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Vulnerability Assesment & Adapation Measures of Forest Sector in Syria

Related to the Project Activity

Programs Containing Measures to facilitate Adaptation to Climate Change

Project Title

Enabling activities for preparation of Syria's initial national Communication to the UNFCCC, (Project Nr.00045323).

National Project Director
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The project implemented in the ministry of local administration and Environment (MLAE)/General Commission of Environmental Affairs (GCEA), in collaboration with Global Environmental Facility (GEF) and United Nation Development Programm (UNDP) in Syria.

Evaluating the Vulnerability of Forest Sector in Syria to Climate Changes

(INC-SY_V&A_ Forest -En)

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This report has been approved unanimously by the technical committee, during the Technical Workshop which took place on 24/ 03/ 2009 in the Dedeman Hotel Palmyra.

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1. Introduction

Syrian forest cover has been degraded continuously during the past centuries. During the period of 1516 to 1924, the colonizing governments exploited forest resources for wood production to for fuel for Turkish trains during the I World War, and to build the railroad to *Baghdad* and al-*Hijaz*.

Forest resources in Syria were subject to additional pressures during the French occupation period. Forest fuels were used to smoke tobacco, and the citizens of Syria to show unsatisfaction with the French colonialism burned forests.

Forest resources in Syria suffered severe destruction and degradation during the last few decades due to the large growth rates of the rural populations and the high rates of illiteracy in these areas where most forests are located. Harsh climatic conditions coupled with poverty lead to increasing pressures on forest resources in Syria during the last few decades. Horizontal agricultural expansion, constructional expansion, overgrazing, and woodcutting exerted high pressures on Syrian forest resources.

In addition, forest fires, both man-induced and natural, are considered the main driving forces behind the degradation of forests and natural vegetation cover. According to the available information regarding forest fires in Syria, during the last 15 years, forest fires affected more than 20000 hectares of Syria forests that are located in the coastal area.

The causes and severity of forest fires were attributed to climate conditions, vegetation types and characteristics, and human activities. Though the information on forest fires are scarce, it is safe to say that around 99 % of forest fires incidents in Syria are due to human activities including agricultural activities, grazing, beekeeping, tourism …etc. (*Ali*, *2004b*). It should be mentioned that the capacity to manage forest fires in Syria: preventive measures, fire detection, and fire suppression, is not sufficient.

2. The status quo of forests in Syria

The natural forests occupy about 232840 hectares of Syria surface area, and the area that is artificially forested between 1953 and 2007 is around 268753 hectares. Therefore, the total area of Syria that is occupied with forests exceeds half a million hectares (501593 ha.), which accounts for 2.71 % of the total area of Syria (Table 1).

2.1. Natural forests

The area of natural forests of Syria amounts to 232840 hectares according to survey statistics of the Directorate of Forests for the year of 1993 (more up to date statistics are not available). These forests occupy 1.26 % of total area of Syria, and are concentrated in the provinces of: *Lattakia*, Hamah and *Idlib* (Table 2). Natural forests are composed of different species of conifers and broad-leaves.

Table (1): Forest areas and Species in Syria.

	Natural Forests	Area (ha.)	Artificial forests (ha.)
	Species		
Conifers	*Pinus brutia*	50000	67189
	Pinus halepensis	300	
	Abies cilicica	978	
	Cedrus libani	8	
	Cupressus sempervirens	250	
	Juniperus excelsa	4000	
Broad leaves	Oaks	134383	201564
	Pistacia atlantica	262220	
	Populus euphratica	8082	
	Castanea sativa	4	
	Amygdalus spp., *Crataegus* spp., *Pyrus syriaca*	8615	
total	232840		268753
Overall total of Syrian forests	**501593**		

Table (2): Distribution of Natural forests in Syria.

Province	Area of province (ha.)	Forest percentage in province (%)	Percentage of total Natural forests in Syria (%)
Lattakia	67372	29.33	28.94
Hamah	43691	4.93	18.76
Idlib	42111	6.88	18.09
Damascus rural	21963	1.21	9.43
Homs	18116	0.43	7.78
Tartous	16888	9.32	7.25
Aleppo	12131	2.01	5.21
Al-Hasakah	4220	0.18	1.81
Al- Souadae	3376	0.61	1.45
Al-Raqah	1954	0.09	0.84
Al-Qunitrah	655	0.35	0.28
Dier Alzour	372	0.01	0.16
Total	**232840**	**1.26**	**100**

Natural forests in Syria can be grouped into three different categories according to Shalabi (1997):

1. 25 % of the total natural forests are climax or semi-climax forests and the land coverage of these forests is almost 100 % (Fig. 1). Most of these forests are located in *Lattakia* province.
2. 50 % of the natural forests is *maquis* (Fig. 2), located in the provinces of: *Lattakia*, *Damascus, Homos, Hamah*, and *Idlib*.
3. 25 % of the natural forests cannot be considered forests (Fig. 3) since these "*forests*" are made-up of scattered trees and/or shrubs. This type of forest cover is located in the mountains of *Al-balaas, Abid-Alaziz*, and *Abou Rhojmeen* where *Pistacia atlantica* trees are the most common, and in Anti-Lebanon Mountains where *Juniperus excelsa* are the most common species.

Taking into consideration that the category 3 forest cover (the last 25 % above) cannot be considered real forests, the natural forests in Syria would form only 174630 ha., which accounts for 0.994 % of surface area of Syria. It should be mentioned that the area of natural forests has been noticeably decreased since 1993 due to forest fires, especially in *Lattakia* province.

Fig. (1): Climax forests in *Al-Baier* and *al-Basiet* areas North of *Lattakia* province.

Fig. (2): *Quercus calliprinus* maquis.

Fig. (3): Semi obliterated forest areas on the Syrian side of Anti-Lebanon Mountains.

2.2. Geographic distribution and the present state of Syrian natural forests

2.2.1. Coastal area forests

- ***Al-Baier* and *al-Basiet* forests**

These forests are located in the north-west part of Syria in semi-humid bioclimatic zones. The precipitation ranges from 840 to 1200 mm/ year. These forests are considered the core of the real natural forests in Syria with an area of 50000 hectare dominated by *Pinus brutia* forests (Fig. 4). *Pinus brutia* forests start from sea level in al-Basiet to 900 meter above sea level in al-Baier. Pure stands of Turkish oak, *Quercus cerris*. ssp. *pseudocerris*, can be found in this area too where soil properties suite this species (Fig. 5).

Understory is developed and made-up of different species, the most important of which are:*Ceratonia siliqua, Arbutus andrachne, Rhus cotinus, Myrtus communis, Cornus mas, Pistacia palaestina, P. lentiscus, Acer syriacum, Phillyria media, Fontanesia philyreoides, Rhamnus palaestina, Styrax officinalis, Fraxinus ornus, Laurus nobilis, Juniperus oxycedrus*.

Light-loving species are found at the edges of the forests: *Calycotome villosa, Spartium junceum, Cistus villosus, C. salviifolious, Erica verticillata, Poterium spinosum, Genista acanthoclada*.

Fig. (4): Pinus *brutia* forest in *Al-Baier* and *Al-Basiet* region in the north-west part of Syria.

Al-Baier and *Al-Basiet* forests grow in soils developing on different bedrocks. These forests are relatively in good state in spite of suffering from fires (Fig. 6), cutting and destruction, and still can be considered climax or semi climax forests. The average annual wood productivity of these forests is two m^3/ ha/ year.

Fig. (5): Climax forest of *Pinus brutia* and *Quercus cerris*. ssp. *pseudocerris* in *Al-Baier* and *Al-Basiet* area north-west Syria.

Fig. (6): Forest fires remove large areas of climax forests in Lattakia (Syria).

Pinus brutia forests are also found in other parts of the coastal area on soils developing on marl and calcareous marl in *Wadi Qandiel, Al-Hafeh, Salma*, and along the Northern Big River to *Jisr Al-Shour*.

A forest stand of *Quercus cerris*. ssp. *pseudocerris* is found in al-*Frunloug* (in *Al-Baier*, 47 km north of *Lattakia*). The area of this forest is tens of hectares. Topography is tough, and the elevation above sea level ranges from 550 to 620 meters. Precipitation is around 12000 mm/year, and the absolute minimum temperature for the coldest month of the year does not drop below 5.6 C^o.

This forest is considered the best in Syria in terms of maturity and stability. Tree cover is estimated between 85 and 90 %, and the average tree height is 20-22 m. Trees density is 500-720 trees/ ha., and the annual wood growth rate is 4.75-7.15 m^3/ ha. Natural regeneration is almost absent in the parts near the road due to the high pressures of forest visitors.

A mixed forest of *Quercus cerris* ssp. *pseudocerris* and *Pinus brutia* is also present in Al-Baier area, especially on northern exposures where soil conditions permit. Tree cover is estimated at 75 %, and the average tree height is 8– 15 meters.

- **Forests of the Northern Part of the Coastal Mountains**

The most important parts of these forests are Slenfeh forests, 20000 ha these forest consist of:

Abies cilicica and Cedrus libani forests: The fir forest: Fir forest, Abies cilicica forest, is found on the western exposure of the coastal mountains range on elevation above sea level ranging from 1080 to 1450 meters. Fir forest occupies 978 ha, mainly on the western exposure (Fig. 7), but fir stands are also found on other exposures: eastern, northern, and southern exposures (*Ali, 2006*).

Average annual precipitation exceeds 1470 mm, and M= 24.6 C^o, and m= 0.25 C^o. The dry period is only three months. *Abies cilicica* stands grow on soils developing on hard calcareous rocks, and rarely on dolomite rocks.

Fig. (7): *Abies cilicica* forest on the eastern exposure in the upper part of northern coastal mountains.

The Cedar of Lebanon forest: The cedar of Lebanon forest is located on the eastern exposure (Fig. 8) of the same mountain range, and it occupies only 8 hectares at elevation above sea level ranging from 900 to 1450 meters (*Ali, 2006*). The soils are formed on hard calcareous rocks.
Scattered old individuals of cedar are found on the southern exposure around the fir village (*Blataah*).

Fig. (8): Cedrus libani forest on the eastern exposure of the Syrian coastal mountain range.

Tree cover of both species (fir and cedar) does not exceed 40 to 50 % due to human activities, yet very distinctive stands can be found.
Fir and cedar forests are accompanied by a number of forest species, the most important of these species are:

Ostrya crpinofolia, Carpinus orientalis, Juniperus drupacea, Quercus libani, Fraxinus ornus, Sorbus torminalis, S. area, Cotoneaster nummularia, Acer monspessulanum, A. hyrcanum, Rhamnus cathartica. Quercus cedrorum, and Sambucus ebulus.

In addition, several rare and endangered species are found in both forests such as *Paeonia corallina*, and *Helleborus vesicarius*. Several fruit tree rootstocks are found in both forests: *Prunus mahaleb*, *Pyrus syriaca*, *Crataegus* spp., *Prunus ursina* … etc.

- **Turkish oak, *Quercus cerris* ssp. *pseudocerris*, forests**

Turkish oak forests occupy relatively large areas on the western slopes between 900 and 1250 meters above sea level, and on the eastern slopes between 1000 and 1100 meters above sea level. Average precipitation is 1360 mm per year, M= 25.6 C^o, and m= 1.5 C^o, and the dry period is 3- 4 months. The best formation of Turkish oak stands is found in *Kitif al-Ozer in Slenfeh* (Fig. 9), which is about 1100 meters

above sea level. Tree cover ranges from 75 to 85 %, the dominate height of trees is 16-24 meters, and the annual wood growth rate is 4.4 – 5.9 m^3/ ha. *Abies cilicica* and *Cedrus libani* were introduced in the understory about 30 years ago without any subsequent silvi cultural practices to manage the new, mixed forest. The dense understory layer hindered the regeneration process of Turkish oak. Few seedlings of Turkish oak can be found in the openings where sufficient light reaches the ground. The new understory layer negatively affected biodiversity in the site (*Qubaily and Ali, 2000*).

Fig. (9): A forest of Turkish oak *in Kitif al-Ozer* in *Slenfeh* (*Lattakia* province). *Abies cilicica* and *Cedrus libani* were introduced in the understory 30 years ago.

The average tree height of the other Turkish oak formations is 8-12 meter, the tree cover is very modest, and the productivity is low. Turkish oak forests in other locations consist only of scattered trees due to unsustainable cutting practices and overgrazing.
A number of forest species accompanies Turkish oak in the area:
Rubus sanctus, Quercus infectoria, Daphne oleifolia, Lonicera orientalis, Rhamnus cathartica, Styrax officinalis, Cornus mas, Astragalus spp.

- **Forests of the Southern parts of the Coastal Mountains**

These forests include *Pinus halepensis, Cupressus sempervirens, Quercus calliprinus, Quercus infectoria*, and *Quercus aegilops*.
Pinus halepensis Forests: Small patches of *Pinus halepensis* are found near *al-Qadmous* (*in Bannias*) at 600 meters above sea level in the EU-Mediterranean forest floor. Tree cover does not exceed 50 % in general, and average tree height is 3-7 meters. There is another small stand of *Pinus halepensis*, 300 ha, about 10 km north-west *Safetah (Tartous)* at 150-250 meters above sea level. Tree cover reaches 90 %, and the average tree height is

10 to 25 meters. Both of these *Pinus halepensis* stands are found on soils formed on marl and calcareous marl bedrocks.

***Cupressus sempervirens* forests;** A forest stand of *Cupressus sempervirens* of 250 ha is located in the Eu-Mediterranean forest floor in *Gara Douran (Al-Samrah)* west of *Kassab* (Fig. 10) on the Syria-Turkish borders. *Cupressus sempervirens* is accompanied by *Quercus calliprinus* and *Ceratonia siliqua*. This stand is highly degraded.

Fig. (10): *Cupressus sempervirens in Gara* Douran (Al-Samrah) west of *Kassab (Lattakia)* on the Syria-Turkish borders.

Natural stands of *Cupressus sempervirens* are found on soils formed n marl and calcareous marl in the region of Ain Halakim, in Alzina north of Musiaf, and in al-Qadmous in Hamah, and in Joubt Burgal (Lattakia). Annual precipitation in these areas is about 900 mm. Tree cover is 50 % and average tree height is 3-7 meters.

***Castanea sativa* Forest:** There is a small forest of *Castanea sativa* (about 4 hectares) in Wadi al-Nadhara on calcium free soils formed on basalt rocks. *Castanea sativa* is accompanied by *Quercus cerris* ssp. *pseudocerris*, *Q. aegilops*, and *Quercus infectoria*.

***Quercus infectoria* forest:** Remnants of a *Quercus infectoria* forest are found in al-Qadmous between 700 and 1000 meters above sea level. This forest is highly degraded, tree cover doesn't exceed 60 %. The low tree cover permit more sun light to infiltrate to the ground making the site drier, which led to invading the site by *Quercus calliprinus*. Recovery of *Quercus infectoria* entails cessation of fires, cutting and grazing.

***Quercus calliprinus* forest:** *Quercus calliprinos* occupies relatively large areas of the coastal mountains between 300 and 700 meters above sea level. *Quercus calliprinos* high

forest no longer can be found except around shrines. *Quercus calliprinos* is present mainly as maquis (Fig. 2) mixed with a number of associates such as: *Pistacia palaestina, Styrax officinalis, Phillyrea media, Arbutus andrachne,* and *Rhus cotinus*. In the opening where more sun light reaches the ground, the degradation indicative species dominate *Genista acanthoclada, Poterium spinosum, Calycotome villosa, Cistus villosus, C. salviifolious,* and *Erica verticillata.*

The maquis plays a very important protective role on steep slopes, yet it is subject to human wrongdoings (Fig. 11). The recovery of the *Quercus calliprinos* forest requires the immediate cessation of human activities causing the degradation of this very vital ecosystem.

In addition to the above mentioned forest ecosystems, in the past, mixed forests of *Ceratonia siliqua*, *Olea oleaster*, and *Pistacia lentiscus* occupied substantial areas of the coastal region especially between sea level and 300 meters above sea level, but most of land once occupied by these species was turned into agriculture land.

Fig. (11): Overgrazing the maquis.

2.2.2. Forest cover in the Kurds mountain north-west Aleppo

Fires, overgrazing and agriculture expansion especially in flat areas and hilly sites with moderate slopes have removed about 50 % of forest cover in the Kurds mountain north-west Aleppo.

Forest cover in the Kurds mountain north-west Aleppo consists of two different ecosystems:

- ***Xerophillous conifers* and *evergreen oaks***

Xerophillous conifers occupy soils forming on marl rocks in the northern part of the mountain range where elevation above sea level does not exceed 780 meters, and these

conifers are represented by *Pinus brutia*. *Xerophillous* oaks occupy terra-rossa soils in the central and northern parts of the mountains, and *Quercus calliprinus* and its associates represent these oaks.
On igneous rocks (basalt and green rocks) both forests, *Pinus brutia* and *Quercus calliprinus*, are found.

- ***Deciduous oaks***

In the upper parts of the Kurds Mountain deciduous oaks dominate. A *Quercus cerris*. ssp. *pseudocerris* forest prevails on elevations between 900 and 1160 meters above sea level, and in other parts of the mountain on elevation of 600 meters above sea level (*Quorniah* village). *Quercus infectoria* dominates up to the elevation where *Quercus cerris* ssp. *pseudocerris* starts. Deciduous oaks are accompanied by *Styrax officinalis, Cercis siliquastrum, Crataegus monogyna, Platanus orientalis, Pyrus syriaca, Prunus ursina, Tamus communis, Phillyrea media, smilax aspera, Pistacia palaestina, Pistacia atlanica, Rhamnus palaestina, Clematis cirrhosa, Jasminum fruticans, Ephedra campylopada,* and *Bryonia syriaca* (*Shalabi, 1997*).

2.2.3. Al-Kalamoun Mountains Forests

These forests are located on the tops of the anti-Lebanon mountain range. Degraded, open wood formations are found in these areas. The precipitation is low, 200– 600 mm/ year, and snow represents a large part of precipitation on elevations above 1800 meters above sea level. Climate is dry to very dry. Remnants of *Juniperus excelsa* forests occupy the summits of the mountains, old trees can be found on sites of very rough topography. Natural regeneration of *Juniperus excelsa* is almost absent.
Areas where *Juniperus excelsa* is found are about 3800 ha., but the actual area that *Juniperus excelsa* occupies doesn't exceed 4000 ha. *Juniperus excelsa* is accompanied by a number of forest species such as: *Pyrus syriaca, Crataegus monogyna, Amygdalus* spp., *Acer monospessulanum, Rhus coriaria, Ulmus* spp., *Rhamnus* spp., and *Rosa* spp.
Juniperus excelsa trees are uprooted and fruit trees such as apple, cherries, apricots and grapes are planted instead.
Sites where *Juniperus excelsa* are found have been suggested as protected areas.

2.2.4. Interior and Eastern regions forests (Jabal Al-Arab)

- **Remnants of *Pistacia atlantica* forests**

Pistacia atlantica forests occupied at one point of time about 300000 hectares of the interior parts of Syria, but nowadays only several hundreds of hectares are present. The decline of the areas occupied by *Pistacia atlantica* is mostly due to cutting and overgrazing. It is found only as scattered trees, especially in valleys. *Pistacia atlantica* trees are scattered in al-Balas Mountain (120 km east of Hamah) in an area of about 12000 hectares, on coarse-textured soils situated on elevations above sea level of 920 meters. *Pistacia atlantica* is accompanied by *Pistacia palaestina*, *Prunus* spp., *Amygdalus orientalis*, and *Pyrus syriaca*.
Scattered trees of *Pistacia atlantica* are found on an area of 4220 hectares in *abid-Alaziz* Mountain, 400-920 meters above sea level, in *al-Hasakah* Province. Annual rainfall is 250-300 mm. Soils are formed on calcareous rocks.
Pistacia atlantica in abid-Alaziz Mountain is accompanied by: *Pistacia khinjuk, Pistacia mutica, Amygdalus orientalis, Prunus* sp.,*Crataegus* sp., *Rhamnus palaestina*, *Artemisia herba-alba, Salsola vermiculata*, *Noea mucronata*, *Achillea* sp., and *Thymus* sp..

In *Abou-Rhojmeen* Mountain, 45 km east of Palmyra, *Pistacia atlantica* trees are scattered on an area of 10000 hectares, where average annual precipitation is between 150 and 200 mm/ year.
Pistacia atlantica is accompanied by *Pistacia palaestina, Prunus* sp., and *Pyrus syriaca*. Cutting has led to the near extinction of *Pistacia atlantica* from these areas.
Areas where *Pistacia atlantica* is found have been suggested as protected areas with an area of 26220 hectares.

- ***Forests of the Northeastern Corner of Syria***

In these areas near the Turkish borders with Syria, patches of forests can be found. *Quercus calliprinus*, *Quercus infectoria*, and *Quercus aegilops* dominate forest formations in these areas.

2.2.5. The southern region forests

The majority of forests in this region had been disappeared due to degradation factors and the rough climatic conditions. These are several forest patches in this region. *Quercus calliprinus* forests occupy the lower elevations, followed by *Quercus infectoria* and *Quercus cerris* ssp. *pseudocerris* on higher elevations (up to 1900 meters above sea level).
These forest types are accompanied by other forest species such as: *Quercus libani, Quercus brantii, Acer monspessulanum, Crataegus sinaica, Crataegus azarolus, Pyrus syriaca, Pistacia atlantica, Pyrus tortuosa*, and *Prunus ursina*.
Jabal Al-Arab forests have been suggested as protected areas.

2.2.6. Hermon Mountain forests

Includes mainly *Quercus calliprinus* maquis mixed with *Quercus infectoria*, *Amygdalus orientalis, Amygdalus sparitioides, Crataegus sinaica*, and *Crataegus azarolus*.

2.2.7. Al-Qusair forests west of Homs

These forests include relatively important remnants of forests of *Pinus brutia, Juniperus excelsa,* and *Quercus calliprinus*. These forests are very degraded.

2.2.8. Euphrates and Al-Jazeera forests

Tamarix tigrensis comes first in terms of areas occupied by forest species, followed by *Populus euphratica*. These two species occupy 37 hectares in Al-Raqah, 1625 hectares in Dier Alzour, and 6430 hectares in al-Hasakah. The area of these forests was much larger in the past, and they are restricted nowadays to the banks on the Euphratic River. The most important associates are: *Lycium barbarum, Typha latifolia*, and *Phragmites communis*.

2.3. Artificial forestation

2.3.1. Historical review of forestation in Syria and its goals

Artificial forestation campaigns in Syria started in 1953 with the goal of restoring forestland to its past eras. These campaigns started by planting 74000 seedlings on an area of 16 hectares in 1953. In 1977, the president of the Syria Arab Republic signed the degree number 108 forming the Higher Committee for Forestation in Syria (HCF). The mandate of HCF was to prepare for planting 12000 hectares each year with forest seedlings. In 1984, the president of Syria directed the authorities to double the areas planted yearly with forest seedlings in all Syria Provinces.

The total area artificially planted with forest seedlings during the period of 1953-2007 reached 268753 hectares (personal communications with the Department of Forestry in Damascus), which translates to 1.45 % of the total surface area of Syria. Therefore, the overall area of forests (natural 268753 ha, and artificial 232840 ha) is about half a million hectares 950153 ha), which forms 2.71 % of the total surface area of Syria. Artificial forestation is concentrated in provinces of *Idlib*, Homs, Aleppo, and Hamah.
Artificial forestation campaigns are still going on. Forest nurseries in Syria produce 1677200 seedlings per year, 25 % conifers and 75 % broadleaves. Around 1 to 2 million seedlings go each year to Lebanon. Forest seedlings are also distributed to citizens, and some are used to replace dead seedling from previous forestation campaigns. Some seedlings are used to rehabilitate degraded forests, and to forest burned areas, and the rest of seedlings are used to forest new areas.

2.3.2. Forest species used in artificial forestation projects

Several natural and introduced forest species were used in forestation campaigns.

- ***Conifers species***
  - a- *Pinus brutia*: Natural in Syria, widely used in different parts of the country.
  - b- *Pinus pinea:* Introduced from Lebanon and Turkey, widely used, and its adapted to local conditions.
  - c- *Pinus radiata*: Introduced from California. It was planted on limited areas in the coastal region, the southern region and in *Idlib*, but it failed to adapt to the local conditions.
  - d- *Pinus canariensis*: Introduced from Canaries Islands in the Atlantic Ocean. It is used limitedly in the coastal area. It is sensitive to the defoliating insect *Thumetopoea pityocampa*.
  - e- *Cupressus sempervirens*: Natural in Syria, widely used in different parts of the country.
  - f- *Cupressus arizonica*: Introduced from Arizona and Texas. It is used in public gardens.
  - g- *Cupressus macrocarpa*: Introduced from Monterey Bay in California. It is used in gardens and sedges.

- ***Broad leaves species***
  - a- *Several species of poplar are used in the forestation projects: Populus alba f. roumi (introduced from Iran and Turkey), Populus nigra f. hamoui (introduced from Central Asia), and hybrids of Populus euramericana (introduced from France). All of these poplar species and hybrids are widely used in productive forestry, and they are all adapted to the conditions of the country.*
  - b- *Eucalyptus spp.: Introduced from Australia, and widely used in the different provinces in Syria because they are very will adapted to the different conditions of soils and climate.*
  - c- *Ailanthus altissima: Introduced from north China, and its used as a street tree. It is well adapted in Syria.*
  - d- *Casuarina cunnighamiana: Introduced from Australia, and widely used in windbreaks, especially in the coastal region.*
  - e- *Acacia cyanophylla: Introduced from west Australia. It is used to forest poor soils, sandy soils, and alongside highways in the moderate climatic zones.*

f- *Robinia pseudoacacia: Introduced from Central and Eastern United States of America. It is used as roadside trees, and in gardens. It is widely adapted to the local conditions.*
g- *Gleditsia triacanthos: Introduced from Eastern parts of the United States of America, and used limitedly in windbreaks.*
h- *Sophora japonica: Introduced from China and Korea. It is used as a street tree because it is highly resistant to pollution.*
i- *Lauris nobilis: Natural in Syria. It has been increasingly used in forestation projects.*
j- *Pistacia atlantica: Natural In Syria. It is used on large scale for forestation of the interior regions of Syria.*

2.3.3. Analysis of artificial forestation in terms if species used and objectives

Many forest species are used in artificial forestation projects, some of these species are natural in Syria, and other are introduced to Syria from different regions of the world. Two factors control the choice of species in forestation projects in Syria: availability of species in the forest nurseries and its suitability for the environmental conditions of the sites to be planted. In some instance, environmentally adapted species are used like *Pistacia atlantica* and *Amygdalus* spp., which are used in appropriate densities in the interior parts of the country. In other instances, species that are not adapted to the prevailing environmental conditions are use as the case with *Pinus* species in the interior parts of Syria, where annual precipitation is not enough to meet the requirements of such species. The result is failure of the new plantations and, therefore, forestations objectives are not realized.

3. Causes of Syrian forest degradation

Causes of Syrian forest degradation can be summarized as fallows:

Fires: forest fires are considered the number one threat to Syrian forests. Man-caused forest fires, regardless of the motives of starting the fires, result in removal of more than 1500 hectares of Syrian forests each year. Most of the damage occurs in conifers forests in the coastal area. These forests are best in Syria in terms of density, yield and stability.

Forest burning for the purposes of agricultural and constructional expansions stand behind the contraction and degradation of Syria forests in the last few decades, especially in provinces where the best forest ecosystem are present: *Lattakia*, *Hamah*, *Idlib*, and *Tartous*.

Man-caused fires accounted for 98 % of fire incidents and forest areas affected by fires in these provinces during the last two decades.

Unknown causes of forest fires were responsible for 41.63 %, 43.77 %, 69.35 %, and 48.15 % of fire incidents that occurred in the last two decades in the provinces of *Lattakia*, *Al-Ghab (Hamah), Hamah, Idlib,* and *Tartous*, respectively *(Ali, 2004)*.

The high number of fire incidents of unknown causes in the main forest areas of Syria comes in harmony with statistics of forest fires causes in the Mediterranean region. Unknown causes of forest fires are responsible for 56 % of forest fires incidents in north Mediterranean countries (European countries), and 63.5 % of forest fires incidents in the non-European Mediterranean countries (*Alexandrian et al.1999*).

Agricultural residue burning, negligence, and deliberate causes of forest fires come second after unknown causes of forest fires in the above-mentioned provinces.

A review of forest fires causes in the main forest areas in Syria as they were recorded in the forest fires reports reveals that a unified form for forest fires reporting does not exist. In addition, accuracy is lacking with regard to the information recorded in these reports. For

these reasons, we suggest that a unified form for forest fires reporting is used in the future by all agencies responsible for reporting on forest fires. Furthermore, methods of filling in the fires report forms should be the same in all parts of Syria. To achieve this, special training should be planned and executed to all foresters responsible for forest fires reporting.

Over cutting and poverty: large-scale of forest cutting in Syria started long ago. The Turkish and French occupations spared no effort to deplete the woods of Syria forests. This process of wood depletion continued due to reliance of locals on fuel wood in most of their daily activities of cooking, house-heating, cloth washing…etc. Other causes of forest cutting include making charcoal, small industries … etc. These practices by communities living nearby the forests are largely due to the lack of the level of social development in these areas.

Poverty stands, in some instances, behind the removal of forest, especially oaks. Many people living in the areas where oak forest species prevail (*Lattakia, Idlib, Hamah*, and *Tartous*) cut oak trees and saplings to turn them into charcoal and make a living of selling charcoal because there is a high demand for this good, and many of those people are in real need to feed their kids. This is a real problem facing forests, and it is much more serious than some people might think. It cannot be dealt with only through prohibition and punishments. This problem should be approached through finding work opportunities for dwellers of forest ecosystems. Forest projects (silvi cultural projects, forest exploitation, forest management, forest protection) should help alleviate this problem. When employing people in the forestry sector, they will fight for the continuation of forests because they become a source of living for them in this cause. In such a way, we may turn some forest violators into forest guards.

Overgrazing: Overgrazing problem starts when grazing animal load of the forest is exceeded, or when the forest is in the regeneration stage. In these cases, grazing results into degradation of the forest. First, the density of palatable forest species start to decline, and the density of thorny, non-palatable species increases. In addition, *Xerophillous* species density increases. Eventually the soil is uncovered, and eroded.

Cows' grazing is less harmful than cheep grazing. Goats are the most damaging domestic animals to the forests.

Forest cutting and agriculture expansion: This infringement upon forest is closely associated with three factors:

- the prevailing economic system in communities living nearby forests
- the nature of lands occupied by forests
- forest dwellers economic state.

If the prevailing economic system was agriculturally oriented, and if the lands occupied by forests were agriculturally productive, this infringement upon forestland would be great. This was what happened in different parts of Syria like the coastal area and the Kurds Mountain in *Aleppo*.

4. Forest management and ownership

The main central government institution responsible for forest management, protection and exploitation is the Forestry Department under the Ministry of Agriculture and Agrarian Reform. The Forestry Department seeks to conserve and manage forest resources and their

protection, conserve biological diversity and establish environmental protected areas. Headed by a Director who reports to the Minister, the Department consists of four divisions, namely: Production (seedlings and afforestation); Silvi culture (management); Protection (fire control and forest police/guards); and Exploitation (public and private forests). In the various Provinces, as part of the Provincial Directorates of Agriculture, there are the Forestry Services, the organizational structure of which is generally modeled after that of the Department. Service Chiefs report to the Forestry Headquarters through the Provincial Directors of Agriculture.

In principle, forestlands in Syria fall under the control of the State, or they are state forests. Therefore, with the exception of forests that occur on privately owned land, the legal presumption is that all forests belong to the State. Provision is made in the forest Law number 25 for the year 2007, however, for the possibility of establishing private and communal forests.

In fact, nearly 99 % of existing forests are owned by the State, with most (~90 %) having been classified as forests of the State's private domain. As such, they have been recorded in the Land Cadastre in the name of the Forestry Department. They are therefore, granted a high degree of legal protection, as lands of the private domain may not be forfeited, nor may any title thereto be acquired by prescription.

Recently, as a matter of both policy and law, the role of private forestry has been officially acknowledged in Syria. Afforestation and reforestation are among the top priorities of the forestry sector, and forest plants and seedlings are widely distributed to interested people, free of charge, to encourage tree planting. Privately owned forests are, in principle, to be managed and preserved by their individual or corporate body holders/owners, under the technical supervision of the Forestry Department. However, there are a number of legal constraints mat presently obstruct the development of private forestry.

The principle tasks done by the cadre of forestry in all parts of Syria are limited silvi cultural work, forestation of burned sites, forestation of degraded forests and new sites. Forest protection from fires and grazing falls also under the mandate of the Department of Forestry. However, grazing in the forests was permitted in some years due to the drought conditions that periodically hit the grazing lands in the interior parts of Syria. This year (2008), forestlands are open for grazing.

The personnel of the Department of Forestry is not large enough to achieve all the tasks under the mandate of the Department. The personnel is not adequate to perform silvi cultural practices that are necessary to prevent forest fires from occurring. It is also not adequate to perform sustainable forest management. Therefore, additional, adequately trained personnel should join the Department of Forestry to fulfill the mandate of forestry.

The performance of the present personnel can be enhanced through better coordination between the Department of Forestry and the Departments of Forestry and Ecologies at the Universities.

5. The environmental value of Syrian forests and their contribution in the national economy

In the absence of a real forest inventory, and; therefore, of reliable data regarding forest resources, it is difficult to assess the role of forestry thoroughly, in terms of market and non-market goods and services, in the Syrian economy. However, recent rough estimates suggest that the contribution of forest production (industrial wood, firewood and charcoal) to the GDP is of minor significance, of around 0.01 % (Central Bureau of Statistics, 2002).

Nevertheless, the environmental role of forests is much more important than its productive function (CAB international, 2005).
A recent study (CAB international, 2005), which is the first of its kind in Syria, has estimated the monetary values of the services (Economic and environmental) provided by Syria forests by 43 billion Euros. The role of forests in protecting watershed (42.5 billion Euros) comes at the top of the values provided by forests. Such values are often ignored because they are not tangible in the short terms, and they are hard to estimate.

6. Forest policy and the forest legislation

No policy has been seriously adopted by the Government to prescribe long-term objectives in the forestry sector. Hence, there is no structured, detailed national strategy formally laid down for the development and conservation of the country's forest. The forestry programme consists of no more than targets to be achieved and budgets to undertake them. However, a recent project financed by the FAO and carried on by the Ministry of Agriculture and Agrarian Reforms is underway to formulate a forest policy for Syria. It is necessary to formulate this policy as soon as possible.

The first Forestry Law enacted by Legislative Decree No. 66/ 1953 was the basic enactment governing forestry in Syria. A second law, much more limited in scope, was the Forest Police Law enacted by Legislative Decree No. 86/1953 (amended in 1962, 1969 and 1970). As a strictly regulatory law focused mainly on prohibitions, limitations and sanctions, it was both restrictive and repressive. It neglected the social dimension of forests, for example by prohibiting the traditional customary rights of
forest users. It did not contain any specific provisions regarding forest policy, administration, inventory, management plans, private forestry,
research, training and extension, social (community) forestry and public participation, and environmental impact assessments. Because of the
repressive character of this law, the forest areas in Syria have seriously declined during the past four decades and many of them have lost their socio-economic and environmental values.
A new Forest Law of 1994 replaced this law. It brought certain improvements to the old one, such as guaranteeing free user rights to people living in forest villages. These rights include the use of dead wood found on the ground, wood for repair of dwellings and the making of agricultural tools, fuel wood, and grazing activities, except for goats and sheep. The procedures to be pursued for the effective exercise of these rights are, however, highly complex and constraining. This law still conserves the main weakness of the previous one concerning policy, social forestry, public participation and involvement, planning, private forestry, research and extension.
Another Law on Environmental Protection was adopted in 1994. It provides, in general terms, the protection of flora, fauna, soil and natural resources. It empowers competent authorities to issue standards, specification and regulations for the protection of flora and fauna and for the sites of protected areas in order to ensure environmental balance and the conservation of living organisms. It is believed that this law will affect forestry in Syria in a positive way.
A new law was enacted in 2007, the forest law No. 25, which is better than the former forest laws. The new law preserved the local communities' wrights to benefit from the forests, and added a social dimension to forests. It also permitted the establishment of

private forestry, and dealt with public participation in forestry planning and tasks. In addition, Law number 25 introduced the concept of sustainable forest management, but it did not deal with other important issues such as forest policy, environmental impact assessment, forestry extension and scientific research.
Additionally, there are two bodies, established in 2001, dealing with the environment, that are also concerned with forestry. One is the General Commission for Environmental Affairs, specially charged with preparation of environmental plans and law, the assessment of environmental problems, the prevention and control of ecologically harmful activities, and the promotion of environmental public awareness. The second is the Supreme Council for Environmental Safety, a prominent decision-making organ that has the power to adopt environmental policies, regulations and standards, as well as to prohibit any environmentally damaging activities.
With regard to legislations related to adapting Syrian forests to climate changes, no legislations have been enacted so far. It is necessary to initiate discussions on formulating and adopting such legislations.

7. Carbon Balance for Syrian forests

Information required to support estimates of forest volume and wood biomass, which are important indicators of the forests potential to sequester carbon, is not satisfactory in Syria. This means that assumptions and extrapolations have to be used and the results are therefore dubious. Estimates of Carbon Balance for Syrian forests are based on estimates provided by the Food and Agriculture Organization (2000 and 2005) in similar conditions.

7.1. Carbon stocks in the Syrian forest ecosystems

The above-ground biomass of one hectare of Syrian forests is on the average 28 tons of dry matter, therefore, the total above-ground biomass of the Syrian forests (Table 1) is: 28 tons dry matter/ ha. X 501000 ha= 14028000 tons of dry matter. Since about 50 % of forests dry matter is carbon (IPCC, 2003), the total amount of carbon in the aboveground biomass of Syrian forests will be 14028000 X 0.5= 7014000 tons.
The carbon in the forest ecosystems is distributed as follows (IPCC, 2003):

- 44 % in the aboveground biomass.
- 6 % in the dead wood.
- 46 % in soils at depth of 30 cm.
- 4 % in forest floor.

Therefore, the total amount of carbon in the different components of the forest ecosystems in Syria is as shown in Table 3.

Table (3): Carbon stocks in Syrian forest ecosystems.

Component	Amount of Carbon (tons)
above-ground biomass	7014000
Dead wood	9564545.455
Soil to the depth of 30 cm	7332818.182
Forest floor	637636.3636
Total	**15940909.09**

7.2. Total amount of carbon sequestered by the Syrian Forests each year

Since the average annual growth rate of conifers is 3.25 tons of dry matter per hectare (the number 3.25 was estimated based on studies from Lebanon, Turkey and Palestine), the overall annual growth of conifers in Syria= 3.25 X 122725 ha= 398856.25 tons of dry matter.

Since the average annual growth rate of broadleaves is 1.25 tons of dry matter per hectare (the number 3.25 was estimated based on studies from Lebanon, Turkey and Palestine), the overall annual growth of conifers in Syria= 1.25 X 378868 ha= 473585 tons of dry matter.

The total amount of growth by the Syrian forests= 398856.25 + 473585= 872441.25 tons of dry matter/ year.

Only about 50 % of dry forest matter is carbon (IPCC, 2003), therefore the total amount of carbon sequestered by the Syrian forests will be 872441.25872441.25 X 0.5= 436220.625 tons of carbon/ year. This amount is equal to 1599475.33 tons of CO_2.

7.3. The total amount of Carbon lost each year by forest fires

According to the official forest fires statistics, about 1003 hectares of Syrian forests are lost to fires each year. However, a number of independent studies (*Ali, 2004b; CAB International, 2005*) showed that the average forest area lost by fires is 1500 ha/ year. Since the average amount of biomass per hectare of Syrian forests is 28 ton (*FAO 2000*), the amount of organic matter damaged by forest fires each year is 1500 X 28= 42000 tons of dry matter. Only about 20 % of the total amount of dry organic matter exposed to fires is burned on site. Therefore, the amount of dry organic matter lost each year by forest fires is 42000 X 0.2= 8400 tons. This amounts to 4200 (42000 X 0.5) tons of carbon, and 15400 tons of CO_2.

7.4. The amount of carbon lost each year through extraction of forest products

Recent estimates (CAB International, 2005) indicated that the average amounts of forest products extracted each year from the Syrian forests are on the average as follows:

- **Industrial wood:** 5095 tons of dry matter
- **Fuelwood:** 3239 tons of dry matter
- **Charcoal:** 155 tons of dry matter.
- **Medicinal plants:** 3167 tons of dry matter
- **Fruits:** 6 tons of dry matter
- **Other products:** 4300 tons of dry matter.

Total **15963 tons of dry matter.**

Since carbon forms only 50 % of the dry organic matter, the amount of carbon removed each year through extraction of forest products is estimated at 15963 X 0.5= 7981.5 tons of carbon and this equals to 29212.29 tons of CO_2.

Based on the above estimates, the forest carbon-stock changes for the Syrian forest will be as stated in Table 4.

Table (4): Carbon stocks changes for the Syrian forests.

	Amount of carbon (tons/ year)	Amount of CO_2 (tons/ year)
Amount of carbon sequestered by the Syrian forests	436220.625	1599475.33
Amount of carbon lost by forest fires	4200	15400
Amount of carbon lost through forest products extraction	7981.5	29212.29
Net amount of carbon sequestered by the Syrian forests each year	424039.125	1554863.04

Therefore, after subtraction of the amounts of carbon lost by fires (4200 tons/ year), and the amounts of carbon lost through forest products extraction (7981.5 tons/ year), from the total amounts of carbon sequestered each year (436220.625 tons/ year), the net amount of carbon sequestered each year by the Syrian forests would be 424039.125 tons (0.424 billion tons). This amounts to 1554863.04 tons of CO_2 (=1.555 billion tons). If we apply a shadow prices of 20 Euros per ton of carbon, the average value of carbon sequestered each year by the Syria forests will be 0.848 billion Euros.

7.5. Carbon-stock changes in forest ecosystems as the area of forestland increased during the period of 2990-2007

Since 1953 up to present time, the Department of Forestry in the Syrian Arab Republic plants areas with forest seedling each year. The Department also, rehabilitates burned and degraded forests in order to enhance the environmental, social, and economic functions of the forests. The area of forestland increased tangibly during the period of 1990-2007, increasing, therefore, the potential of forests to sequestered carbon dioxide from the atmosphere (Table 5).

Table (5): Carbon-stock changes in forest ecosystems as the area of forestland increased, 2990-2007.

Year	1990	2000	2005	2007
Area of forests (1000 ha.)	372	432	461	501
Amount of C stored in above-ground biomass (tons)	5208000	6048000	6454000	7014000
Amount of C stored in dead wood (tons)	710181.82	824727.27	880090.91	956454.55
Amount of C stored in the top 30 cm of soil (tons)	5444727.27	6322909.09	6747363.61	7332818.18
Amount of C stored in forest floor (tons)	473454.5	549818.18	586727.27	637636.36
Total amount of C stored in Syrian forest ecosystems (tons)	**11836363.6**	**13745454.55**	**14668181.82**	**15940909.09**

8. Scenarios of climate change impact on Syrian forests

8.1. Scenario of increasing atmospheric temperature

All Syrian forests are subject to the Mediterranean climate, therefore, the forest ecosystems in Syria are Mediterranean ecosystems. It is expected that the Mediterranean forest ecosystems are among the forest ecosystems that are most affected by climate changes. It is widely accepted that increases in atmospheric temperature by two C^o will lead to substantial changes in plant cover. These changes will include desert expansion, savannah

expansion at the expense of *maquis*, and increases in the areas occupied by deciduous broad-leave forests at the expanse of conifers forests (Climate change, 2007). It is safe to say that coniferous forest is more efficient in storing carbon in comparison with deciduous forests. In addition, about 50 % of Syrian forests are *maquis*, 25 % are deciduous forests, therefore, and it expected that the bulk of Syrian forests (75 %) would suffer from these effects.

About 60 to 80 % of forest species in the Mediterranean forest ecosystems located in Europe are expected to disappear if the atmospheric temperature is increased by 1.8 C^o (Climate change, 2007). On the other hand, abandonment of agriculture land may facilitate the recovery of forests in the Mediterranean basin, therefore, the estimation of climate changes impact on forests is further complicated.

Fires*:* Forest fires frequency and the areas burned are expected to increase because of climate changes. Increases in fire frequency are noticeable in the Mediterranean forests in general (Climate change, 2007). In Syria, forest fires frequency in general, and the frequency of intensive forest fires (burning more than 1000 ha. per fire) have noticeably increased during the period of 2004-2007.

Doubling of CO_2 concentration in the atmosphere scenario*:* in case this scenario is realized, it is expected to result in increasing the number of forest fires by 40 t0 50 % in some parts of the Mediterranean region. In other parts of the Mediterranean region, the number of fires is expected to double, promoting the spread of forest species that sprout after fires and fire-tolerate forest species. The result will be decreases in the amounts of biomass production (Climate change, 2007).

8.2. Decrease in precipitation rates scenario

Scenarios of precipitation changes impact on forests are complex. Precipitation rates are expected to change in some parts of the Mediterranean aggravating drought problems. This scenario is already seen in the eastern region of the Mediterranean basin (Climate change, 2007). Soil water contents exercise control on Mediterranean forest ecosystems and the release of CO_2. However, the drought that took place in 2003, which had severe impact on forest cover, disappeared the following year (Climate change, 2007).

The benefits of increasing CO_2 concentrations in the atmosphere to forest species seems to be limited through the aboveground biomass increases. However, most scientific analyses indicate that increasing atmospheric concentration of CO_2 (when not accompanied with severe drought) during the last century resulted in increasing net productivity in the Mediterranean basin although the atmospheric temperature increased (Climate change, 2007). However, increasing atmospheric concentration of CO_2 is not likely to result in large impact on the Mediterranean basin forests in the next decade because all scenarios indicate that increasing atmospheric concentration of CO_2 will be accompanied by decreases in precipitation rates. If increasing atmospheric concentration of CO_2 is not accompanied by drought, it is likely to have positive impact on the amount of carbon stored in eastern Mediterranean forest ecosystems.

9. Forest ecosystems vulnerable to climate changes

Brutian pine forests, which forms the largest part of climax forests in Syria, are considered the most vulnerable to climate changes. This is evident through the large increases in forest areas lost to forest fires during the past few years. The increase in the number of forest fires is attributed to several factors such as dry, fluctuating wind directions that increased in frequency in the past years.

The average area of forest destruction by fires has doubled during the last five years. This may have severe consequence on *Pinus brutia* forests because these forests are the best in terms of their capacity to sequester carbon. In addition, the biomass of these forests is the highest among the Syrian forests; therefore, burning these forests will result in releasing increasing amounts of carbon in the atmosphere. Furthermore, the severity of insect attack incidents and diseases infections is increasing year after year since 1995 to present. This may be related to climate changes, especially deceasing precipitation rates.

Artificial forest plantations, which make-up more than fifty percent of Syrian forests, are considered more vulnerable to climate changes, especially lower rainfall rates because large percentages of these plantation are in areas drier than the natural habitats for these species (mainly the interior parts of Syria). Furthermore, some of these plantations are still in early stages of development, increasing their vulnerability to high temperature and lack of rainfall. Therefore, this issue should be given special attention from the authorities. Only forest species well adapted to environmental conditions should be used. Effort should be oriented to managing these plantations, and this is more important than establishing more plantations.

10. Procedures for alleviating climate changes impacts on forest ecosystems

10.1. Integrated and sustainable forest management

Recently, s strategy for integrated forest management in a participatory approach was officially adopted. This strategy will not be complete in the end if the concept of environmentally sustainable forest management is not taken into consideration. This concept forms a guaranty for forest conservation in the long run in general, and for forest protection against fires in particular.

The main goals of environmentally sustainable forest management in Syria should be:

- Providing sustainable supply of wood and other forest products.
- Tree cutting based on pre-set plans.
- Land use in a productive and sustainable way.
- Preserving the main functions of the forest (economic, environmental, social, cultural, and esthetic).
- Pre-condition for sustainable management and welfare of rural and civil communities.

The concept of environmentally sustainable forest management has developed over time to include issues and values considered of high importance for forest resources in Syria such as soil and water conservation, genetic resources conservation, environmental maintenance and protection against forest fires.

Special attention should be given to the following issues:

- Large areas of forest are being lost to agriculture.
- Overgrazing is causing degradation of ranges and affecting natural regeneration of forests.
- Illegal charcoal production, forest cutting and fires, especially in *Pinus brutia* forests in the coastal mountains, are main factors of forest degradation.

Improving the present state of forest resources in Syria to function properly requires the application of environmentally sustainable forest management concept in the main forest areas where local communities are not aware of the negative impacts of forest degradation and removal on their well-beings.

10.2. Rehabilitation of degraded natural forests and *maquis*

Since 25 % (58210 ha) of Syrian natural forests are at verge of disappearance, and 50 % (116429 ha.) are *maquis* formations in different stages of development it is of great importance to rehabilitate these forest ecosystems and turn them into climax forests. Such action may result in increasing biomass of these forests and the rate and efficiency of carbon sequestration.

If we consider the rate of forestland increases during the period of 1990-2005 (Table 5), we find that the area of forestland in Syria has increased by 129000 hectares, or 7588 hectares per year. On the other hand, improving, rehabilitation and tending of the natural forests and forest plantations is more effective and efficient in terms of carbon sequestration than foresting new areas. Rehabilitating 7588 hectares, (the size of the new areas forested each year during the period of 1990-2007) will result in increasing tree cover for these degraded forests by 18.75 %, which would mean on the average sequestration of additional 77361 tons of carbon each year.

Assuming the rates of forest fires and the rates of forest products extraction remain fixed during the next 24 years, the net increase in the amount of carbon fixed each year by Syrian forests would be 54152 tons. Presuming that the average price for carbon in the European markets is 20 Euros, the value of the carbon fixed each year would be 1.083 million Euros per year (26 million Euros for the next 24 years) (Tale 6).

Table (6): Scenario of rehabilitating degraded forests to increase the rate of carbon fixation and the estimated value of this carbon.

	Year		Total increase for in period of 2008-2032	Average increase per year
	2008	2032		
Net carbon fixed per year (tons)	424039.125	1723711.125	1299672	54153
Estimated value of carbon fixed	0.848 billion Euros	0.874 billion Euros	25.99 billion Euros	1.083 billion Euros

10.3. Establishment of protected areas

Thirteen forest-protected areas (Table 7) have been established since Syria has ratified the Biodiversity Convention. Forest protected areas fall under the jurisdiction of the Ministry of Agriculture and Agrarian Reform, which has allocated some forest guards to protect these areas. Application of appropriate management plans for these protected areas, specially developing and protecting these areas, will result in decreasing CO_2 emissions from these ecosystems and increasing their efficiency of sequestering CO_2. However, it should be brought to attention that the majority of forest-protected areas in Syria are "*protected areas on papers only*", although management plans have been prepared and adopted for some of these areas (Cedar fir protected area). The procedures of protected areas protection and management don not differ from those applied to the rest of forests.

Table (7): Forest protected areas (PA) in Syria.

Name of PA	Area (ha)	Province	Type
Cedar and Fire PA	1350	Lattakia	A forest of *Abies cilicica*, and a forest of *Cedrus libani*
Al-frounlug PA	5000	Lattakia	Oak and pine forest
Om Attiour PA	1000	Lattakia	Pine forest and sea shore
Raes al-Basiet	3000	Lattakia	*Pinus brutia* forest
Abou Qubais PA	4500	Hamah	Mixed forests, mainly broad leaves
Al Sharaah al-Sharqiah PA	1000	Tartous	Evergreen forest
Al-Balaas Mountain PA	Not determined yet	Hamah	A degraded forest of *Pistacia atlantica*
Abid al-Aziz Mountain PA	11000	Al –Hasakah	A degraded forest of *Pistacia atlantica*
Al-Thaurah Pa	590	Al-Raquah	Artificial plantation
Abu Rhojmeen Mountain PA	60000	Homs	*Pistacia atlantica*
Domnah PA	653	Al-Souaidae	Oak forest
Qara Douran PA	1250	Lattakia	*Cupressus sempervirens*
Al Basil Forest PA	2000	Idlib	forest

11. Recommendations

Since the area of forestland in Syria exceeds the capacity of the Department of Forestry to manage and care for these forests, it is advised that instead of horizontal expansion of forestland, the efforts of the Department of Forestry be directed toward protecting the existing forests against fires, insects and diseases, especially artificial forest plantation, in a way that help mitigate the expected impacts of climate changes and forest fires on them. Additionally, it is advised that the Department of Forestry rehabilitate burned and degraded forests to increase their capacity to fix CO_2 and minimize its release.

Application of integrated forest fires strategy, which is based on the concept of environmentally sustainable forest management, will play a decisive role in protecting forests against fires and fires suppression.

Land use planning should be based on sound principles, and forestland should stay as such forever. Forestlands should be delineated clearly, and forest management plans should be prepared and executed in appropriate ways so that the efficiency of forests to sequester CO_2 is increased, while decreasing its emission.

Department of Forestry has an important role it can play in developing new strategies for integrated and environmentally sustainable forest management plans. The role of the Department of Forestry should no longer be limited only to technical role as it has been for a long time.

Preparation, adopting and execution of a formal forest policy for forest development and conservation should be achieved as soon as possible. The forest program should not be limited to goals and budgets to achieve these goals arbitrarily.

Formulation and adoption of new legislations regarding mitigation of climate changes impacts should be done soon.

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