areas immediately adjacent Dubrovnik itself would probably be limited by safety considerations.

(b) **Slano and Brsecine.** These are areas along the main access road to Dubrovnik and near several hotels.

TABLE J.12: ESTIMATED NET BENEFITS OF REFORESTATION AT THE PROPOSED SITES

County, site	Area planted (ha)	Area thinned (ha)	Net present value of net benefits (US$)	Economic rate of return (%)	Net benefits per area treated (US$/ha)
Lika-Senj					
Jasenje-Bisernjakovica	161	0	139,139	18.6	864
Zadar-Knin					
Musapstan-Zemunik	2,277	0	-681,667		-299
Novigrad	350	0	480,176	17.6	1,372
Split-Dalmatia					
Peruca	50	0	-59,502		-1,190
Trogir	233	0	407,689	25.3	1,750
Dubrovnik & Neretva r.					
Slano	75	20	134,526	23.3	1,416
Podimoc	355	30	-150,939		-392
Rudine Ostrikovac	180	60	-107,790		-449
Brsecine	70	24	135,684	22.2	1,443
Petrinj	60	25	117,381	22.5	1,381
Srdj	120	342	1,287,851	33.7	2,788

(c) **Petrinj.** This area is close to camping areas at Ston, and part fronts on the Stonski Canal, which is used for water activities. The current reforestation plan is more limited than the one originally proposed, under which 155ha would have been planted and 25ha thinned. As originally proposed, part of the site would have contributed very little to landscape benefits since it lay on the reverse side of the slope from the tourist areas. The current plan focuses on the visible areas.

(d) **Novigrad.** The estimated rate of return to reforestation of 17.6% is almost certainly an under-estimate, because the benefits of erosion prevention on fishing in the lagoon could not be accounted for. It is also likely that erosion is causing damage to the town itself (as in the case of Trogir) which reforestation would also help reduce. However, no information is available on this problem at this time, since the town was, until very recently, near the front lines.

(e) **Trogir.** Although landscape benefits again dominate, erosion prevention is an important objective for reforestation at this site and comes close to justifying reforestation on its own. The current plan, in which 233ha are to be reforested, is more limited than the initial reforestation plan, under which 372ha were to be reforested. Reforestation activities have been focused on areas that contribute the most to erosion reduction.

(f) **Senj.** As in the case of Trogir, erosion prevention is an important objective. Here too, reforestation activities have been focused on a the areas that contribute the most to erosion reduction.

If reforestation was fully implemented at these sites, 1,069 ha would be planted and 411 ha would undergo silvicultural treatment. The total NPV of reforestation activities on these sites is US$2.7 million, and the ERR is 24.2%.

31. The analysis shows that reforestation would definitely *not* be profitable at Rudine-Ostrikovac and Podimoc in the Dubrovnik area. Both are remote and not visible from tourist areas, so their landscape benefits are limited to regional ones. Although both would be very good hunting areas, these benefits are insufficient to justify reforestation. Neither site is upstream from cities or other valuable infrastructure, so the benefits of reduced erosion are very small.

32. In some sites, the analysis shows that reforestation is questionable on the basis of available information.

(a) **Musapstan-Zemunik.** This site, the largest of those proposed, is near the city of Zadar. The current estimates show that reforestation is not profitable at this site. However, the estimates do not include, for lack of information, the recreational benefits which this area would probably furnish to the inhabitants of Zadar. Once recreational benefits are included, it is possible that reforestation would in fact be justified. Until information on recreational benefits is obtained, reforestation should probably not be undertaken here, except perhaps on a small fraction of the proposed areas (perhaps 100-200ha), chosen to have low costs (ie where manual soil preparation could be used) and where landscape and recreational benefits are clearest (areas directly visible from tourist areas and/or where specific plans exist for recreational use). Whether to proceed with reforestation of the rest of the site could then be re-examined later. The required information could be obtained either by undertaking a survey of willingness to pay for forest recreation among the local population (similar to that carried out among tourists) or by monitoring and evaluating resident use of the surviving forest in the area (substantial forest areas remain).

(b) **Peruca.** The analysis of the Peruca site is greatly hampered by the unavailability of information on the benefits of erosion prevention in reducing sedimentation of the Peruca hydroelectric plant. Moreover, these benefits would have to be relatively large, on a per hectare basis, to overcome the deficit in the current estimates. Yet the area does not appear to have a very high erosion potential, and vegetation cover seems adequate. A decision on whether to reforest this site should be postponed until estimates of these benefits become available.

33. **Krka National Park sites.** Three of the proposed sites, Brdo sv Kate, Cusilica Brdo, and Vlake in Sibenik county lie mostly or entirely in the Krka National Park. Because of this, several types of use, including wood production and hunting, are restricted. Landscape benefits are also limited in this case. Although many tourists visit the National Park and one of the sites is visible from the access road, the sites are not in areas normally visited by tourists. The primary function of the areas to be reforested is to contribute to the Park's ecosystem, a function which is extremely difficult to value. These sites, therefore, have few quantifiable benefits. Yet protection of the area has been acknowledged as important by its designation as a National Park. The appropriate criterion to judge the desirability of reforestation in these areas, therefore, is cost-effectiveness rather than cost-benefit. The reforestation plans for these areas have been prepared in consultation with the State Agency for the Conservation of Cultural and Natural Heritage (SACCNH) and the park manager, and are consistent with the objectives and laws governing the National park. On all the sites in or near the National Park, replanting is undertaken on a complementary basis, where

TABLE J.13: SENSITIVITY OF ESTIMATED ECONOMIC RATE OF RETURN TO REFORESTATION TO ASSUMPTIONS ABOUT TOURIST WILLINGNESS TO PAY FOR VISIBLE LANDSCAPE BENEFITS AND THE RECOVERY OF TOURISM

	WTP for landscape benefits (US$/tourist/day)				Recovery of tourism (million overnights after 6 years)		
County, site	Base 1.50	1.00	0.75	0.50	Base 60	50	40
Lika-Senj							
Jasenje-Bisernjakovica	18.6	16.4	15.3	14.2	18.6	17.5	16.4
Zadar-Knin							
Novigrad	17.6	13.8	11.7	<10.0	17.6	15.7	13.8
Split-Dalmatia							
Trogir	25.3	21.4	19.3	17.2	25.3	23.4	21.4
Dubrovnik & Neretva r.							
Slano	23.3	17.7	14.7	11.4	23.3	20.6	17.7
Brsecine	22.2	17.0	14.1	10.9	22.2	19.7	17.0
Petrinj	22.5	17.3	14.4	11.2	22.5	20.5	17.3
Srdj	33.7	26.6	22.5	17.7	33.7	30.3	26.6

natural regeneration has failed entirely. In most cases, sites are simply be protected from grazing to allow natural regeneration to take hold. When replanting is undertaken, a mixture of species would be used, avoiding non-indigenous species. The unit cost estimates (Table J.3), show that costs are in line with costs at other sites. These sites add 169ha to be planted and 286ha to be undergo silvicultural treatment.

34. **Sensitivity analysis.** Visible landscape benefits provide the bulk of the estimated benefits at each site where reforestation is justified. Checking the sensitivity of results to assumptions made in deriving these benefits is important, therefore.

(a) **Tourist willingness to pay for landscape benefits**. Table J.13 shows the results of sensitivity analysis to the assumptions made on tourist willingness to pay for visible landscape benefits. In the base case, tourists are assumed to be willing to pay 1.50 US$/tourist/day for visible landscape benefits. As discussed earlier, this is a conservative figure based on several sources of information, including surveys of tourists in Croatia and in competing tourist destinations in Italy, and hotel room price data. The table shows that the results of the analysis (in terms of whether reforestation is justified on a given site) are remarkably robust to significant changes in the assumptions made about this critical value. Only one site which was thought to be profitable in the base case becomes unprofitable if willingness to pay is reduced by as much as two-thirds. Increasing the assumed willingness to pay would increase returns to reforestation at each site. Very large increases would be necessary, however, for sites which are not currently estimated to be profitable to be accepted.

(b) **Recovery of tourism**. The results are also dependent on the assumptions made about the recovery of the tourist industry. In the base case, it is assumed that tourism recovers to the prewar level of 60 million tourist overnights annually within 6 years. Table J.13 shows the impact of more pessimistic assumptions on the estimated rate of return to reforestation. As

TABLE J.14: ESTIMATED BENEFITS FROM REFORESTATION COMPARED TO TOTAL BENEFITS AND TOTAL COSTS

	Composition of total benefits (%)				Composition of total costs (%)			
County, site	Landscape	Hunting	Wood production	Erosion protection	Landscape	Hunting	Wood production	Erosion protection
Lika-Senj								
Jasenje-Bisernjakovica	54	9	0	37	115	41	19	81
Zadar-Knin								
Novigrad	89	11	1	0	180	38	23	2
Split-Dalmatia								
Trogir	67	6	3	25	223	42	30	93
Dubrovnik & Neretva r.								
Slano	98	2	0	0	291	27	7	1
Brsecine	97	2	1	0	273	26	7	1
Petrinj	97	2	0	0	279	28	7	1
Srdj	96	3	0	0	556	36	21	1

can be seen, reforestation remains profitable at all the selected sites even if tourism recovers to only two-thirds of prewar levels within the specified time horizon.

This robustness applied to other assumptions made in estimating visible landscape benefits, such as the area visible. The results are also not sensitive to changes in the assumptions about other benefits, since in every case landscape benefits alone are sufficient to justify reforestation. The exceptions to this are noted in the discussion of individual sites above. At Musapstan-Zemunik (Zadar) and Peruca (Sinj), additional information on benefits not currently included in the calculations might change the results. At Trogir and Senj, erosion benefits are important. A significant reduction in these benefits would not by itself change the decision to reforest these sites, but would make it much more sensitive to changes in the assumptions about visible landscape benefits. The results are also robust to increases in the cost of reforestation. Reforestation would remain justified on all the selected sites even with a 25% increase in the cost of reforestation.

Selection of additional sites

35. On the basis of the results of the economic analysis of the initial list of sites proposed by Hrvatske Sume, 1,138ha of a planned 5,000ha to be reforested have been selected (including the Krka sites). Criteria are required for the selection of additional sites to complete the planned reforestation program. The results of the analysis allow a simple set of selection criteria to be developed. As can be seen in Tables J.11 and J.14, landscape benefits are the single most important benefit from reforestation in the island and coastal zones of Croatia. Indeed, landscape benefits alone are sufficient to justify reforestation in every case in which reforestation was found to be profitable. On the other hand, except where erosion threatens urban areas directly, all other benefits combined are insufficient to justify reforestation. Since landscape benefits are in turn a function of the size of the tourist population and of the visible area in any given tourist area, simple tables can be developed which show whether, in any given area, landscape benefits are likely to be sufficient to justify reforestation.

36. According to the criteria agreed with Hrvatske Sume, burnt areas of high landscape importance to the tourist industry will be identified in close cooperation with local tourist authorities and municipalities. Whether the landscape benefits are sufficient to justify reforestation at the site can then be determined from Table J.15, which shows the minimum tourist population necessary, for a given size of tourist area and a

TABLE J.15: MINIMUM TOURIST POPULATION NECESSARY TO ACHIEVE A 15% RATE OF RETURN TO REFORESTATION, FOR A GIVEN SIZE OF TOURIST AREA AND A GIVEN ECONOMIC COST OF REFORESTATION

	Economic cost of reforestation (US$/ha)				
Size of tourist area	1,000	1,200	1,400	1,600	1,800
Small	180	220	260	300	340
Medium	480	580	690	790	900
Large	1,200	1,450	1,720	1,980	2,230

given economic cost of reforestation, for the proposed investment to provide a 15% rate of return. The size of the tourist area is based on the extent of the area visible from the main areas frequented by tourists (hotels, beaches, marinas, historic town centers, and so on). A cutoff value for the ERR of 15% was thought appropriate, since estimated rates of return at sites already approved, counting all benefits, are generally in the 20-25% range. The estimated returns at the Srdj site show that very high rates of return are achievable if reforestation is undertaken in areas very visible to large numbers of tourists. Within the group of sites exceeding this cutoff, priority will be given to sites which exceed the minimum by the greatest margin and to those which also provide other benefits (such as hunting, recreation, or erosion protection), in addition to landscape value. Documentation for the proposed sites and the annual planting plan would be reviewed annually by Hrvatske Sume and the Bank. Sites larger than 300ha would be subject to special attention, up to a full economic analysis if appropriate. Appendix J.3 provides detailed instructions on the use of these criteria to select additional sites for reforestation.

37. A range of likely returns from the additional sites is projected, based on the range of returns found at sites already selected. It was assumed that reforestation and silvicultural activities on the remaining area would be undertaken in equal annual installments throughout the project's life. Benefits from reforestation undertaken later will tend to be higher, since landscape benefits wil be magnified by the larger tourist populations, giving a range of 20-27 percent for additional sites.

Conclusion

38. The analysis shows that reforestation in areas of strong significance to the landscape of tourist areas is justified. If reforestation is implemented at all the sites with positive estimated returns, the NPV of net benefits from the reforestation sites already selected under this component will be about US$2.7 million (total benefits of about US$3.9 million minus total costs of US$1.2 million), with an economic rate of return of about 24.2%. The criteria developed for selection of additional sites to complete the planned reforestation program should ensure that rates of return on these sites are at least 15%; it is not unreasonable to expect, however, that returns from reforestation should exceed 20% at several sites.

III. FOREST FIRE MANAGEMENT COMPONENT

Background

39. In the last 20 years, there has been a significant increase in the extent of forest fires in the island and coastal areas of Croatia. Figure J.3 shows the trend in total area burnt in the period 1972–93. Many of these fires are located in important touristic areas, particularly in the Istrian peninsula and in Dalmatia. The distribution of fires and mean area burnt in the counties (*Zupanjas*) in the island and coastal areas of Croatia is shown in Figure J.4.

40. The increasing extent of damage caused by forest fires resulted from insufficient attention to preventive measures and from inefficient suppression. Firebreaks were rare and often poorly maintained; none incorporated access roads for firefighters. Silvicultural measures designed to reduce the likelihood and incidence of fires were inadequately implemented. The coordination of fire-fighting forces was often poor, with air tankers being operated by the Army in former Yugoslavia while ground forces were under the authority of local municipalities.

41. Since the establishment of the Republic of Croatia in 1990, there has been a substantial improvement in forest fire management. Protective measures have been incorporated into forest management plans and fire-fighting forces coordinated under the Ministry of the Interior (MoI). Because of limited resources and the war situation, however, much remains to be done.

Forest fire management

42. The Forest Fire Management component of the project would fund a comprehensive package of activities whose overall aim is to reduce the total area burnt, especially in tourist areas. This would be achieved by (i) decreasing the likelihood of fires through prevention measures; (ii) increasing the resistance to fires through silvicultural measures and defensive works such as firebreaks; and (iii) increasing the speed and effectiveness of response to fires through improvements in fire-fighting forces. The specific activities being considered are described in detail in Annex H.

FIGURE J.3: TOTAL AREA BURNT IN ISLAND AND COASTAL AREAS OF CROATIA, 1973-93

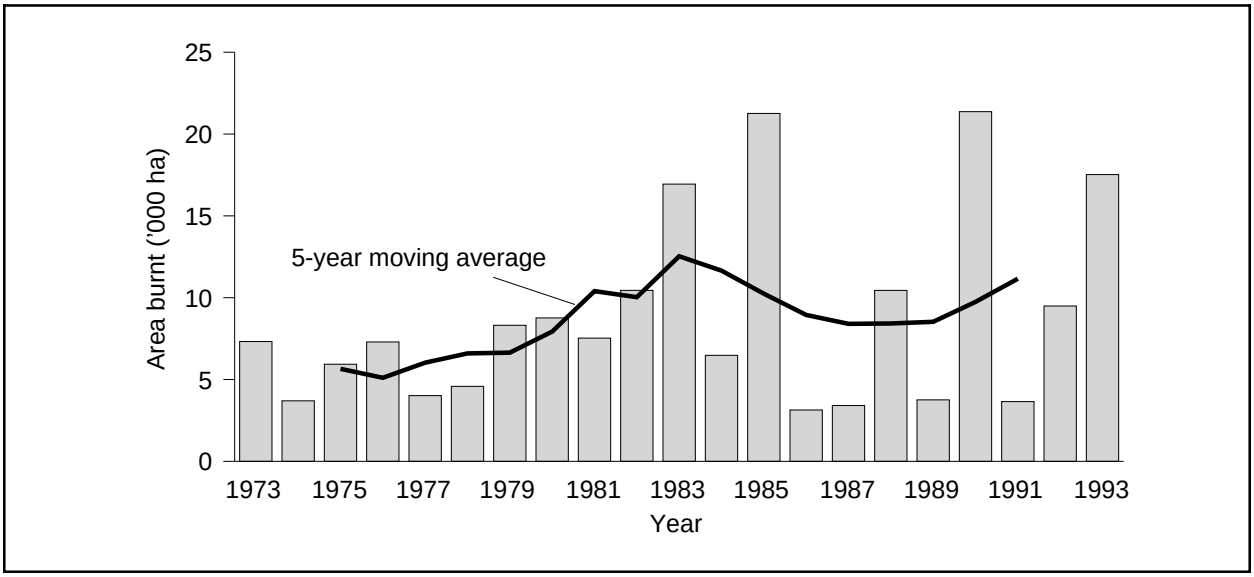
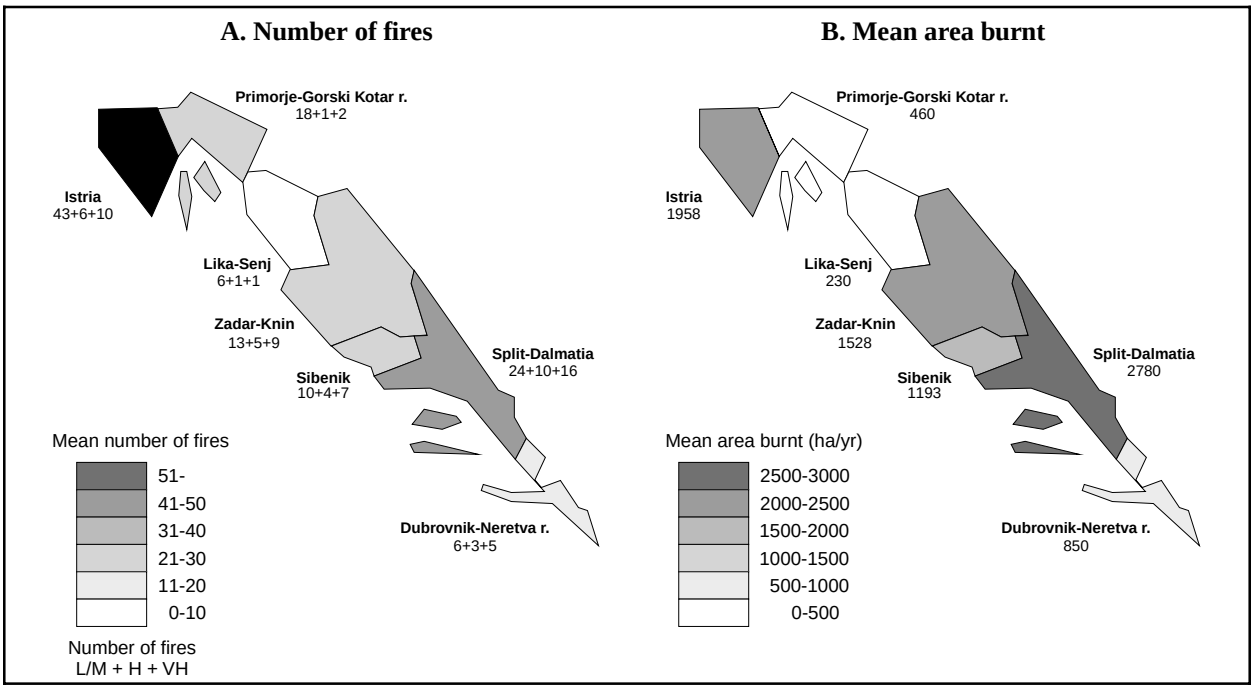


FIGURE J.4: DISTRIBUTION OF FOREST FIRES IN THE COASTAL AREAS OF CROATIA



43. The largest single expense in the Forest Fire Management component is for the acquisition of tanker aircraft to fight forest fires (US$20 million base cost). The Croatian Ministry of the Interior (MoI) has proposed that a seaplane air tanker be procured to fulfill this objective. Given Croatia's long coastline (about 500km) and the narrowness of the area vulnerable to forest fires (5-10km on average), the use of seaplane air tankers with the capability of refilling their tanks by scooping up seawater provides the most viable option for aerial fire-fighting. Croatia already operates two seaplane air tankers, but they are insufficient to cover the entire area to defended effectively.

44. This section examines the economic costs and benefits of the proposed forest fire management activities. Because of the importance of the proposed expenditure in fire-fighting aircraft, particular attention is given to this aspect of the fire management component.

(a) *Without project*. The baseline, without-project scenario assumes that Croatia fire-fighting forces remain essentially unchanged and that no additional preventive measures are taken. Croatia's current fleet of two seaplane air tankers is assumed to be operated until the end of their useful life, at which time they are replaced by two equivalent aircraft.

(b) *With project*. The with-project scenario assumes that the full package of prevention, pre-suppression, and suppression measures described in Annex H is implemented, including the acquisition of a seaplane air tanker.

45. The analysis considers the proposed fire management package as a whole because the different aspects of the proposed package are closely related. The benefits of the proposed investments in communications equipment, observation points, stand-by facilities for pilots, and weather forecasting, for example, will be derived from improvements in detection time and reductions in reaction time, which will allow fire-fighting forces to reach fires faster, before they have had a chance to grow and cause substantial

TABLE J.16: FOREST FIRE MANAGEMENT COMPONENT: ECONOMIC COSTS (EXCEPT AIRCRAFT)
(thousand US$)

	Year						
	0	1	2	3	4	5+	**Total**
Investment costs:							
Prevention							
Publicity	25	5	45	70	15		**160**
Roadside cleaning	38	56	56	56	56		**263**
Thinning	188	235	235	235	235		**1,127**
Pre-suppression							
Weather forecast system	442						**442**
Improved detection	88						**88**
Fire-fighting roads	700	700	700	700	700		**3,500**
Supression							
Communications equipment	2,663						**2,663**
Terrestrial fire-fighting	1,970	1,350					**3,320**
Standy facilities	1,525	240					**1,765**
Total Investment	**7,638**	**2,586**	**1,036**	**1,061**	**1,006**	**0**	**13,328**
Recurrent Costs							
Prevention							
Publicity		100	40	310	300		**750**
Pre-suppression							
Improved detection	161	161	161	161	161	161	**964**
Supression							
Communications equipment		94	122	122	122	122	**581**
Terrestrial fire-fighting	77	141	141	141	141	141	**780**
Total Recurrent	**238**	**495**	**463**	**733**	**723**	**423**	**3,076**

damage. Silvicultural measures and the establishment of firebreaks can increase the forest's resistance to fires, but fire-fighting forces are still required to extinguish them. Investments in communications equipment and control centers are necessary to improve the management of fire-fighting.

46. Several less ambitious packages of activities were considered and evaluated during project preparation. For example, measures aimed at improving the timeliness of fire detection and in reducing the response time could substantially increase the effectiveness of current fire-fighting forces at modest cost. The rate of return on such measures would be relatively high. A more comprehensive approach was adopted for several reasons:

(a) A limited package focusing on improvements to fire detection and response time would have high rates of return, but its total impact would be limited in the absence of additional fire-fighting forces. Only about half the fires are currently being fought at all, with the rest being allowed, for lack of equipment, to burn themselves out naturally.

(b) Moreover, improvements in the efficiency of existing forces alone would only be felt in the Dalmatian region. In the important tourist areas of Istria and Primorje, where 27% of the area burnt is found, improvements in the effectiveness of existing forces would have a

minimal impact. Measures to reduce detection and reaction time, for example, might reduce the area burnt in an average year by as much as 6% in Dalmatia, but would have almost no effect on the area burnt in Istria and Primorje.

(c) The impact of a comprehensive package of measures is likely to be greater than the sum of its parts: the reduction in area burnt resulting from implementing the package of activities are greater than the cumulative reduction in area burnt resulting from each element of the package.

The proposed measures are designed to work together as part of a comprehensive forest fire management strategy. The prevention and pre-suppression efforts are targeted in the areas at highest risk and where fires would be most damaging.

Costs

47. Table J.16 shows the economic cost of each part of the Forest Fire Management component, except for the aircraft costs, which are discussed below.

48. The estimates of effectiveness and operating costs of the seaplane air tanker are based on the Canadair CL–415, the only such air tanker currently in production. This aircraft is an improved version of the Canadair CL–215, which has been widely used in fire-fighting throughout the world (including in the former Yugoslavia; Croatia currently operates two of these older models). Information on the operating costs of the

TABLE J.17: ESTIMATED ECONOMIC OPERATING COSTS FOR THE SEAPLANE AIR TANKER (US$)

Initial cost	Aircraft	20,000,000
	Initial spare parts stock	1,500,000
Annual operating costs	Parts	300,000
	Maintenance	268,931
	Fuel and oil	75,856
	Crew	44,527
	Travel	54,177
	Insurance	200,000
	Total	**943,491**

Notes:
- The air tanker is assumed to have a useful life of about 24 years. The residual value at the end of this period is expected to be low, since the aircraft will have been operated in a saltwater environment..
- An annual utilization of 250 hours (including training and operational flights) is assumed.
- *Parts*. Estimates of the annual cost of parts is based on a combination of MoI and Canadairestimates. A 3-year stock would be acquired initially and renewed annually as parts aredrawn from it for use.
- *Maintenance*. Based on Canadair estimated manpower requirements of 6.32 and 4.99 hours per flight for 200 and 300 hours/year.
- *Fuel and oil*. Canadair data on fuel consumption (850 l/hr) and oil consumption (1 l/hr).
- *Crew.* The crew is assumed to follow current Croatian practice of including a pilot, a co-pilot, and a mechanic. They are assumed to be employed for 12 months at current salaries (net of taxes).
- *Travel*. Hotel and *per diem* expenses for flight and maintenance crews during fire-fightingoperations, based on MoI data.
- *Insurance.* Replacement cost, assuming a 1% chance of a complete hull loss.

aircraft was provided by the MoI and supplemented where necessary by additional information provided by Canadair (the manufacturer of the aircraft) and other sources experienced in the use of these aircraft (in particular, the French Sécurité Civile, who has operated CL–215s for 25 years and is currently switching to CL–415). Table J.17 summarizes the expected annual economic cost of operation.

Benefits

49. As mentioned above, the benefits of the entire forest fire management package are considered together, since the individual components are designed to work together as part of a comprehensive forest fire management strategy. The basic measure of benefits is the reduction in area burnt that would result from implementation of the proposed measures. The value of this reduction is then calculated using measures of the benefits provided by forest areas which would be lost if these areas were destroyed by fire.

50. **Reduction in area burnt.** Estimating the reduction of area burned that would result from implementation of the proposed activities is extremely difficult. Both the number of fires and their severity vary substantially from year to year, depending on numerous factors such as weather conditions, the availability and dryness of fuel (which in turn is partly dependent on the severity of previous fires), and the incidence of anthropogenic and other causes of fires. The incidence of forest fires is particularly high in the important tourist areas of Dalmatia and the Istrian peninsula (see Figure J.4). Moreover, most fires are concentrated in coastal areas: according to MoI data, 48% of fires are within 5 km of the coast and a further 38% within 10 km.

51. Two different models were used in an attempt to estimate the reduction in area burnt (relative to the without-project case in which the current fleet of two CL–215 air tankers remains unchanged) that might be expected to result from implementation of the proposed forest fire management activities.

(a) The MoI used a mathematical model of fire spread over time to estimate the reduction in mean area burnt per fire. Illustrative conditions were assumed (flat terrain, fire in the crown of black pine forest, winds of 30 km/hour, fire about 10km from the coast). Travel times to the fire (and hence the size of the fire when it is reached) are then dependent on fire location, the aircraft's base, and aircraft performance. The time taken to extinguish a fire of given size once it is reached is also dependent on the number of aircraft and their speed and capacity.

(b) Daniel Alexandrian, consultant to the World Bank, used a slightly different mathematical model to arrive at estimates of reductions in area burnt. This model is described in Appendix J.2. It distinguishes between fires in different risk conditions, and computes the likelihood that fire-fighting forces will succeed in bringing them under control, depending on the size of the fire when fire-fighting forces reach it (which depends on fire location and aircraft performance) and on the number and capability of aircraft available. Separate estimates are then made of area burnt when fires are controlled and when they are not, and these are then weighted by the probability that fires will be controlled to arrive at estimates of the mean area burnt.

In both models, the effects of other project activities are modelled through their effect on detection and reaction times. For example, additional lookout towers, more extensive patrolling, and improved communications are assumed to reduce alert times from the current average of 17 minutes to about 10 minutes. Improvements in airport facilities and in forecasting of high risk conditions (through investments in weather forecasting) are assumed to reduce reaction time (measured by the time for the aircraft to take off)

TABLE J.18: ESTIMATED REDUCTION IN MEAN FOREST AREA BURNT IN THE ISLAND AND COASTAL AREAS OF CROATIA

Scenario	Fleet	Mean burnt area per fire (ha)	Reduction in total area burnt (ha)	(%)
A. MoI estimates				
Without Project	2 CL-215	16.0	-	–
With Project:	2 CL-215, 1 CL-415	12.2	3,898	51
B. Alexandrian estimates				
Without Project	2 CL-215		–	–
With Project:	2 CL-215, 1 CL-415		1,400 – 1,800	16 – 21

from about 40 minutes to 15 minutes.

52. Table J.18 shows the estimated reduction in area burnt, relative to the without-project case, as computed by these two models. As can be seen, the estimates of reductions in area burnt made by the two models differ substantially. According to MoI estimates, the mean area burnt would be reduced by about 50%. Alexandrian's estimates are much lower, in the 16-21% range. Because of poor past forest fire management, Croatia has considerable room for improvement in the extent of damages caused by forest fires. Nevertheless, a comparison of these estimates to what has been achieved in other Mediterranean countries shows that reductions in area burnt of over 50% would be unprecedented. In fact, most Mediterranean countries have, at best, only managed to stop trends towards *increasing* area burnt. A 50% reduction in area burnt would also mean that Croatia would have the lowest ratio of area burnt per area at risk—lower even than France, which devotes vastly more resources to the endeavour. The order of magnitude of reductions estimated by Alexandrian appear to be more reasonable, and are used in the analysis below. Values in the middle of the range he estimated are used: 1,600 ha/year. It should be stressed that although these estimates are probably the best that can be achieved given the current state-of-the-art in fire modelling, considerable uncertainty remains.

53. **Value of lost forest benefits.** Whether the proposed expenditures on forest fire management are justified depends not only on the quantity of forest area saved from fire, but also on the value As discussed above, evaluating the benefits to forest fire prevention and suppression reforestation differs from evaluating the benefits to interventions such as reforestation in that the specific areas in which fires will be prevented or reduced are unknown (except broadly, based on the past distribution of fires). What is needed, therefore, is an estimate of the *average* benefits obtained from forest areas—benefits which would be lost if an average hectare burnt.

54. **Landscape value.** Several steps are necessary to derive per hectare values from the willingness-to-pay figures derived from the tourist surveys. Since the specific areas which will burn are not known *ex ante*, the value of each kind of hectare that might burn must be computed. A weighted average of these values is then used to estimate the expected value of lost landscape benefits when a random hectare of forest burns. The calculations below, therefore, are conducted separately for areas of forest visible from tourist resorts in each county. Since tourist populations vary by county, the total value of landscape benefits also varies by county. The probability that a given hectare will burn will also depend on which county it is located in. The actual damages experienced in each case will depend on the pattern of regeneration experienced after the fire, so within each county separate estimates must be made for areas that regenerate

TABLE J.19: ESTIMATED BENEFITS OF FOREST LANDSCAPES VISIBLE FROM TOURIST AREAS IN THE ISLAND AND COASTAL AREAS OF CROATIA

County	Total Forest Area (ha)	Visible Forest Area (ha)	Benefits of visible forest landscapes (US$/ha) Year 0	1	2	3	4	5+
Istria	99,512	9,951	1,046	1,464	1,882	2,300	2,719	3,137
Primorje & Gorski Kotar r.	205,609	20,561	328	459	590	721	853	984
Lika-Senj	177,645	17,765	35	50	64	78	92	106
Zadar-Knin	247,693	24,769	89	125	160	196	231	267
Sibenik	57,002	5,700	256	358	460	562	665	767
Split-Dalmatia	177,691	17,769	299	419	538	658	778	897
Dubrovnik & Neretva r.	90,339	9,034	360	503	647	791	935	1,079
Total	**1,055,491**	105,549	**284**	**412**	**540**	**668**	**796**	**853**

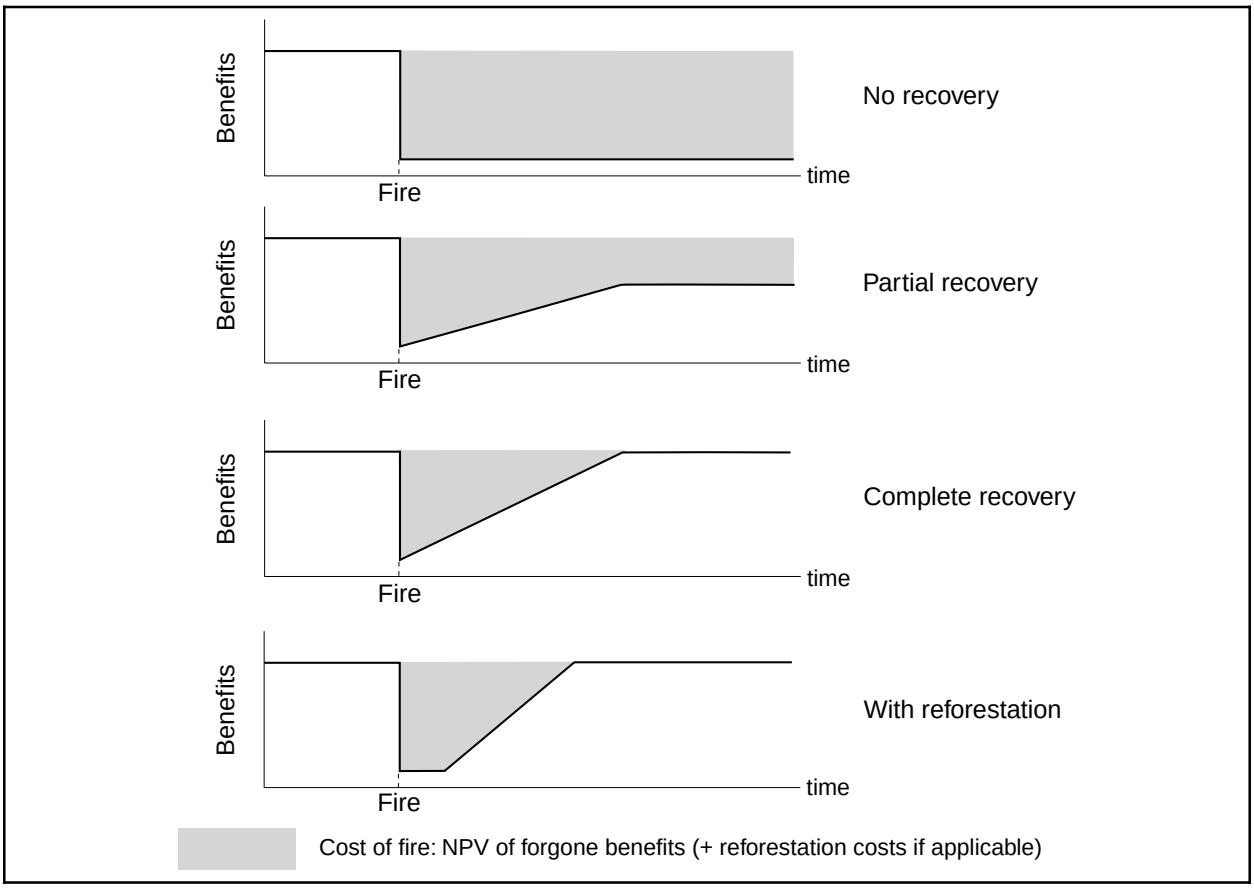
differently. Since tourist populations (and, hence, total landscape benefits) are assumed to grow over time, the calculations must also be repeated for each year until the tourist population stabilizes.

(a) Given the estimated tourist population in each county in each year (see Table J.7), the total benefit derived from forest landscapes is estimated for each county.

(b) The value per hectare then depends on the size of the area affected. Forest landscapes which are not seen by tourists will not be valued as highly as those which can easily be seen by large numbers of tourists. The project is supporting the development of GIS databases which will, in the future, allow for precise estimation of the forest areas visible from tourist areas. Since these data are not yet available, it is assumed that 10% of the forest area in each county is visible by tourists. These estimates are then used together with the estimates of total benefits to obtain the value of landscape benefits generated by each hectare of visible forest in each county (Table J.19).

(c) From these estimates, the value of lost benefits in areas damaged by forest fires can be estimated. It is reasonable to assume that in the year in which the fire occurs, the landscape value of burnt areas is completely destroyed. In many cases, however, forests damaged by fire will regenerate. The benefits of forest landscapes are not always lost forever, therefore, but only until regeneration occurs. This is illustrated in Figure J.5. Three models of natural regeneration were developed in consultation with Croatian foresters and World Bank forestry experts and are used in the calculations. In the first, the forest never recovers, so that the landscape benefits are lost forever. In the second, the forest recovers but the landscape benefit is only partially restored. This may occur, for example, if high forest is replaced by shrubland. Shrubs may be more attractive than bare slopes, but their landscape value is lower than of high forest. For the partial recovery model, it is assumed that only half the initial level of benefits is restored. The third model is one of full recovery, which is assumed to require 10 years. These different models illustrate range of possible recovery scenarios. Examples of each type were observed during the field visits. The relative frequency with which each type occurs is unknown, however. On the basis of the relative proportions of different types of forests, their vulnerability to fire, and their likely recovery paths, it is assumed that each of the cases has a weight of about 1/3. When the damages from fires are large, it may be worthwhile to intervene to reforest the affected the areas. In this case, the

FIGURE J.5: MODELS OF THE RECOVERY OF FOREST BENEFITS FOLLOWING FIRES



cost of the damages will equal the value of the lost benefits before the reforestation occurs (assumed to take 5 years) plus the costs of reforestation. The possibility of reforesting burnt areas sets an upper bound on the damages caused by fires. The calculations assume that reforestation will be undertaken wherever it is economically viable. The estimated value of the loss of landscape benefits from destruction of a hectare of visible forest by fire is shown, for each county, in the top panel of Table J.21 below.

(d) The final step is to calculate the importance of these particular areas in the total area vulnerable to fire. The values for each county are first weighted by the relative frequency of fires in each county to obtain a value for the mean loss of landscape benefits from destruction of a hectare of visible forest by fire anywhere in the visible areas. Then, since about 48% of all forest fires occur 5km from the coast and since all visible forest areas are on the coast, these mean values are given a weight of 0.5 to arrive at a normalized mean value for the loss of landscape benefits from destruction of a hectare of visible forest by fire anywhere in the coastal areas.

The result of these calculations is shown in Table J.21. The value of the loss of landscape benefits resulting from saving a hectare of forest in visible areas is about 1,800 US$ at the beginning of the project, when tourist populations are still small, climbing to about 2,500 US$/ha once the tourist population has recovered to pre-war levels.

TABLE J.20: ESTIMATED VALUE OF LOST WOOD PRODUCTION RESULTING FROM FOREST FIRES, BY COUNTY

County	Mean stock (m^3)	Value of (US$/ha)		
		Pulp	Logs	Total
Istria	26.0	208	0	208
Primorje & Gorski Kotar r.	111.0	710	533	1,243
Lika-Senj	111.3	713	534	1,247
Zadar-Knin	45.0	324	108	432
Sibenik	10.3	83	0	83
Split-Dalmatia	16.3	130	0	130
Dubrovnik & Neretva r.	32.6	234	78	313
Coastal Area	**53.8**			

55. The steps to converting regional forest values into a value for the loss resulting from destruction of a hectare of forest by fire are similar to those described above, except that the estimates apply to the entire area rather than to a specific part of it. Because of this, the per hectare benefits are substantially lower than those generated in visible areas. The estimated value of the loss of landscape benefits from regional forests are shown in the second panel of Table J.21.

56. **Hunting.** About half the coastal forest areas are considered suitable for hunting. For simplicity, all are assumed to be good hunting lands. The value of the loss of hunting benefits resulting from forest fires is then derived in the same way as for landscape benefits, with some areas failing to recover, other recovering only partially (so that the end result is marginal hunting land), and some recovering completely. The results are shown in the third panel of Table J.21. In addition to benefits derived from leasing hunting rights, some income generated from fees charged per animal taken. The local populations also obtain some benefits, in the form of recreation and meat value. These latter benefits are very low on a per hectare basis, however (on the order of about 1 US$/ha), and so are ignored here.

57. **Wood production.** The value of lost wood production resulting from forest fires is estimated using the value of the mean standing stock on each hectare. About 80% of the standing stock is assumed to have commercial value, with the relative proportion of sawlogs and pulpwood depending on the density of the stock (<30 m^3/ha, 100% pulp; 30-70m^3/ha, 90% pulp; >70m^3/ha, 80% pulp). The results are shown in Table J.20. Again, the calculations are conducted separately for each county and the resulting values are weighted by the relative distribution of burnt areas, giving the average values shown in the bottom panel of Table J.21.

58. **Other benefits.** In addition, several other categories of benefits should be mentioned:

(a) **Non-timber forest products.** Whether production of secondary non-timber products would rise or fall after forest fires is uncertain, any medicinal and aromatic plants, for instance, prefer open areas such as those created by forest fires to the interior habitat of shaded high forest.

(b) **Recreational value.** Recreational benefits seem unlikely to affect the estimates here significantly. Although recreational benefits can be quite significant on individual sites, only a relatively small proportion of the total area is affected, so the contribution of recreational value to the average value of forest lands is likely to be quite small.

TABLE J.21: ESTIMATED VALUES OF FOREGONE BENEFITS FROM A HECTARE OF FOREST AREA DESTROYED BY FIRE
(US$/ha)

	Forest Area Affected (ha)	Mean Area Burnt (ha)	Year 0	1	2	3	4	5	6	7	8	9	10+
Loss of landscape benefits from visible forests													
Istria	9,951	979	7,245	8,623	9,886	10,961	11,760	14,989	14,989	14,989	14,989	14,989	14,989
Primorje & Gorski Kotar r.	20,561	230	3,059	3,496	3,892	4,225	4,471	4,602	4,602	4,602	4,602	4,602	4,602
Lika-Senj	17,765	115	588	640	685	721	747	761	761	761	761	761	761
Zadar-Knin	24,769	764	1,339	1,459	1,566	1,655	1,721	1,756	1,756	1,756	1,756	1,756	1,756
Sibenik	5,700	597	2,598	2,939	3,247	3,507	3,699	3,801	3,801	3,801	3,801	3,801	3,801
Split-Dalmatia	17,769	1,390	2,875	3,861	3,635	3,939	4,164	4,283	4,283	4,283	4,283	4,283	4,283
Dubrovnik & Neretva r.	9,034	425	3,260	3,739	4,173	4,538	4,809	4,952	4,952	4,952	4,952	4,952	4,952
Total/Mean	**105,549**	**4,500**	**3,516**	**4,255**	**4,581**	**5,011**	**5,329**	**6,109**	**6,109**	**6,109**	**6,109**	**6,109**	**6,109**
Weighted mean	**1,055,491**	**9,000**	**1,758**	**2,127**	**2,290**	**2,505**	**2,665**	**3,055**	**3,055**	**3,055**	**3,055**	**3,055**	**3,055**
Loss of landscape benefits from regional forests													
Istria / Primorje	305,121	2,418	466	508	543	572	593	604	604	604	604	604	604
Dalmatia	750,370	6,582	142	155	166	174	181	184	184	184	184	184	184
Total/Mean	**1,055,491**	**9,000**	**229**	**250**	**267**	**281**	**291**	**297**	**297**	**297**	**297**	**297**	**297**
Loss of hunting benefits	**1,055,491**	**9,000**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**
Loss of wood production benefits													
Istria	99,512	1,958	208	208	208	208	208	208	208	208	208	208	208
Primorje & Gorski Kotar r.	205,609	460	1,243	1,243	1,243	1,243	1,243	1,243	1,243	1,243	1,243	1,243	1,243
Lika-Senj	177,645	230	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247
Zadar-Knin	247,693	1,528	432	432	432	432	432	432	432	432	432	432	432
Sibenik	57,002	1,193	83	83	83	83	83	83	83	83	83	83	83
Split-Dalmatia	177,691	2,780	130	130	130	130	130	130	130	130	130	130	130
Dubrovnik & Neretva r.	90,339	850	313	313	313	313	313	313	313	313	313	313	313
Total/Mean	**1,055,491**	**9,000**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**	**295**
Total			**2,381**	**2,771**	**2,951**	**3,180**	**3,350**	**3,745**	**3,745**	**3,745**	**3,745**	**3,745**	**3,745**

(c) **Watershed protection.** In some areas, forest help protect dams or urban areas from erosion. As with recreational benefits, these benefits are potentially quite significant on specific sites but generally small on average. Improvements to hydrological conditions are similar but harder to quantify.

(d) **Microclimatic effects.** Forests can affect local microclimates by providing shade and windbreaks. This effect is generally unquantifiable.

The exclusion of these benefits, whether for lack of data or for other reasons, implies that the estimated value of forest benefits used in evaluating the forest fire management component of the project are conservative. Actual benefits, if they could be fully quantified, are likely to be larger than those assumed in the calculations.

59. Table J.21 summarizes the results of the calculations on the value of a hectare of forest area destroyed by fire. The estimates in Table J.21 show the expected value of an average hectare lost to forest fires in the given years. Thus, the expected average loss resulting from the loss of hectare of forest to fire in year 1 is

TABLE J.22: ECONOMIC ANALYSIS OF THE FOREST FIRE MANAGEMENT COMPONENT: SUMMARY

Net Present Value (US$ million)	7.7
Economic Rate of Return (%)	13.0
Total reduction in area burnt in 25-year period (ha)	39,520
Breakeven reduction in area burnt (ha/year)	1,370

US$2,770/ha. Depending on where fires actually occur in that year, average losses may in fact be higher or lower than this figure. Similarly, the average value of a hectare of forest burnt in year 2 will be about US$2,950/ha. Areas which burn in future years will result in higher losses because, since the tourist populations will be larger in future years, the loss of landscape benefits will be larger.

Returns to forest fire management

60. The economic analysis of the forest fire management component is shown in Appendix J.1. The results are summarized in Table J.22. These results indicate that, under the assumptions made, the proposed investments in forest fire management are economically worthwhile.

61. **Sensitivity analysis.** The analysis is necessarily dependent on many assumptions. In most cases, conservative assumptions were made, so the result that the proposed investments are worthwhile is likely to be robust. Nevertheless, it is worth reviewing some of the key assumptions made.

(a) **Effectiveness of suppression measures.** Estimating the reductions in area burnt that would be achieved thanks to the project is extremely difficult because of the extreme variability of forest fires. The estimates used in the analysis are the best that can be made given the present state of knowledge in this field, but nevertheless remain quite uncertain. To examine the sensitivity of the results, the minimum areas that would need to be saved under either scenario for the investment to be worthwhile was calculated. This breakeven values is 1,370 ha/year, about 15% less than assumed, and close to or below the minimum values estimated by Alexandrian. If the value of saved areas were higher (see below), even lower breakeven levels would result.

(b) **Value of landscape benefits.** The analysis is critically dependent on the landscape benefits provided by forests. If these benefits were substantially lower, the returns obtained by protecting forest areas would be much smaller, and the proposed investments would most likely not be justified. Estimating the benefit derived from non-marketed goods such as landscapes is still an imperfect science. Considerable evidence suggests that these benefits are considerable, including the results of surveys of tourists in both Croatia and competing tourist destinations, and price differentials in hotel room prices. Nevertheless, extremely conservative values have been assumed for landscape benefits. On the basis of the available information, values as high as 3-4US$/tourist/day for protection of visible forests could have been defended, yet a value of 1.50 US$/tourist/day is used. The proposed investments would remain profitable even if these values were further reduced by about 15-20%.

(c) **Calculation of per hectare benefits.** Numerous steps are required to arrive at estimates of per-hectare benefits. Among these, the assumptions that were made about the way in which forests recover from forest fires play an important role. If burnt areas never recovered

naturally, the benefits to forest fire prevention would be extremely high. Conversely, if forests areas always recovered extremely rapidly, only very modest investments in fire management would be justified.

(d) **Value of omitted benefits.** For lack of data, several benefits provided by forest areas, such as recreation, production of non-timber products, watershed protection, and climate moderation, could not be included in the analysis. Individually, these benefits probably add relatively little to the value of an average hectare of forest, even though they might be quite high on specific sites. Cumulatively, however, their impact might be significant. A $100 increase in the value of benefits lost on an average hectare affected by fire, for example, would increase the NPV of the proposed investments by about 20%.

Conclusion

62. The conclusions of this analysis are that the proposed investments in forest fire management are worthwhile, resulting in a net present value of net benefits of about US$7.7 million and an economic rate of return of about 13.0%, and should be undertaken.

V. SUMMARY

63. The reconstruction component has a NPV of US$2.8 million and a rate of return of about 24% on the sites already identified. The criteria that have been developed for selection of additional sites will result in rates of return of at least 15% on these sites. Based on the range of returns obtained on already-selected sites, reforestation at the additional sites is projected to have a NPV of US$5-7 million and rates of return of about 20-27%. The forest fire management component has a NPV of about US$7.7 million and an economic rate of return of about 13.0%. Both components are worthwhile.

64. **Distribution of benefits**. The distribution of benefits from both components is closely tied to the category of benefits. In the reconstruction component, landscape benefits accrue to the tourism sector, through greater tourist attendance and higher prices; wood production benefits accrue to Hrvatske Sume; hunting benefits accrue to Hrvatske Sume through income from hunting leases, and indirectly to the tourism sector through increased attractiveness of destinations; erosion prevention benefits accrue to municipalities who no longer have to repair damages caused by sedimentation. In the forest fire management component, the same is true except that benefits take the form of averted losses rather than increases in benefits. The tourist sector and municipalities on the coast will also gain additional, unquantified benefits in the form of improved local micro-climates. It is also worth stressing that local populations also value coastal forests, both in and of themselves and for their recreational, hunting, woodfuel, and non-timber benefits, as was made clear by the social survey carried out during project preparation (unfortunately, this survey does not provide sufficient information to value these benefits).

APPENDIX J.1: ECONOMIC ANALYSIS OF FOREST FIRE MANAGEMENT COMPONENT

Net Present Value: 7.7 million US$
Rate of Return: 13.0 %

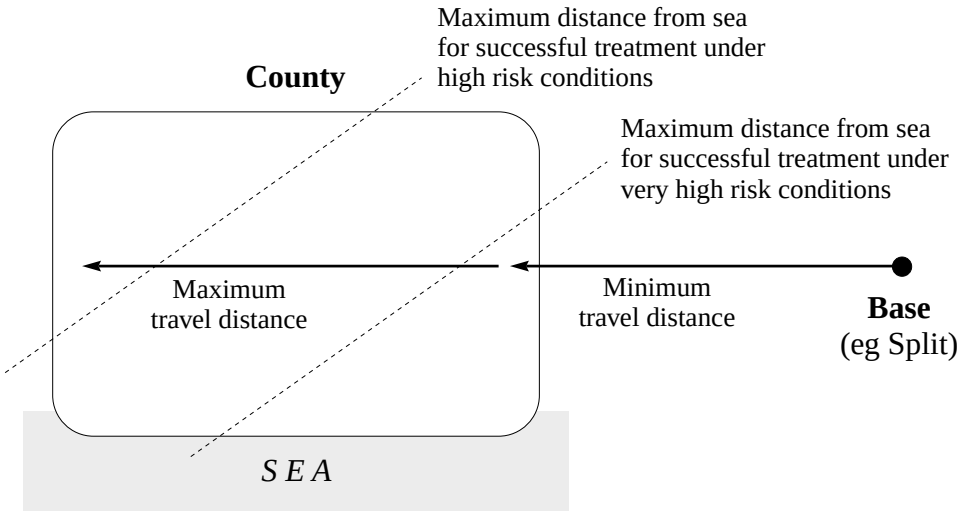
Total reduction in area burned: 39,520 ha
Breakeven reduction in area burned: 1,370 ha / year

	Without Project				With Project					Incremental costs		Incremental benefits			Net benefits	
Year	Aircraft Purchase (000 US$)	Aircraft Operation (000 US$)	Total (000 US$)	Area Burned (ha)	Aircraft Purchase (000 US$)	Aircraft Operation (000 US$)	Other Investments (000 US$)	Total (000 US$)	Area Burned (ha)	Current Value (000 US$)	Present Value (000 US$)	Reduction in area burned (ha)	Current Value (000 US$)	Present Value (000 US$)	Current Value (000 US$)	Present Value (000 US$)
0		2,010	2,010	9,000	20,900	2,754	7,876	31,530	7,560	29,520	29,520	1,440	3,429	3,429	-26,091	-26,091
1		2,010	2,010	9,000		2,754	3,081	5,835	7,528	3,825	3,477	1,472	4,079	3,708	254	231
2		2,010	2,010	9,000		2,754	1,499	4,253	7,496	2,243	1,854	1,504	4,439	3,669	2,196	1,815
3		2,010	2,010	9,000		2,754	1,794	4,548	7,464	2,538	1,907	1,536	4,885	3,670	2,347	1,764
4		2,010	2,010	9,000		2,754	1,729	4,483	7,432	2,473	1,689	1,568	5,253	3,588	2,780	1,899
5		5,061	5,061	9,000		5,805	423	6,228	7,400	1,167	724	1,600	5,993	3,721	4,826	2,997
6		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	659	1,600	5,993	3,383	4,826	2,724
7		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	599	1,600	5,993	3,075	4,826	2,477
8		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	544	1,600	5,993	2,796	4,826	2,251
9		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	495	1,600	5,993	2,542	4,826	2,047
10		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	450	1,600	5,993	2,310	4,826	1,861
11	10,400	1,610	12,010	9,000	10,400	2,354	423	13,177	7,400	1,167	409	1,600	5,993	2,100	4,826	1,691
12		2,010	2,010	9,000	0	2,754	423	3,177	7,400	1,167	372	1,600	5,993	1,909	4,826	1,538
13		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	338	1,600	5,993	1,736	4,826	1,398
14		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	307	1,600	5,993	1,578	4,826	1,271
15		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	279	1,600	5,993	1,435	4,826	1,155
16		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	254	1,600	5,993	1,304	4,826	1,050
17		5,061	5,061	9,000		5,805	423	6,228	7,400	1,167	231	1,600	5,993	1,186	4,826	955
18		2,010	2,010	9,000		2,754	423	3,177	7,400	1,167	210	1,600	5,993	1,078	4,826	868
19		1,458	1,458	9,000		2,202	423	2,625	7,400	1,167	191	1,600	5,993	980	4,826	789
20		1,458	1,458	9,000		2,202	423	2,625	7,400	1,167	173	1,600	5,993	891	4,826	717
21		1,458	1,458	9,000		2,202	423	2,625	7,400	1,167	158	1,600	5,993	810	4,826	652
22		1,458	1,458	9,000		2,202	423	2,625	7,400	1,167	143	1,600	5,993	736	4,826	593
23		1,058	1,058	9,000		1,802	423	2,225	7,400	1,167	130	1,600	5,993	669	4,826	539
24		1,058	1,058	9,000		1,802	423	2,225	7,400	1,167	118	1,600	5,993	608	4,826	490

APPENDIX J.2: MODEL TO ESTIMATE THE EFFECTIVENESS OF FIRE-FIGHTING MEASURES

a. Daniel Alexandrian, consultant to the World Bank, used a model based on the Canadian fire spread model, which has been widely used worldwide including in Mediterranean countries, to estimate the effectiveness of different equipment options. His approach begins by focusing on fires which are actually fought by aircraft ("treated"). Fires in low-risk conditions would generally not be fought with aircraft, unless they are in very remote locations. Even in high and very high risk conditions, not all fires are treated because of limitations imposed by the availability of equipment and other reasons (eg fires at night). The proportion of fires treated will be affected by project investments (with more aircraft, a higher proportion of fires can be treated).

b. The likelihood of treated fires being extinguished depends on the conditions (fuel quantity, wind strength) and the distance the aircraft have to travel to reach them (which affects the size of the fire when treatment begins) and the extinguishing power that the aircraft can bring to bear (which depends on the distance of the fire from the nearest water body, the aircraft speed and capacity, and the number of aircraft). For each county, the model estimates what proportion of fires are likely to be treated successfully, based on these factors. The area burnt when fires are successfully treated is computed; for those where treatment is unsuccessful, the average area burnt is assumed.



APPENDIX J.3: CRITERIA FOR SELECTION OF ADDITIONAL REFORESTATION SITES

1. **High importance to the landscape of tourist areas.**

The new sites must be of high importance to the landscape of tourist areas. To ensure this, they must be selected in close cooperation with representatives of the local tourist organization and the municipality. Both the local tourist organization and the municipality must write a letter to Hrvatske Sume confirming that the proposed site is of high importance to the landscape of tourist areas.

2. **Evaluation of landscape benefits.**

Before preparing a detailed work plan, Hrvatske Sume will make a preliminary visit to the site to *estimate* the cost of reforestation. Depending on the size of the tourist area and the number of tourists, reforestation may not be justified if the cost is too high. The attached table shows the minimum number of tourist overnights needed to justify reforestation at 15% ERR, given the size of the tourist area and the cost of reforestation:

	Economic cost of reforestation (US$/ha)				
Size of tourist area	1,000	1,200	1,400	1,600	1,800
Small	180	220	260	300	340
Medium	480	580	690	790	900
Large	1,200	1,450	1,720	1,980	2,230

Cost of reforestation: The cost of reforestation used in evaluating the benefits must (i) include all activities involved in reforestation, including clearing, land preparation, planting, weeding, and restocking; and (ii) be evaluated in *economic* terms rather than *financial* terms. Since labor costs form the bulk of the reforestation costs, the main way in which economic costs diverge from financial cost is in the value attributed to labor. Financial cost calculations include many taxes and other transfers which are properly omitted from economic cost calculations. To calculate the economic costs of any activity such as clearing, the following formula is used:

$$\text{Economic Cost} = \text{Financial Cost} \times \left(1 + \text{Labor Share} \times \left(\frac{23}{36} - 1\right)\right)$$

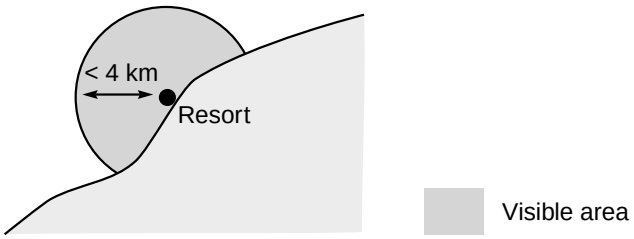
Where the labor share is share of labor costs in total costs. This formula assumes that the financial value of casual labor (including the value of food and field allowances paid to workers) is 182HRK per day (about 36US$) while the economic value is 115HRK per day (23US$). As the labor market adjusts to changed conditions in the following years, these assumptions will have to be adjusted.

Size of tourist population: The *prewar* number of tourist overnights should be used in the evaluation.

Size of tourist area: The size of the tourist area is based on the extent of the area visible from the main areas frequented by tourists (hotels, beaches, marinas, historic town centers, and so on). This in turn depends on how concentrated the areas frequented by tourists are, and on the topography of the site.

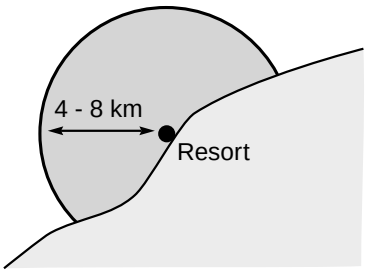
Guidelines for determining the size group of a given tourist area:

Small tourist area
Tourist facilities concentrated in small area *eg Novigrad*

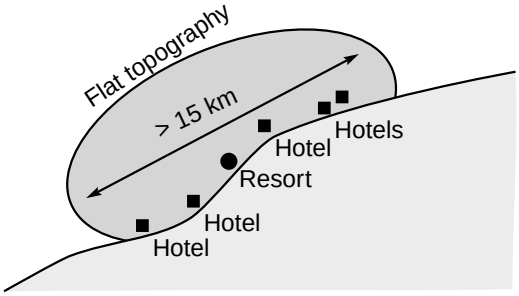


Medium tourist area

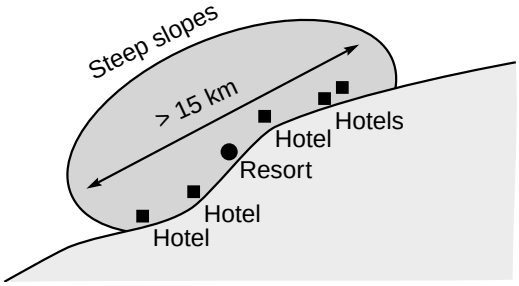
a. Tourist facilities concentrated in relatively small area, but topography means a large area is visible *eg Trogir*



b. Tourist facilities spread out, but flat topography limits visibility *eg Sibenik town*



Large tourist area
Tourist facilities spread out, and topography means a large area is visible
eg Dubrovnik, Makarska



3. **Screening of preliminary selections.**

For all the sites where the preliminary evaluation shows that reforestation is justified, lists of other benefits expected from reforestation should be prepared. Priority should be given to sites where (i)

the tourist population is much larger than the minimum shown in the table as being necessary to justify reforestation; and/or (ii) substantial other benefits are expected in addition to landscape benefits. The aim should be to prepare work plans for sites covering 1,000-1,500ha each year.

4. **Preparation of detailed reforestation plans.**

For each site selected, detailed reforestation plans should be prepared.

- The proposed species composition should be reviewed by FRI.
- Measures to protect aquatic fauna will be adopted.
- If any part of the site is in or near a national park, the state agency responsible should be consulted and their approval of the proposed reforestation plan should be obtained.

Once final estimates of the cost of reforestation are available, the table should be checked again to confirm that reforestation is justified.

5. **Submit reforestation plans for approval at the annual project review.**

Documentation required for approval at the annual review:

- *Letter from the municipality* to Hrvatske Sume confirming that the proposed site is of high importance to the landscape of tourist areas. This letter should also mention other benefits the municipality expects to receive.
- *Letter from the local tourist organization* to Hrvatske Sume confirming that the proposed site is of high importance to the landscape of tourist areas. This letter should also provide information on the tourist area, including number of hotels (indicating category and number of beds); number of other facilities (eg campgrounds, private accommodations); whether the reforestation site is visible from the town center, from the beaches used by tourists, from the marina, etc. The letter should also provide estimates of the number of tourist overnights prewar.
- *Map of the reforestation site and the tourist area* it is in, indicating whether the tourist area is considered small, medium, or large.
- *Detailed reforestation plan*, with detailed cost estimates.
- *Detailed list of other benefits* expected in addition to landscape benefits, if any. This list should be as specific and detailed as possible (ie it should not just say "protection from erosion" but also provide a detailed description of what kinds of damages erosion is causing).
- If any part of the site is in or near a national park, a *letter from the SACCNH* indicating that the proposed reforestation plan has been reviewed and is acceptable.

This documentation will be considered sufficient to authorize reforestation on sites of up to 300ha. Larger sites will require special justification, perhaps including a full economic analysis.