COST action FP0703 – ECHOES

Expected Climate Change and Options for European Silviculture

COUNTRY REPORT
GREECE

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I. Impacts

There is evidence of a recent drying in the Eastern Mediterranean area, rainfall declined rapidly after 1970. Meteorological records in Greece indicate a clear trend towards a drier climate in recent decades (Luterbacher and Xoplaki, 2003). The forecasted changes introduce significant impacts on Mediterranean forest.

I.1. Observed impacts

The observed impact of climate change (higher temperatures, less rainfall) on forests are:

- **Growth reduction.** It has been reduction in tree-ring width of *Pinus brutia* in the inland of Samos. The most recent decline let to lowest annual radial stem increment after 100 years (Sarris et al. 2007)
- **Forest declines.** Intense crown discoloration, needle fall and mortality of fir trees have been observed throughout Greece Taygetos –Region of Peloponnisos to Cenral and Northen Greece along the border with FYROM. . (Raftoyannis and Radoglou, 2001; Raftoyannis et al. 2008). Dieback of Scots pine (Pinus silvestris) in some of the southernmost stands such as those in Pieria Region of Central Macedonia.
- **Increased risk of fires.** Large scale forest wildfires are among the impact of climate change affecting Mediterranean forest in Greece. Wildfires burn even high altitude forests in Northern Greece. Recently we experience such fires in 2007 and 2009
- **Invasion of species.** Invasion of pioneer conifers species like Pinus nigra to areas where broadleaved species normally prevail (Aspropotamos –Region of Thessaly)
- **Phenological changes.** Changes in phonology may have serious consequences for forest species, Some effects have already observed as that Spring come forward a cable of weeks.
- **Physiological changes.** Physiological changes and Metabolic will occur as changes in productivity and evaportranspiration and long term modification of nutrient reservoirs so far the study of beach forest on south eastern distribution limit has similar seasonal trend in a number of physiological parameters during three years (Fotelli et al. 2009)

I.2. Expected impacts

- Growth reduction
- Forest declines
- Increased risk of fires
- Shifts in species range
- Species loss (changes in biodiversity
- Phenological changes
- Invasive alien species Climate change will certainly increase the invasiveness of alien species (e.g. Ailanthus altissima, Acacia spp. Robinia pseudocacia)
- Physiological changes and Metabolic

I.3. Monitoring impacts

In the frame of project “Adaptation of forest management to climate change in Greece” (Life +Environmental Policy and Governance) (2010-2013), research will be carried out on 3 selected sites where changes in vegetation have already been observed (1. dying out of fir in Central Greece, 2. the dieback of Scots pine forest in Pieria 3. the oak –Castanea forests of Aspropotamos (site indicating the invasion of conifers in broadleaved forest)

I.4. Impact management

Adaptation of Forest management to climate changes is needed. The discussion is open in Greece and new guidance should defined to promote synergies between climate change adaptation, biodiversity conservation and sustainable use in forestry.

I.5. Case studies

The case of dieback in fir forest in Central Greece will study intensive

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II. Adaptation

II.1. Vulnerability of forests and forestry

In the future, Greek forests will be more vulnerable, due to climate change (higher temperatures, less rainfall) and human pressure (overpopulation, land use change, mismanagement).

II.2. General adaptation strategy or policy

In Greece, there is no general adaptation strategy or policy for all sectors. A committee on the Effects and Adaptation to Climate Change was announced in June 2009 and will be funded by the Bank of Greece.

II.3. Forest adaptation measures

In Greece, there are not any forest adaptation strategies or measures for the country as a whole or a part of it.

The IUCN Centre for Mediterranean Cooperation (IUCN-Med), the WWF Mediterranean Programme Office and the WWF Greece Organisation brought together member organisations, partners and experts in a regional workshop entitled “Adaptation to Climate Change in Mediterranean Forest Conservation and Management”, which took place in Athens (Greece) on 14-17 April 2008. The main recommendations included in the final report are:

1. The Mediterranean forests will autonomously adapt to climate change without the need for human intervention.
2. A key adaptation strategy in the face of uncertainty is to maintain ecological structure and processes at all levels and reduce existing pressures on natural ecosystems.
3. The best adaptation strategy should support the increase of diversity at all levels (genus, species, communities and landscape).
4. The maintenance of high genetic diversity will help ensure a higher forest adaptive capacity.
5. Conservation measures for “genetic reserves” will require conservation measures for the habitats , and not just for the genotype or rare species.
6. In order to secure pollen and seed movement, measures that disturb the genetic system of forest populations should be avoided (e.g., fragmentation of forests and low forest density).
7. Restoration activities should focus on the protection of natural regeneration and where planting occurs or is needed, the used material should derive from local seed.

8. Accelerate migration by planting new tree species that are better adapted to the predicted climate conditions, although this option may have high risks due to climate change uncertainties.
9. Increase mixed forest stands and tree diversity, especially in ecotonal zones, combining different life strategies (resprouting, fruit trees, etc.) and drought tolerant species. Mixed forest stands are considered by experts as more “natural” and resilient to changing climate conditions or to likely consequences of climate change (e.g. pests).
10. Changes in rotation intervals and harvesting periods: i.e. longer rotation periods may be expected to compensate for growth rate reduction due to water constraints and increase the amount of carbon sequestered in tree biomass, forest soil and vegetation as a whole.
11. Promote close-to-nature forestry.
12. Plan for “fire-smart” landscapes: More efficient ways to deal with increasingly severe conditions of the more intense and frequent wild fires due to global change should be considered.

II.4. Research studies of forest adaptation

Some research studies and their results as regards forest adaptation in Greece are the following:

Plant species native to site are the best choice when selecting for reforestation because they tolerate low water potentials during the mid-summer drought (Raftoyannis et al. 2006) and have lower mortality rates than other species (Radoglou and Raftoyannis 2001).
(A European approach for assessing regrowth potential of woody plants: parameters for plant vitality and dormancy of planting stock. FAIR CT95-0497, 4th Framework Programme, Research Directorate, European Commissionm,1997-1999).

Natural regeneration should be the favoured method of ecosystem restoration after wildfires because active restoration treatments can be ineffective or even damage ecosystems (Raftoyannis and Spanos, 2005; Spanos et al. 2005)
(Eco-engineering and conservation of slopes for long-term protection from erosion, landslides and storms (ECOSLOPES). QLRT-2000-00289, 5th Framework Programme, Research Directorate, European Commission, 2001-2004).

Currently, are there ongoing research studies and which are their main objectives?

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III. Mitigation

Mitigation is all the activities made by man or nature to reduce greenhouse gas emissions and to enhance greenhouse gas sinks (IPCC, 2002).
All the countries that signed the Convention and Kyoto protocol are obliged to implement into their policies national programs to measure GHG's and to mitigate climate change by addressing sources and sinks. Furthermore, they have to promote processes that control, reduce or prevent emissions of GHGs in relevant sectors, e.g. forestry and promote sustainable management, enhancement of sinks and reservoirs, including biomass in forests.

III.1. Carbon accounts

Summary of National Emissions and Removal Related Trends
In 1990, total GHG emissions for Greece were estimated at 107.71 Mt CO2 eq. In 2007, GHG emissions (without LULUCF) amounted to 131.85 Mt CO_2 eq showing an increase of 22.42 % compared to base year emissions and of 24.91% compared to 1990 levels. If emissions / removals from LULUCF were included then the increase would be 25.24% (from 102.37 Mt CO_2 eq in 1990 to 128.20 Mt CO_2 eq in 2007). Carbon dioxide emissions accounted for 86.1% of total GHG emissions in 2007 (without LULUCF) and increased by approximately 36.6% from 1990.
For GHG reporting of the LULUCF sector, Greece has not a formal monitoring system of land use change. For the needs of the reporting in the frame of the Convention, the Tier-1 approach has been used and the data sets used were:

- First National Forest Inventory (1st NFI) prepared by the General Secretariat of Forests and Natural Environment (GSFNE, 1992, 1994) of the Ministry of Rural Development and Food
- "Agricultural Statistics of Greece" of the National Statistical Service of Greece (NSSG, annual census)
- Afforestation registry and statistics of the Greek Ministry of Rural Development and Food
- "Distribution of the Country's Area by Basic Categories of Land Use" of the National Statistical Service of Greece (NSSG, decennial survey)

In Greece, there is no advance system for the monitoring of land uses convenient for the implementation of LULUCF inventory by following an approach Tier-2 or Tier- 3. Therefore, for the accounting of the areas and their change a mix of Approach Tier-1 and Tier-2 was used, by combining data from the above-mentioned sources. However, in order to construct the land use matrix, given that a second national forest inventory has never been implemented, supplementary data to 1st NSI were

used (e.g. croplands converted to forest land by afforestation) and assumptions were made according to available data. (MINENV, 2008)

Because there is no convenient system for the recording of land use areas in the LULUCF sector, the above mentioned system is currently under review and a new approach for estimating land use and carbon pools change is proposed for the years 1990-2008. The new system is based on the establishment of a land use and land use change matrix for the period 1990-2008 from satellite images and additional spatial and descriptive data. As far as the carbon pools are concerned, the change of carbon in above ground biomass it is implemented by the 'Carbon Stock Change' method. The above ground biomass is estimated using allometric diameter - biomass functions. Diameter distributions are obtained from sample plots of the local management plans that are constructed regularly across Greece every decade.
A new monitoring system for the land use and carbon pools change that will be based on permanent sample plots it is also proposed for the years after 2012 for the LULUCF sector. In this system Greek allometric diameter - biomass functions will be calibrated for the most important tree species and permanent plots will monitor the land use changes. The implementation of this system will increase the accuracy of the estimation of GHG's of the LULUCF sector (FRI, 2009).

III.2. Forestry as a source of bio-energy

The market for bioenergy in Greece presented considerable growth after a number of financial incentives introduced in 1997. However, the field has much more potential than the already exploited and there are certain technical and non-technical factors hindering further commercial development.
The re-use of wood wastes for energy utilization in the wood industry, in Greece is limited to 50% and is distributed by 2/3 for covering the demand for raw material (100.000 m^3) and 1/3 for covering the energy demand (50.000 m^3). Incentives are given by the state to increase this percentage. (Ntzouras etal, 2002. Efstahiadis and Ntzouras, 2003).
Apart from short rotation plantations for energy natural Aleppo and brutia pine forests with a dense understorey of evergreen broadleaved shrubs comprise a good source of forest bio-energy. These forest ecosystems are often threatened by natural and human-caused fires. Basic management purpose of these forests has to take aesthetics as well as soil erosion protection, adjustment of water flow, honey production, wood and resin production into account. Annual thinning of the understory and overstory vegetation creates favorable conditions for fire protection, wood productivity and pine regeneration. The removable biomass (understorey plus overstorey), fresh and dry matter ranges from 5.08 to 64.04 ton/ha and 4.11 to 35.94 ton/ha respectively. The average cost per productive factor for harvesting and handling of the removable biomass was estimated at 68.43 EURO/t, 14.83 EURO/t and 11.23 EURO/t for labor, machinery and variable costs respectively. The money saved would support favorable forest management plans for the protection of the pines forests promoting energy schemes in Greece (Chatziathanassiou etal, 2002)
In the frame of the EC-funded 'ECHAINE' project coordinated by CRES the existing harvest methods (for saw timber and traditional fuelwood), proposing modified methods (in which residues are collected efficiently with respect to technical, economic, safety and environment aspects) and doing trials of these new methods

were studied. Geographic Information System usedl to describe and analyse potential supply of wood fuel to the studied area (Skarvelis et. al. 2004)
Bioenergy in Greece is considered as a “problem-solving” form of energy production and energy saving, especially in the wastewater and agro-industrial sectors where the main applications exist. Bioenergy use was estimated at 39 PJ/year, in 2001, about 3.4% of the total primary energy consumption in the country by that year. Of this, biomass (mostly wood consumed directly in the domestic/residential sector) accounted for 64,4%, or 0.946 Mtoe. Domestic use of wood (burning of wood in open heaths for cooking, water and space heating) accounted for about 74% (0.70 Mtoe) of total biomass energy production. The remaining 26% (0.24 Mtoe) was produced by the combustion of wood by-products and agricultural residues, and the utilisation of biogas produced in landfills, agro-food industries and municipal wastewater treatment plants (Panoutsou and Papamichail, 2004).

III.3. Political processes, instruments and strategies for mitigation

Conversion of oak coppice forests into high forests
Greek forest legislation (§4, art 62, Law N 86/1969) enforces the seedling management system of the 2/3 of public owned oak coppice forests and ¼ of the private owned, this means conversion into high forests by either tending measures or enrichment with conifers and other appropriate species. According to the National Forest inventory (GDFNE, 1992) the total area covered by oak type forests is 1.471.839 Ha, from this area 1.180.000Ha are coppice forests, the mean stocking volume of these forests are quite low (19 m^3/Ha). Apatsidis (2003) in his study for the converision of oak forest into high forests reports that the area of oak forests where the mean diameter is above 10 cm and the stocking volume is 115 m^3/ha is only 123.000 Ha producing mainly fuel wood. This conversion will contribute in the CO_2 mitigation and will turn them into big sings of CO_2.
Aforestation: In Greece every year 3.916 Ha of agricultural land converted into forest land under the EU directives (2080/1992 and 1257/1999). Additionally Greek Forest service by its reforestation project reforestate about 4.000Ha per yea. This rate has been reduced to 15.000Ha last years.

III.4 Research studies on mitigation

Nikolaou, and Diakoulaki, (2003) used the life cycle assessment approach to assess bio-electricity system in Greece and found that Biomass production contributes significantly to the total energy consumption and to CO_2 and SO_2 emissions, biomass combustion in the power plant to the total CH_4, N_2O and NO_x emissions, while the contribution of biomass transportation and storage is relatively small to all parameters considered in their study.

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