5 FORESTRY SECTOR

5.1 INTRODUCTION:

The forestry sector in Lebanon provides opportunities for mitigating climate changes through reduction of Greenhouse Gaz (GHG) emissions and through increased absorption and storage of carbon in forests, soils, detritus, and in long-term biomass products.

The main mitigation options involve:

1) Reducing emissions of GHG by maintaining existing carbon sinks through conservation and protection of forests, improvement of management practices.

2) Sequestering carbon by expanding forest cover and increasing carbon storage in forest, soils and in long-term products.

The approach used in this study for the evaluation of the role of forests in Lebanon for mitigating climate change is conform to the Comprehensive Mitigation Assessment Process (COMAP).

The approach consists of:

1. Identification of Mitigation options significant to Lebanon;
2. Assessment of the current and future land area available for restraining emissions and for carbon sequestration;
3. Determination of the land area and wood production scenarios;
4. Estimation of the emission reduction and the carbon sequestration per unit area of forests for each mitigation option;
5. Estimation of the total and unit costs and benefits of each option;
6. Evaluation of the cost-effectiveness of mitigation options.

5.2 SCREENING OF THE MITIGATION OPTIONS:

Lebanese governmental forestry orientations expressed by official declarations, and adopted forestry and land tenure policies, aim at the conservation of the environment and bio-diversity, the protection of soil and water and the provision of social services through:

- The Protection and conservation of natural forests and improvement of forest management in order to:

  a) Improve wildlife protection
  b) Reduce forest losses due to insects and diseases
  c) Insure natural forest regeneration and development.

- Expansion of the forest area from 75,000 hectares (1) to 200,000 hectares as a low target and up to 282,000 hectares as a high target through reforestation, agro-forestry, and urban forestry. (2)

The rate of expansion of the forest area as well as the protection and conservation of the existing forests are based on the current trends of land use and are essentially directed to environmental and social purposes but could also lead to increase carbon sequestration in biomass, soil and wood products.

5.3 ASSESSMENT OF THE CURRENT & FURTURE LAND AREA:

Table A5-1 shows the land use pattern in Lebanon in year 1994 (1) as base year and the most likely trends (baseline scenario) in land use change in years 2000, 2005, 2015 and 2040 respectively. Table A5-2 shows the land use as the first mitigation scenario and table A5-3 as the second mitigation scenario.

Forestland consists of: Land covered by forest with two levels of crown density cover: 1) more than 40% 2) from 10 to 40% and wasteland where the crown cover is less than 10%. Wasteland include woodlands and range lands with 60 + 147 thousands ha respectively in year 1994.

The changes of forestland occurring from year 1994 to 2040 concern:

- The Baseline scenario:

a) Increasing the bio-mass density of existing degraded and understocked forests, through increasing of the area of more than 40% crown cover from 32,000ha in 1994 to 55,000ha by year 2040, this means that understocked forests (crown cover 10-40%) will be reduced from 43,000 to 20,000ha. This change will be the results of enhancing regeneration through appropriate management and protection of forest stands. (3)

b) The reforestation of 38,000ha of woodlands (crown cover less than 10%) up to the year 2040. The reforested area will be added to the dense cover forest. The area of the dense forest will increase 38,000ha. The woodlands area will decrease of the same amount.

- The mitigation scenario:

The first mitigation scenario, shown in table A5-2, describes a future that is essentially similar to that in the Baseline scenario, except that it assumes that policies or programs are implemented to encourage adoption of measures that will reduce GHG emissions and enhance carbon sinks. (3)

It means that in addition to the changes occurred in the Baseline scenario in the field of forest protection and management as well as in reforestation, more intensive management/protection and more expansion of forest area are foreseen:

1. In the first mitigation scenario (Table A5-2); all the forests will become dense (crown cover more than 40%) and the total forest area will increase up to 200,000ha it means additional 87,000ha versus the Baseline scenario.

2. In the second mitigation scenario (Table A5-3) the total forest area will reach the amount of 282,000ha that means an additional 82,000ha will be reforested versus the first mitigation scenario.

Notes: Protected land in Lebanon is included in Forestland, it is mentioned for record.

Grassland is the land used for pasture; part of it could be converted to agriculture uses by land reclamation and irrigation.

Cropland is intended to increase by acquisition of Grasslands; the increase will be from 297,000ha to 360,000ha in the Baseline scenario and to 380,000ha in the Mitigation scenarios.

Table A5.1.Step 1.1 Land use pattern, Baseline scenario (Area x 1000 hectares)

		1994[1]	2000	2005	2015	2040
1	Forest land:					
	> 40% crown cover	32	32	39	54	93
	10 - 40% crown cover	43	43	39	34	20
	< 10% crown cover: Woodlands	60	60	57	47	22
	Range lands	147	147	147	147	147
	Sub-total	282	282	282	282	282
2	Protected land[2]		(6)	(12)	(20)	(36)
3	Grass land (pasture)	316	316	308	293	253
4	Crop land	297	297	305	320	360
5	Other	126	126	126	126	126
	Total	1021	1021	1021	1021	1021

[1]Sources: Bio-diversity Country Study (1996) and agriculture census (1998), Ministry of agriculture.

available. (4) and (2)
[2]For the record, this area is already included in forestland.

Table A5-2.Step 1.2 Land use pattern, first mitigation scenario (Area x 1000 hectares)

1	Forest land:	1994[1]	2000	2005	2015	2040
	> 40% crown cover	32	32	62	132	200
	10 - 40% crown cover	43	43	28	8	0
	< 10% crown cover:					
	Woodlands	60	60	45	0	0
	Range lands	147	147	147	142	82
	Sub-total	282	282	282	282	282
2	Protected land[2]		(6)	(24)	(48)	(100)
3	Grass land	316	316	303	278	215
4	Crop land	297	297	310	335	380
5	Other	126	126	126	126	126
	Total	1021	1021	1021	1021	1021

[1]Sources: Bio-diversity country study (1996) (4) and agriculture census (1998), Ministry of Agriculture. (2) Trends of land change are based on judgements of officials and expert estimation, since no official statistics are available. (3)
[2]For the record, this area is already included in forestland.

Table A5-3.Step 1.2 Land use pattern, second mitigation scenario (Area x 1000 hectares)

1	Forest land:	1994[1]	2000	2005	2015	2040
	> 40% crown cover	32	32	62	132	282
	10 - 40% crown cover	43	43	28	8	0
	< 10% crown cover:					
	Woodlands	60	60	45	0	0
	Range lands	147	147	147	142	0
	Sub-total	282	282	282	282	282
2	Protected land[2]		(6)	(24)	(48)	(100)
3	Grass land	316	316	303	278	215
4	Crop land	297	297	310	335	380
5	Other	126	126	126	126	126
	Total	1021	1021	1021	1021	1021

[1]Sources: Bio-diversity country study (1996) (4) and agriculture census (1998), Ministry of Agriculture. (2) Trends of land change are based on judgements of officials and expert estimation, since no official statistics are available. (3)

[2]For the record, this area is already included in forestland.

5.4 DETERMINATION OF THE LAND USE AREA &WOOD PRODUCTION SCENARIOS:

Developing a national mitigation strategy requires identification and analysis of different actions that the government can take to encourage adoption of measures and practices that reduce GHG emissions or enhance carbon sinks. Based on the analysis, policy-makers can then decide which options satisfy specific policy objectives and which are also within institutional, political, and budget constraints.

The different actions / options will be identified and analyzed through the various scenarios that will be processed using COMAP model which has been developed for estimating the impacts of mitigation options on the reduction of GHG emissions, enhance carbon sequestration, as well as on the costs and benefits of each option. The various scenarios will be based on the following options:

Land use: (Area x 1000 ha)

	Table	Options/ Changes
- Baseline scenario	Table A5-1	Forest area from 75 to 113
- First Mitigation scenario	Table A5-2	Forest area from 75 to 200
- Second Mitigation scenario	Table A5-3	Forest area from 75 to 282

5.4.1 FOREST PROTECTION & MANAGEMENT:

Estimation of the impacts of mitigation options will result from the comparison of the effects of mitigation options versus those of Baseline scenario. The most-likely-trends scenario is chosen as the Baseline scenario against which the mitigation scenarios are compared.

In forest protection and management the changes are assumed to be on:

- The discount rates: 5%,10%, and 15%;
- The enhanced management and the intensity of sylvicultural practices applied which affects positively the trees growth and consequently the biomass growth and density (mitigation scenario).

Thus the following scenarios will be analyzed:

Scenario No.	Table No.	Discount Rate %	Mitigation versus Baseline
1	A5-8	5	//
2	A5-9	10	//
3	A5-10	15	//

These scenarios assume that the total area of protected forest remains unchanged. The Baseline amount of carbon stored may be estimated as that which would have been released in the absence of efficient protection measures and poor sylvicultural practices monitoring.

5.4.2 EXPANSION OF CARBON SINKS BY REFORESTATION:

To expand the stock of carbon in biomass, soil, and wood products, we assume that carbon will need to be stored in perpetuity and estimate the amount of stored carbon on a given area over an infinite number of rotations. The total carbon stored includes the carbon in biomass soil, litter, understory, and wood products. Thus the options will be on the amount of reforested area and the length of the rotation age, in addition to the three discount rates which will be applied: 5%, 10%, and 15 %.

The different scenarios will be as following:

Scenario No.	Table No.	Discount Rate %	Reforested land X 1000ha	Rotation age years
1	A5-11	5	125	75
2	A5-12	10	125	75
3	A5-13	15	125	75

Here the amount of reforested land (125,000ha) will bring the total area up to 200,000ha, being the first governmental target. The rotation age (75 years) is calculated assuming that the total area will be composed of 25% of coppiced forest (broad leafed species) with a rotation age of 25 years; and 75% of high forest (cedars, pines, junipers, and cuppressus) with a rotation age of 95 years.

Scenario No.	Table No.	Discount Rate %	Reforested land X 1000ha	Rotation age years
4	A5-14	5	125	100
5	A5-15	10	125	100
6	A5-16	15	125	100

The above set of scenarios shows that the rotation age is an average of 100 years assuming that 200,000ha of forest will be composed of 25% of coppiced forest with 30 years rotation age and the 75% of high forest with 125 years rotation age.

Scenario No.	Table No.	Discount Rate %	Reforested land X 1000ha	Rotation age years
7	A5-17	5	125	125
8	A5-18	10	125	125
9	A5-19	15	125	125

The same as above except that the rotation age of high forests is assumed to be 150 years which could be attained in planting more Cedrus and Juniperus which could be maintained for more than 200 years rotation contrary to Pinus and cuppressus.

The following scenarios assume that the reforested area will be 207,000ha bringing the total forest area up to 282,000ha which is the second governmental target. The same three rates of discount are applied as well as the three rotation ages: 75, 100, and 125years which are the average rotation age of the 25% of the area of coppiced forest and 75% of high forest.

Thus the scenarios will be:

Scenario No.	Table No.	Discount Rate %	Reforested land X 1000ha	Rotation age years
10	A5-20	5	207	75
11	A5-21	10	207	75
12	A5-22	15	207	75

Scenario No.	Table No.	Discount Rate %	Reforested land X 1000ha	Rotation age years
13	A5-23	5	207	100
14	A5-24	10	207	100
15	A5-25	15	207	100
13	A5-26	5	207	125
14	A5-27	10	207	125
15	A5-28	15	207	125

5.4.3 ANALYSIS OF FOREST PROTECTION MITIGATION OPTION (AS PER COMAP MODEL)

See Appendices tables A5-8, A5-9, and A5-10.

Step 2 and 3 show that the forest area (75,000ha) remains unchanged from 1994 to 2040 under the Baseline and the mitigation scenario. But the carbon stocks increase due to stopping the forest degradation through protection measures and forest management practices.

The Baseline scenario assumes that the 75,000ha of forest will receive inadequate protection and poor management practices that lead to some increase in carbon stocks. The biomass density will increase as follow: the forest with more than 40% crown cover increases from 32,000ha in year 1994 up to 50,000ha in year 2040, and the area with 10 40% crown cover decreases from 43,000ha to 20,000ha. In the mitigation scenario adequate steps are taken to insure that the forest area is well protected and enhanced management practices are applied.

This will lead to a bigger increase of the biomass density and carbon density; the forest with crown cover of 10- 40% will be converted totally to more than 40%; the total area of forest will be closed forest and wood production improved.

Step 4: Estimating carbon pool and sequestration.

Determine the current and future biomass density under each scenario. In order to determine the carbon pool and sequestration, the following data are used:

- Current bio-mass density: 146 t/ha (it is the average biomass density of high forest stands and coppiced forests).
- Carbon content of biomass: 0.5
- Soil carbon density: 60 t/ha

These figures are estimated (3) based on the revised (1996) IPCC guidelines. (6)

In the Baseline scenario it is assumed that the biomass density continues to increase at a rate of 1% per year. Under the mitigation scenario the biomass density will increase at a rate of 2% per year (3). The soil carbon density increases consequently at a rate of 1% under the Baseline scenario and 2% under the mitigation scenario. The total carbon density will be the total of the bio- mass carbon density and the soil carbon density; it amounts to: 14,587,500 t.c in baseline and to: 20,175,000 t.c in the mitigation scenario.

Step 5: Estimating costs and benefits.

Step 5.1: Cost of forest protection.

In the Baseline scenario the forest area was poorly protected and managed, and the expenditure, which may be based on the annual government budget is $ 2 /ha/year. In the mitigation scenario the costs increase to $ 78, $66,or $ 60 per ha and per year depending on the discount rate 5%, 10%, or 15%. These figures are the stream of costs and present values from 1994 to 2040 (Step5.1.1). Initial costs are $ 30/ha in year 2005 and recurrent costs are $ 5 /ha/year until 2040. (3)

Step 5.2: Benefit from land conversion. (Not applicable)

Step 5.3: Benefit or cost of providing alternative products.

There are no benefit or cost of providing alternative products, since the rural populations demand for products and services will remain the same in the two scenarios. Forest products will satisfy the future needs / demands of local population.

Step 5.4: Benefit from forest protection.

The benefit provided by wood production and by certain services (recreation, ecotourisme, aromatic and medicinal herbs, fungus, etc) is valued at $ 100 /ha/year in the Baseline scenario, and at $ 300 /ha/year in the mitigation scenario. The increase is the result of adequate protection and management in the protected forest.

The figures used are based on the National bio-diversity study of Lebanon achieved in 1996 , the Ministry of Agriculture with the assistance of GEF / UNEP project. (4)

Step 6.1: Determine the carbon pool and annual sequestration for each scenario.

Multiplying the total carbon density (step 4.4) by the forest area, under each scenario yields the pool of carbon for each year. The annual incremental carbon is the difference of the carbon pool between the mitigation scenario and the baseline scenario.

The baseline scenario C. pool is: t.c 14,857,500
The mitigation scenario carbon pool is: t.c 20,175,000
And the incremental carbon sequestered is: t.c 5,587,500 which means a reduction of $t.Co_2$: 20,450,250 (for ref.: see para. 5.4.4 step 6.1)

Step 6.2: Determine the total cost and benefits of sequestration.

For the two scenarios, the costs of forest protection are computed by multiplying the cost of one ha/year, by the area of forest protected (75000ha). Similarly, the benefits from protection are calculated by multiplying the benefits provided by one ha/year, by the forest area. The incremental net cost is calculated in comparing the two scenarios. The output of costs and benefits is present in tables A5-8, A5-9, and A5-10.

Step 7: The cost-effectiveness indicators of conserving carbon are summarized in Table 5-4 below:

Cost effectiveness indicators are calculated as follows:

- Initial cost of Forest protection:
  $ /t.c = initial cost x forest area / total incremental C.
  $ /ha = initial cost as estimated

- The present value of costs for carbon sequestration is:
  $ /t.c = mitigation scenario benefits / total incremental C. pool sequestered
  $ /ha = mitigation scenario benefits / forest area

Present value of cost per hectare and per ton of carbon is the sum of initial cost and the discounted value of all future investment and recurring costs during the life time of the project.

Table A5-4.Forest protection cost effectiveness indicators- Area: 75,000ha

Discount Rate %	Initial cost of Forest protection		Net present value Of costs	
	$/t.C	$/ha	S/t.C	$/ha
5	0.403	30	3.94	293
10	0.403	30	4.66	347
15	0.403	30	4.78	356

5.4.4 ANALYSIS OF A REFORESTATION MITIGATION OPTIONS:

The comprehensive mitigation assessment process (COMAP) is used in this analysis; the output of this analysis is present in tables A5-11 to A5-28.The different steps are as follows:

Step 2 and 3: Determine current and future land area for the baseline and mitigation scenarios.

In the baseline scenario (Table A5.1) it is assumed that the woodlands (wasteland) decrease from 60,000ha in base year 1994 to 20,000ha in year 2040 due to reforestation of 38,000ha of wastelands. This estimation is done by the Head of the forest service (Ministry of Agriculture) and the consultant, based on the reforestation program, the government budget and the trends of foreseen activities. Total area of wasteland (woodlands and rangelands) is 207,000ha in year 1994, and will decrease up to year 2040 to become 169,000ha.

In the mitigation scenarios, two options are assumed to happen:

The first option (Table A5-2) assumes that adequate steps are taken to ensure that 125,000ha are reforested by year 2040. The total area of forest increase up to 200,000ha (75,000ha + 125,000ha) and similarly the wasteland area decrease from 207,000ha to 82,000ha by year 2040.

The second option (Table A5-3) assumes that efforts are taken to ensure that all the wasteland area (207,000ha) is converted in dense forest by year 2040. Then the total forest area becomes 282,000ha.

The reforested lands will be managed in rotations consistent with the planted species, which are mainly Cedrus Lebani, juniperus excelsa, pinus pinea, pinus brutia, and P.halepennis, Cupressus sempervirens, and Abies cilicica. Native broad-leaved species such as Quercus, Acer and Sorbus species will be mixed with the coniferous species. All these species could be managed in different rotations: 100 to 200 years for Cedrus, Juniperus, Abies and Cupressus species, and 80 to 125 years for pinus species according to the desired forest products.

Also the broad-leaved species could be managed in coppiced forest for fuel wood production in short-term rotation 20 to 30 years. We assume that only 1/4 to 1/5 of reforested land can be used in coppiced broad-leaved forest.

Consequently, 3 rotation ages are used in the mitigation scenarios as options: 75,100, and125 years rotation, are the three options considered. They are average period rotations taken in consideration the species aforementioned and the coppice and high forest regimes.

Step 4: Determine the current and future carbon pool, emission and sequestration for each scenario.

Step 4.1: In baseline scenario for the calculation of the carbon pool and sequestration of wasteland, the following data are used:

- Biomass density (t/ha): 5t/ha, (waste-lands are continuously grazed) remains unchanged until year 2040.
- Carbon content (ratio): 0.5.
- Soil carbon density is assumed to be 20 t/ha.

Data are estimated on the basis of experts views in comparison with similar degraded waste-land in Turkey reference to the study on Accumulation of Co_2 in the forests in Turkey and Bulgaria (ref.11)

Step 4.2: In the mitigation scenarios, reforestation has the potential to increase carbon density through increased carbon in vegetation, soil, decomposing matter and forest products.

- **Vegetation carbon:** We assume that three rotation periods can be applied: 75years, 100 and 125 years, as averages depending on percentage of various species used in plantation and on desired forest products: timber, fuel wood, non wood-products, as well as on forestry policy related to environmental protection function or production function pursued by the government. We consider that the plantation is operated in rotation for an indefinite time period. The annual biomass growth is estimated at 3 t/ha/year and the carbon ratio = 0.5. Vegetation carbon is calculated for each rotation period accordingly.

- **Soil carbon:** It is assumed that the storage period of carbon in soil is 75 years and the annual increment of carbon is 2 t/ha/year under the rotation for indefinite time period.

- **Decomposing matter:** The decomposition of biomass on soil creates a stock of carbon. In perpetual rotation analysis we assume that the decomposition period is 6years, and the amount of decomposing carbon left behind is 5 t/ha/year.

- **Forest products:** The amount of carbon stored in the form of products will depend on the product life; the longer the product life the more carbon will be stored away. We assume that the products are replenished at the end of their life cycle and that the products oxidize or decompose at the end of their lifetime. In Lebanon the average product lifetime is estimated at 40 years and the amount of carbon stored in the products is 30 t/ ha.

Step 4.3: Summarizes the carbon density estimated in step 4.1 which amount to: t.c/ha 22.50 for Baseline scenario and in step 4.2 for Mitigation scenario which amount to: t.c /ha: 249 for 75 years rotation, 316 for 100 years, 384 for 125 years.

Step 5: Estimating costs and benefits.

Step 5.1: In the baseline scenario the cost of wasteland is assumed to be $ 5/ ha. In the mitigation scenario, reforestation incurs an initial cost in year 2000 of $ 1500/ha; recurrent maintenance costs, which are incurred, increase from $ 10/ha to $ 30/ ha. Similarly, monitoring costs increase from $ 5/ha to $ 15/ha. The stream of total costs per ha is shown in step 5.1.1. The present value of stream of costs is computed using a discount rate equal to 5%, 10%, and 15% respectively.

Step 5.2: In the baseline scenario the benefits, amount to $ 20/ha. In the mitigation scenario the benefits from reforestation amount to $ 22045/ha are derived from timber, assuming that the mean annual increment is $3m^3$/ha/yr (3) and non-timber production (fuel wood, fungus, fruit, herbs, etc). The present value of the stream of benefits ($/ha) is computed in step 5.2.1.

Step 6.1: Determines the carbon pool and annual sequestration for each scenario. Multiplying the total carbon density (Tc/ha) by the land area, under each scenario, yields the pool of carbon (Tc) for each scenario as presented in (table A5-5) below:

Table A5-5.Carbon pool-reforestation

Rotation age Years	Mitigation C.pool In t	Incremental C. sequestered In t
1- Reforested area: 125,000		
75	23,529,750	19,434,750
100	29,337,000	25,242,000
125	35,213,850	31,118,850
2- Reforested area: 207,000		
75	42,123,250	38,028,250
100	53,404,000	49,303,000
125	64,819,950	60,724,950

Step 6.2: Determines the total costs and benefits of sequestration. The difference between the baseline and mitigation scenarios net benefits yields the total incremental benefit.

Step 7: Expression of the cost- effectiveness indicators of conserving carbon.

- The net present value of benefits is calculated as indicated before in para. 5.4.3 step 7.

The various scenarios correspond to the following selected options:

- Rate of discount 5, 10 and 15%
- Rotation age: 75 , 100 and 125 years
- Land area reforested up to year 2040:125,000ha and 207,000ha

Table A5-6. Cost- effectiveness indicators- Reforestation

Reforested area - ha-	Rotation age - years -	Discount Rate %	Initial cost		Present value Of costs	
			$/t.C	$/ha	$/t.C	$/ha
125,000	75	5	27.50	2586	15.39	1445
		10	25.60	2400	12.82	1204
		15	23.80	2238	10.79	1013
	100	5	21.20	2586	11.84	1445
		10	19.70	2400	9.87	1204
		15	18.40	2238	8.31	1013
	125	5	17.20	2586	9.61	1445
		10	16.00	2400	8.01	1204
		15	14.90	2238	6.74	1013

Table A5-7. Cost- effectiveness indicators- Reforestation

Reforested area - ha-	Rotation age - years -	Discount Rate %	Initial cost		Present value Of costs	
			$/t.C	$/ha	$/t.C	$/ha
207,000	75	5	14.10	2586	12.82	2356
		10	13.10	2400	10.55	1938
		15	12.20	2238	8.77	1611
	100	5	10.90	2586	9.89	2356
		10	10.10	2400	8.14	1938
		15	9.40	2238	6.76	1611
	125	5	8.82	2586	8.02	2356
		10	8.18	2400	6.61	1938
		15	7.63	2238	5.49	1611

5.5 COSTS OF INCREMENTAL CARBON SEQUESTERED AND CO_2 REDUCED:

The incremental C. sequestered is the increase quantity of C. resulting from the mitigation options applied. Consequently an amount of Co_2 is reduced from the atmosphere. The equivalent amount of Co_2 reduced is calculated by the conversion of one t.c to 3.66 ton of Co_2. . This is based on the results given by the US Country Study Program (1994) as referenced in the proceeding of the XI World Forestry Congress. (1997)

5.5.1 Forest protection and management:

- Protected area: 75,000ha
- Discount rate 10%

Incremental C. sequestered		Equivalent Co_2 reduced		Total Cost
t.c	Initial cost $ / t.c	t. Co_2	Cost $ / t. Co_2	In $
5,587,500	0.403	20,450,250	0.110	2,251,726

5.5.2 Reforestation:

- Reforested area: 2 options 125,000ha and 207,000ha
- The rotation age is: 100 years
- Discount rate applied is: 10%

Reforested area	Incremental C. sequestered		Co_2 reduced		Total Cost
ha	t.c	Initial cost $ / t.c	t. Co_2	$ / t. Co_2	In $
125,000	25,242,000	19.70	92,385,720	5.38	497,267,400
207,000	49,303,000	10.10	180,448,980	2.76	497,960,300

5.6 STRATEGY

To implement the mitigation scenarios described above; the government has to elaborate and implement a strategy expressed by forestry policies, which govern the use of forest resources and influence levels of activities in the forestry sector.

Polices that aim to maintain carbon stocks and expand carbon sinks should include the following:

Forest protection and conservation policies: To preserve existing forests and assure

- Undertaking a new-forest inventory and mapping (the first one was done in 1966) including a descriptive structure and composition of forests stands.

- Developing forest management systems that improve the long-term productivity and ecological integrity of the forests.

- Developing sound methods of fighting fire, insects, and diseases.

- Establishing a network of ecological forest reserves throughout the country.

- Adopting forest ecosystem management to assure a sustainable development that takes into consideration the capacity of forests and the various human-uses and needs.

- Introducing intensive silviculture practices to increase forest growth and to get more wood from every tree.

- Training of forest service personal in forest management techniques and practices.

Reforestation:

- The success of reforestation programs is due to the knowledge of ecological, ecophysiological, and genetical criteria of the forest species and seeds to be used. Importance should be given to these technical aspects because of the climatic and soil constraints that encounter the foresters in Lebanon, as well as in all the Mediterranean countries. Thus a well-trained personal, at professional and technical levels, is a prerequisite to plan and execute a reforestation national program.

- Long rotation periods adapted to species characteristics will increase carbon stock periods and reduce the cost per reforested unit area as well as the cost of the carbon sequestered.

- Quality of wood produced should permit its use for long life products; thus more carbon will be stored away. Quality of wood depends on forest species and management systems

- Aggressive reforestation policies applied both by Forest Administration and villagers. These policies may include incentives to private owners of degraded lauds for reforestation, emphasizing expanding plantation forestry for industrial wood.

- Research on species and seeds provenance and on appropriate techniques for harvesting and regeneration of forests.

Other measures

- Amendment of the forest laws to allow various parties to participate in implementing reforestation programs and forest management plans and to share benefits generated from timber products and other non-wood products.

- A comprehensive land use planning and zoning through which appropriate land is spread for agriculture, forestry and pasture. The less productive land will be re
among various uses of land; especially conversion of forest or forest lands to other uses. Thus the delimitation and mapping of lands reserved for reforestation is essential to plan and elaborate reforestation programs.

- Urban policies that not encourage extensive and wasteful conversion of natural forests and forest lands to other uses.

- Grazing, in forests and reforested lands should be managed to avoid damages that goats and sheep could cause to regeneration of old forest stands or to the growth and development of young forest and new reforested lands. Serious prejudices will affect any forestry development plan if the grazing problems are not solved.

- Agro-forestry practices (windbreaks, linear plantations, and community forest) should be encouraged in agricultural areas. Thus part of rural populations needs of forest products will be provided, alleviating the pressure on neighboring forest areas.

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