# Forest Area Change and Afforestation in Europe: Critical Analysis of Available Data and the Relevance for International Environmental Policies

Giuliana Zanchi, Daniel Thiel, Tim Green and Marcus Lindner

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Giuliana Zanchi, Daniel Thiel, Tim Green and Marcus Lindner

Publisher: European Forest Institute
Torikatu 34, FI-80100 Joensuu Finland
Tel. + 358 13 252 020
Fax. + 358 13 124 393
Email: publications@efi.int
http://www.efi.int

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## 1. INTRODUCTION

The conversion of land to forest is recognized as an eligible measure to achieve mitigation of climate change and biodiversity protection and enhancement goals promoted by recent environmental policies.

The mitigation policies aim to reduce greenhouse gas emissions from individual countries in order to prevent climate change. Quantitative emission reduction targets were established by the Kyoto Protocol for the countries that ratified it. Besides measures that directly reduce emissions, as in the transport and energy sector, some activities in the agriculture and forestry sectors can be used to help countries to fulfil their commitments. The capability of trees and plants to sequestrate carbon through photosynthesis is recognised as a possibility to counteract anthropic emission of greenhouse gases. These activities, called Land use, Land-use change and Forestry (LULUCF) activities, entail the increase of biological carbon stocks in vegetation and soil and they mainly consist of the promotion of new plantations, the increase of carbon stock in the forests or soil carbon in agricultural and grazing land. Articles 3.3 and 3.4 of the Kyoto Protocol and the Marrakesh Accords identify and define the LULUCF activities that can be accounted for to fulfil national commitments. The activities must follow specific accounting and reporting rules in order to generate carbon credits.

Another mitigation strategy entails the substitution of fossil fuels with renewable energy sources and plant biomass can be used for this purpose. The effect of substitution is a direct emission reduction in the atmosphere. Forest residues as well as forest products, bioenergy crops and short rotation coppices can be used for energy production.

As a consequence of the ratification of the Convention on Biological Diversity, signed in 1992 in Rio de Janeiro, several countries committed themselves to undertake other national and international measures on biodiversity aimed at, for example, the conservation and sustainable use of biological diversity. The land conversion to forest land can also have positive or negative effects on biodiversity conservation and enhancement. A comprehensive evaluation of these activities should take into account sequestration potential and biodiversity increase or conservation targets in order to further both aims with the same action.

The forestry activities that have an effect on greenhouse gas (GHG) mitigation and biodiversity in Europe can be summarised under four main types:

- Afforestation – conversion to forest land actively promoted through planting of trees
- Natural succession – conversion to forest land due to natural succession processes that take place after land abandonment
- Short rotation coppices – dedicated planting of trees for energy production in intensively managed plantations with fast growing species (for example, aspen, willows, eucalyptus).
- Forest management – increase of carbon stock in forest land by changing management practices (e.g. increasing rotation length).

The first two activities entail a land use change to forest land. Land conversion can have legal implications for the owners since forestland is subjected to management constraints in several European countries and conversion to other land uses may be prohibited. The establishment of short rotation coppice is generally not considered as a land-use change as these plantations are still classified as agricultural land because of the nature of the products and management features. Forest management never entails a land use change because it must occur on land that is already forest.

This report aims to give first an overview of the policy context for activities promoting land conversion to forest. Requirements and rules surrounding forestry activities and the associated legal implications for farmers and countries complying with the rules will be reviewed. Second, dynamic trends of carbon sinks and sources in different forestry activities will be analysed. Third, existing information and databases on conversion to forest land or plantations at the European level will be presented. We conclude with a discussion about quality of available data, gaps and uncertainties and the identification of present and possible future trends in afforestation activities in Europe.

## 2. THE POLICY CONTEXT

The United Nations Framework Convention on Climate Change (UNFCCC) signed at the 1992 "Earth Summit" in Rio de Janeiro established an international agreement to reduce greenhouse gas emissions in order to prevent climate change. Quantitative and legally binding commitments were determined in the Kyoto Protocol. The Protocol commits the countries that ratified it to reduce their emissions by at least 5% in comparison to the base year (usually 1990) during the First Commitment period (2008-2012).

Land use, land-use change and forestry (LULUCF) were included in the Kyoto Protocol to the United Nations Convention on Climate Change as options offered to countries for fulfilling their commitments to reduce net emissions to the atmosphere. Article 3.3 and 3.4 of the Kyoto Protocol refers to emissions by sources and removals by sinks resulting from activities in the LULUCF sector. Article 3.3 refers to afforestation, reforestation and deforestation activities since 1990 (mandatory activities) and Article 3.4 refers to additional voluntary activities in land management to be decided later. In 2001, a decision reached at the seventh session of the Conference of Parties to UNFCCC in Marrakesh specified the voluntary activities that Parties may elect to comply with the Kyoto Protocol commitments during the First Commitment Period (2008-2012). These activities are forest management, cropland management, grazing land management, and revegetation. By the end of 2006 every country had to decide which activities of Article 3.4 were elected at the national level.

As general requirements, the activities must be human-induced and must have taken place since 1990. In addition, an accounting rule was established to reduce the risk of impermanence of promoted land-use changes. Once a country elects an activity or starts reporting a piece of land, it becomes mandatory to report this in the future: "Once Kyoto land, always Kyoto land".

The partial accounting of carbon credits in the agriculture and forestry sector required the establishment of accounting and reporting rules to avoid incorrect estimates of carbon sinks and sources connected to LULUCF activities. The emissions and removals from LULUCF activities are accounted according to two main rules:

- *Gross-net accounting*: only considers carbon stock changes resulting from the difference between emissions and removals in the commitment period and does not draw comparison with the base year. A debit occurs when emissions due to the activity are higher than removals within the commitment period; on the other hand credits are generated if the LULUCF activity leads to net removals within the commitment period. Gross-net accounting will therefore give carbon credits even where removals from an activity are diminishing over time, and will give carbon debits even where emissions are being reduced over time.
- *Net-net accounting* compares emissions and removals connected to a certain activity during the commitment period with emissions and removals during the base year. A credit is created when a net carbon sink can be measured comparing the two different periods.

During the first commitment period afforestation, reforestation, deforestation and forest management must follow gross-net accounting, while net-net accounting rules must be applied to revegetation, cropland management and grazing land management.

The conversion to forest land may qualify for afforestation, reforestation and possibly revegetation depending on specific national definitions of forest. By the end of 2006, every Party had to elect a national definition of forest within established ranges of minimum area (0.05-1 ha), minimum crown cover (10-30 %) and a minimum height at maturity (2-5m). The election of different values affects the area that qualifies for the different activities. To be reported as afforestation or reforestation an activity must entail a conversion to forest according to the national definition. The excluded vegetation, based on dimensional criteria, might be reported under revegetation when the additional activity of Art.3.4 is elected at the national level.

Forest biomass can also be used as a renewable energy source to substitute fossil fuel and avoid greenhouse emissions in the atmosphere. Short rotation coppice (SRC) is one of the methods used to provide biomass. According to the national definition of forest, SRC may be classified as conversion to forest if they meet the minimum thresholds reported above. In this case SRC are classified and reported as afforestation/reforestation under the Kyoto Protocol and they follow the gross-net accounting rule. In practice carbon accumulation occurs mainly in the soil, since the carbon sink in the wood biomass saturates quickly. Carbon dioxide losses in the biomass are not accounted for since it is assumed that the biomass is a renewable energy, produced in a sustainable manner[1]. When SRC are not classified as forest

[1] According to IPCC Guidelines, $CO_2$ emissions from biomass must not be accounted in the national carbon balance, because combusted biomass is replaced by regrowing biomass. The emissions are not accounted for, however they must still be reported in order to track how much renewable energy has been produced to avoid double counting. Emissions of other GHGs ($CH_4$ and $NO_2$) from biomass

according to the national definition, they must be reported as cropland. In this case, the soil carbon sinks can only be accounted for when the country elects cropland management as an additional activity under Art. 3.4, and the net-net accounting rules must be applied.

At the 1992 Earth Summit in Rio de Janeiro, another important international agreement was signed: the Convention on Biological Diversity. The Convention aims at the conservation and sustainable use of biodiversity. It is legally binding for its 168 signatories and it is a national responsibility to achieve the Convention's goals through the implementation of national biodiversity strategies and action plans integrated in the general environment and development policies, as in the agriculture and in the forestry sectors. In decision VI/26 a Strategic Plan for the Convention on Biological Diversity was adopted and Parties committed themselves to "a more effective and coherent implementation of the three objectives of the Convention, to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth". Each country that signed the Convention has to report what it did to implement the accord and on the effectiveness of the measures in meeting the objectives of the Convention. The report must be submitted to the Conference of the Parties (COP). Afforestation programs can promote biodiversity conservation and enhancement. For instance the conversion to forest of degraded land, the establishment of mixed stands or planting of indigenous species can help in fulfilling the goals of the Convention.

## 2.1. Consequences of legal requirements

The agricultural and forestry actions promoted by European, national and regional policies that entail activities listed in Art. 3.3 and 3.4 of the Kyoto Protocol are potentially eligible to achieve national commitments of emission reduction, provided that the requirements and rules listed in the Kyoto Protocol and in the Marrakesh Accords to account for the credits generated by these actions are respected.

One constraint is that each country can only account for actions that are human-induced and took place after 1989. The definition of 'human-induced' is not univocally determined and can be interpreted in a strict or a broad way. For instance the definitions of afforestation and reforestation in the Marrakesh Accords state that the conversion of land to forest can be obtained "through planting, seeding and/or the human-induced promotion of natural seed sources". Under a broad interpretation, the natural expansion of forest in abandoned agricultural land might be reported by countries as a LULUCF activity to comply with their Kyoto Protocol commitments. The inclusion of land abandonment in the national land use planning might be enough to respect the human-induced criterion. In fact the process is often taking place in marginal areas where it is not convenient for farmers to cultivate the land because of disadvantageous social and economical conditions, often a consequence of policies

utilization are accounted, since the combustion of biomass releases these gases and this is not compensated by any reverse biogenic mechanism.

promoted in the agricultural sector that preferably sustain agriculture in more productive areas.

Moreover, once an activity is elected and reported in the Kyoto inventory it must be reported for the future. The effectiveness of LULUCF activities in the mitigation policies can be limited by the potential impermanence of the land-use change. Unless legal constraints prevent this (see below), land converted to forest can be reconverted to the former land use (e.g. cropland). In terms of carbon, the re-conversion means that all the credits gained in the afforestation process are lost and produces carbon debits within the accounting period. To prevent this, countries have an interest to encourage irreversible LULUCF activities. In some countries national legislation is already in place to restrict the re-conversion of afforested area back to other land uses. For example, in several countries the conversion to forest land is legally binding after a certain period. This period varies between countries and the obligations for land owners after afforestation are therefore different. The afforestation policies promoted in Europe are usually based on a voluntary adhesion by the land owner and the legal restrictions can influence the rate or modalities of policy application. Where the law does not require an irreversible land-use change the area can be reconverted to the previous use and the risk of reconversion is generally higher on productive agricultural land.

Other obligations for the accounting of agricultural and forestry measures arise from the monitoring requirements for the Art. 3.3 and 3.4 activities. A monitoring system of Kyoto lands must be implemented in order to account and report for all carbon stock changes occurring on those lands. The development of inventory and monitoring systems (if not already in place and sufficient for the purpose) may increase the costs and reduce the effectiveness of the LULUCF activities in comparison to alternative mitigation actions. In addition, the accounting and reporting rules for net-net and gross-net accounting are different and consequently the data needs are different. Supplementary information in the base year (1990) is required for net-net accounting (for example, for revegetation activities).

Short Rotation Coppice (SRC) can be subjected to similar obligations and restrictions as afforestation and reforestation, when classified as forest land. The reconversion from SRC to crop would lead to the loss of carbon credits generated by the higher carbon sink in the soil under SRC. Most countries classify SRC as cropland and in this case soil carbon losses in the case of a reconversion will only be accounted if the country has elected cropland management. When comparing carbon sequestration in afforestations with the fossil fuel substitution generated from biomass produced in SRC, the latter has the advantage that avoided emissions are not reversible: once avoided they have a permanent positive effect in the atmosphere. On the other hand permanent afforestation/reforestation can generate positive externalities such as improved landscape and biodiversity. Afforestation/reforestation activities promoted to reduce GHG emissions can also play a role in complying with the Convention on Biodiversity. Particular attention should be paid to the site and the species selection in new plantations in order to enhance biodiversity. However, quantitative commitments are lacking in the treaty.

## 2.2. Afforestation policies

The EU afforestation actions promoted since 1990 were developed inside the Common Agricultural Policy and they mainly occurred on agricultural land. An analysis of the European policies in forestry was given in the Special Report No. 9/2004 on Forestry Measures within Rural Development Policy, together with the Commission's replies. Since 1990 the EU had developed several forestry actions:

- Since 1992, the EU supported afforestation on agricultural land with the Council Regulation 2080/92, as part of the accompanying measures under the 1992 MacSharry reforms;
- In 1998 the Council set out an EU forestry strategy whose guiding principles were the promotion of sustainable forest management and acknowledgment of forest multifunctionality;
- From 2000, forestry expenditure was integrated into the support for Rural Development by Council Regulation 1257/1999. One of the objectives of the support was to extend woodland areas with due regard to environmental impact. Two types of actions were set: afforestation and other forestry measures.

The Special Report No. 9/2004 shows that afforestation policies were applied mainly in the Mediterranean countries (Spain, Italy, Portugal), whereas the northern EU countries concentrated on other rural development priorities (Fig. 1). The general aim of EU policies have been the expansion of woodlands in agricultural areas with different priorities given by different countries. In some countries like Spain, marginal areas were favoured for conversion in order to combat erosion, while in other countries with comparable climate conditions (Italy and Portugal), high value agricultural lands were converted to forest. In the long run, the conversion of marginal agricultural land rather than productive land might be more effective for the Kyoto Protocol purposes since it reduces the risk of reconversion to the former land use because of lower opportunity costs of the land. The species selected for the European actions were also different in different areas. Under Council Regulation 2080/92, mono-specific plantation of fast-growing species to mixed stands with indigenous species were planted with different results for biodiversity conservation and enhancement.

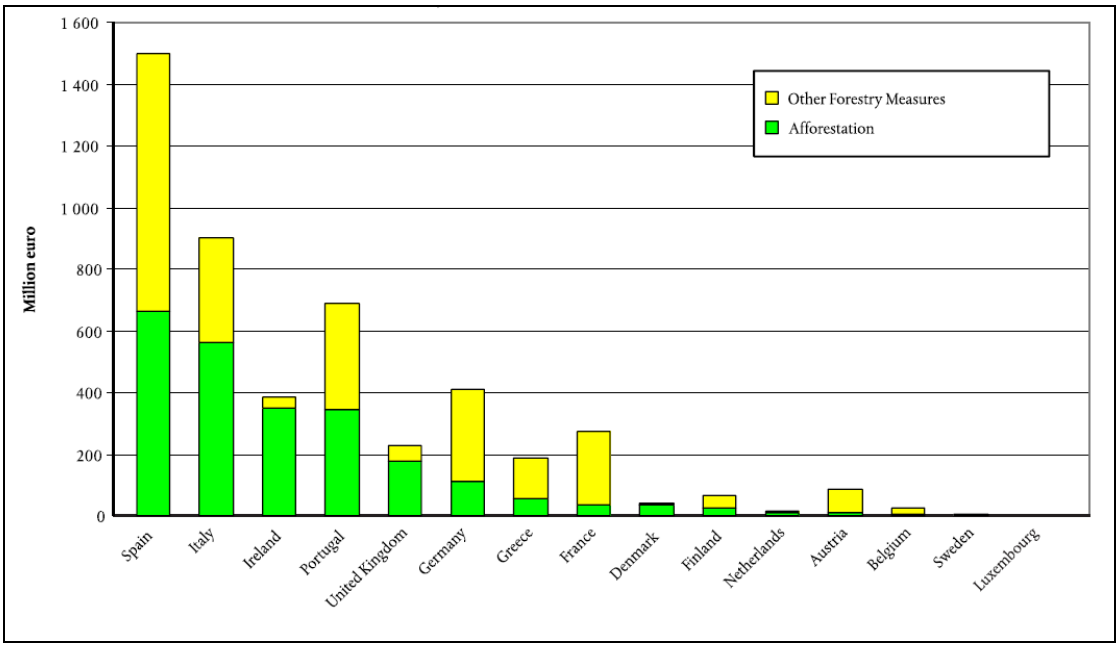


**Figure 1.** Financial forecast of forestry measures 2000 to 2006: EU contribution under EAGGF (Source: Court of Auditors, Special Report N 9/2004).

The future strategies for afforestation in the European forestry policies are mainly contained in the actions identified under the European Agricultural Fund for Rural Development (EARFD) and the 2006 EU Forest Action Plan, where emphasis is put both on mitigation strategies and biodiversity conservation and enhancement.

The EARFD was established by Council Regulation 1698/2005 and it constitutes a single instrument to finance the rural development policy for the period 2007-2013. The Regulation takes into account that "in order to contribute to the protection of the environment, the prevention of natural hazards and fires, as well as to mitigate climate change, forest resources should be extended and improved by first afforestation of agricultural land and other than agricultural land"; according to the Regulation any first afforestation should be adapted to local conditions and compatible with the environment and it should enhance biodiversity. Under the heading "Improving the environment and the countryside" (Section 2 - Axis 2), afforestation measures are sustained on agricultural and non-agricultural land together with measures to establish agroforestry systems (Art. 36(b)). Afforestation is sustained under EARDF in areas suitable for afforestation for environmental reasons such as protection against erosion or extension of forest resources contributing to climate change mitigation.

The 2006 EU Forest Action Plan "provides a framework for forest-related actions at Community and Member State level and serves as an instrument of coordination between Community actions and the forest policies of the Member States". It is developed as a proposal for actions to be implemented at the national level and a set of key actions is identified to achieve the Plan's objectives. Specific actions are identified to support the role of forests for greenhouse mitigation and biodiversity enhancement and protection (key actions 6 and 7). Afforestation activities are

specifically mentioned and sustained under key action nine: enhance the protection of the EU forests; afforestation should be promoted by Member States for environmental and protective objectives with support from the EARDF instrument. Under the key action four a set of activities to promote the use of forest biomass for energy generation is identified.

In addition to European policies, individual countries are developing national policies in the LULUCF sector. In some cases the countries are developing *ad hoc* actions in order to comply with their commitments. The Italian government granted €5.25 million for forest management projects, afforestation and reforestation with indigenous plants in marginal lands for the Kyoto Protocol purposes. Other countries have national afforestation programs that are developed independently from specific policies. Afforestation was actively promoted in Ireland in the last decades and the afforestation rate was around 20000 ha $yr^{-1}$ between 1990 and 2002. Mainly conifers were planted, but an increase in diversity and the planting of broadleaves was encouraged in the most recent years. On the other hand the high afforestation rate promoted by high subsidies had sometimes ecologically negative effects, such as afforestation of bogs with high conservation value (Gilsenan 2003). The simultaneous effect of afforestation activities on GHG mitigation and biodiversity need to be recognized in integrated afforestation policies addressing both aims.

## 3. CARBON DYNAMICS IN FORESTRY ACTIVITIES

Conversion to forest land is generally associated with positive effects on the carbon balance, particularly if former agricultural land with low soil organic matter content is afforested. The carbon benefits are produced by biomass accumulation during the conversion and by a potential increase of organic carbon in the soil (De Kovel et al. 2000, Post and Kwon 2000, Guo and Gifford 2002, Degryze et al. 2004). However, the carbon dynamics in the conversion to forest can vary a lot and the variability usually increases from mono-specific plantations to secondary succession processes due to the increasing number of factors influencing vegetation dynamics and carbon accumulation patterns in soils.

While forest stands always contain more biomass above-ground compared to grassland or agricultural crops, this is not always true for below-ground biomass and soil organic matter. Post and Kwon (2000) reported soil carbon changes during land use change ranging from small losses under natural succession in the cool temperate zone to an increase of 300 gC $m^{-2}$ $y^{-1}$ in a subtropical wet forest plantation. The variability is due to several environmental and anthropogenic factors. The former land use and possible site preparation strongly influence the soil carbon changes in afforestation activities. A review of soil carbon dynamics in land-use changes revealed that in the case of conversion from pasture to plantation, an average decrease in soil carbon stocks was observed (Guo and Gifford 2002). Natural grasslands and pastures often store more carbon in the soil compared to forests, because of the high root litter input from perennial grasses into the soil. Woody plants deposit more litter on the surface, which leads to carbon accumulation in the forest floor, often at the cost

of lower soil organic matter contents. In their recent review, Jandl et al. (2007) found that after a temporary reduction of soil carbon storage after site preparation and afforestation, most studies revealed a long term accumulation of carbon in the soils. For example the study of Zerva et al. (2005) showed that the establishment of coniferous forests on peaty gley grassland soils in the Scottish uplands can lead to a net accumulation of soil carbon during the second rotation.

The uncertainties increase in succession processes where the soil carbon dynamics are strongly influenced by the vegetation type developing after abandonment. Additionally, climate, territorial factors (soil, bedrock, elevation, slope, exposure, prevailing vegetation type) and disturbances can create very different succession patterns. Since the areas affected by abandonment are placed in various climatic zones, spread over altitudinal and latitudinal gradients and defined by different environment features, the possible outcomes are numerous. Land abandonment can sometimes lead to uncertain or negative change in the amount of the carbon stored in the ecosystem (Goodale and Davidson 2002), land degradation (for example, erosion and desertification) and unstable conditions (for example, increase of fires). Jackson et al. (2002) studied woody invasion into grasslands along a precipitation gradient and found losses of soil organic carbon at the wetter sites substantial enough to offset increases in plant biomass carbon. Discontinued maintenance of terraces can also lead to carbon loss from soils. In the first stage of abandonment terraced soils are favourable for the invasion of shrubs and trees. However, in the absence of maintenance works to the terraces a rapid soil and organic matter loss may occur after the fall of the terrace walls (Dunjò et al. 2003). The terraced lands are usually on very steep slopes and as a consequence of the loss of terraces, the soil might be much more subjected to erosion and the vegetation establishment might also be more difficult. Land abandonment is also reported as one of the main causes of soil degradation and desertification in the Mediterranean region (ICCDD 2000). Soil evolution after the abandonment of cultivated land is connected to the development of the natural vegetation through secondary succession processes (Martinez-Fernandez et al. 1995, Kosmas et al. 2000, Van Rompaey et al. 2001). The establishment of shrub or tree communities is strictly determined by the site conditions: shallow soils and low availability of nutrients can delay the recovery of natural vegetation. The absence of a vegetation cover leads to an increase of erosion processes that can result in degradation and desertification (Garcia-Ruiz et al. 1995, Lasanta et al. 1995, Cammeraat and Imeson1999, Pardini et al. 2003). In Southern European countries another factor that can promote soil degradation is the disturbance by recurrent forest fires. The secondary succession on former agricultural areas leads to an increase in the biomass, but this also increases fuel amounts, increasing fires risk in these regions (Romanya et al. 2001).

Carbon sequestration into plant biomass is influenced by management and species-specific growth rates. Species differ in their carbon accumulation rates into biomass with age. The comparison of white spruce, aspen and hybrid poplar plantations of 10 and 25 years showed a range of sequestration rates from 0.28 to 5.25 tC $ha^{-1}$ $y^{-1}$ (Peterson et al. 1999). The highest carbon accumulation rates are usually observed in fast growing short rotation coppice, which are relatively more efficient at producing wood for substituting fossil fuels. Afforestation with commercial tree species grown for forest production is characterised by a slower initial accumulation of carbon, but the accumulation process lasts longer and can reach much larger pool sizes in the

mature forest stand biomass compared to short rotation coppice. Natural succession processes are much more variable because of a larger number of factors affecting vegetation dynamics. They can show similar carbon accumulation patterns as afforestation, but depending on tree density and species involved, the process may also be a lot slower or blocked at an initial stage. However in all these cases the carbon trend in the biomass is positive, unless there is reconversion to the former land use or temporary stock decreases due to disturbance factors.

General carbon accumulation/depletion rates are usually not available. Some default data are provided in the IPCC Good Practice Guidance (2003) for biomass and soil carbon changes according to macro climatic regions and vegetation types but the uncertainties on the values are very high.

## 4. AFFORESTATION AND BIODIVERSITY

The implications of afforestation for biodiversity depend on many factors such as the previous land use, previous biodiversity values, or the way afforestation is carried out. The surrounding landscape is also relevant. Large scale afforestation of natural grasslands or culturally rich historical small scale landscapes could lead to the loss of specific species, while afforestation of intensively used agricultural areas could enhance biodiversity. Similarly, afforestation of patches in an open landscape could increase biodiversity by creating additional habitats. On the other hand afforestation of open areas in a forested landscape could lead to a loss in biodiversity by destroying specific habitats, because open patches in the forest are known to be beneficial for many species.

Effects of afforestation on biodiversity should therefore be judged by the diversity and structural heterogeneity of the previous and the newly created landscape. Effects on biodiversity also depend on which tree species are used for afforestation. In Western Europe, earlier afforestation activities were aimed at production and exotic coniferous tree species were mainly used. Current afforestation is usually carried out with indigenous species, which are expected to be better for biodiversity (Larsson 2001). Furthermore, biodiversity could be enhanced through specific measures during afforestation. Such measures could include planting mixtures, groups of species with different growth patterns to achieve a diverse structure or leaving parts of the area open, either permanently or to regenerate spontaneously. Also the afforestation pattern in the landscape could be a point of attention, for example, diversity in parcel sizes or taking into account natural landscape elements. Specific attention could be paid to the transition from the forest to open areas. Diffuse forest edges are known to be favourable for biodiversity. Furthermore, afforestation could be used to create corridors, for example within the Natura 2000 framework.

When judging the effect of afforestation on biodiversity, it is important to keep in mind that there are many different indicators of biodiversity. For example, biodiversity can be expressed as number of species present, number of red list species present, number of taxa present, degree of naturalness, etcetera. Afforestation could lead to an increase in one indicator and a decrease in another. It is therefore important not to focus on one indicator, but to look at various aspects.

Similar considerations can be applied to natural succession in abandoned areas. In comparison to active afforestation, some advantages for biodiversity can be recognised in natural processes. The new vegetation is usually composed of local and introduced species with different growth patterns. However some negative effects can also arise from natural forest expansion. Attention must be paid in order to avoid the propagation of invasive or alien species and to maintain special habitats that are important for biodiversity (for example, open spaces in forested areas). Land abandonment should also be avoided in areas that can be affected by soil degradation such as on steep slopes where the establishment of vegetation might be difficult. Abandoned lands may increase forest fire risk and therefore some fuel limiting management practices should be adopted in areas with high forest fire risk.

The effects of afforestation activities may differ between regions. For instance, forest expansion after land abandonment in densely forested areas can lead to the loss of biodiversity, as happens on the Alps where meadows and open spaces are disappearing. In contrast, the effect can be positive on land previously under intensive agricultural management where forest resources are scarce.

The type of afforestation can also affect biodiversity. The choices that will be applied in the new EU member states are of particular interest since they can either create an opportunity to enhance landscape diversity, or lead to a biodiversity decline caused by large scale afforestation of coniferous species.

## 5. DATA COLLECTION ON AFFORESTATION IN EUROPE

### 5.1. European data sources

In Europe, afforestation activities are usually developed inside the Common Agricultural Policy or in national or regional actions. As a consequence there is not a central authority that compiles information on afforestation activities. The available information about afforestation is often restricted to forest area changes, refers to different reference periods, includes both intentional afforestation and spontaneous woody encroachment, and lacks information about which tree species were planted. This information is important in order to characterize the impacts of afforestation on various ecological and economic indicators (see for example Ministerial Conference on the Protection of Forests in Europe and UNECE/ FAO 2003) along with its mitigation potential and effects on biodiversity.

This study incorporates a review of information about afforestation in European countries conducted at EFI between 2003 and 2006. In this chapter we report the collected information for all European countries based on responses to a data request and collation of information from other sources.

#### *5.1.1. Literature review*

Table 1 reports the most important databases available at the European level on forest resources. Following the aim of this work, we reported only available data on forest area and afforestation however the data sources do often include additional information such as growing stocks and disturbances.

The main and most exhaustive data sources at the European level are:

- The Global Forest Resource Assessment 2005 (FRA 2005) coordinated by FAO; information has been collated from 229 countries and territories for three points in time: 1990, 2000 and 2005.
- The report “Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand” - TBFRA 2000 coordinated by UN-ECE/FAO

- Corine Land Cover that provides geographical information on the land cover in Europe[2]

Additional information is reported in other reports but they are often based on the FRA and TBFRA data (Tab. 1).

The data refer to variable time periods and geographical areas. The forest definition can also differ between data sources. The FRA2005, TBFRA 2000 and related sources applied FAO definition for forest: land spanning more than 0.5 hectares with trees higher than five metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. The Corine Land Cover classes are based on qualitative definitions. For example the broad-leaved forests are defined as "Vegetation formation composed principally of trees, including shrub and bush understories, where broadleaved species predominate". Because of differences in reference periods and in definitions, the data are often not consistently comparable between different data sets or even within the same dataset.

[2] In this report the geographical information provided by Corine land Cover were not compared to figures from other data sources to draw European trends of forest area change, because the minimum forest area in the Corine Land Cover is quite large (25 ha) and difficult to compare to other sources.

**Table 1.** Data sources for forest area and forest area change in Europe.

| Source | Available data | Time period | Countries | Notes |
|---|---|---|---|---|
| **FRA 2005**[i] | Extent of forest and other wooded land | 2005 | World (229)<br>Europe (47) | The values for 1990 and 2000 may differ slightly from values reported in FRA2000 because the estimates for 1990 and 2000 have been linearly interpolated or extrapolated from other assessments. The figures for 2005 are forecasts. |
| | Change in extent of forest and other wooded land | 1990–2005 | World (229)<br>Europe (47) | |
| | Change in extent of primary forest 1990–2005 | 1990–2005 | World (229)<br>Europe (47) | |
| | Change in forest plantations | 1990–2005 | World (229)<br>Europe (47) | |
| **Corine Land Cover**[ii] | Geographical information on land cover in Europe | 1990 | Europe (25) | Qualitative definition of forest; minimum unit mapping size of 25 hectares |
| | Geographical information on land cover in Europe | 2000 | Europe (30) | |
| | Land use changes | 1990–2000 | Europe (24) | |
| **TBRFA2000-**[iii] | Forest and Other Wooded Land area | Different for different countries | World (55)<br>Europe (41) | |
| | Changes in Forest and Other Wooded Land, broken down between forest available and not available for woody supply | Different for different countries | World (55)<br>Europe (41) | Country annual changes not comparable because of variable time periods. Natural afforestation is included. |
| | Information about the area of non-forest land turned into forest by planting and seedling and the proportion on the total forest extension | Annual average over a 10-year period | World (36)<br>Europe (30) | The value of the proportion does not always correspond to the figures for planting and total extension. Some countries are missing (Spain, Italy, Greece, Bulgaria, Romania) |
| **MCPFE**[iv]**- Report State of Europe's Forests 2003** | Extent of Forest and other Wooded land | Different for different countries | Europe (40) | Data are based on TBFRA2000data updated with a questionnaire; different update levels were provided by different countries. |
| | Annual change of forest area in Europe, broken down into three forest types (broadleaved, mixed and conifers) where updated data were available | Different for different countries | Europe (32) | Differs greatly from some other data sources: includes natural succession and not human-induced interventions and refers to different reference periods |

| | | | | |
|---|---|---|---|---|
| **State of the World's forest 2003 - Report**[v] | Extent of Forest area | 2000 | World and Europe (38) | Data are mainly taken from the FRA 2000 report |
| | Annual change of forest cover in Europe | 1990–2000 | World and Europe (38) | Includes expansion of forest plantations and losses and gains in the area of natural forests |
| **The development of European Forest Resources, 1950 to 2000: A better information base**[vi] | FRA data adjusted to TBFRA definitions to produce harmonized time series | 1950–2000 | | The actual development of forest area is more regular than the FRA sources indicated. Abrupt changes can often be directly linked to changes in inventory methods or definitions |
| **Evaluation of Regulation N 2080/92 - IDF 2001**[vii] | Chart on completed plantings financed by Reg 2080/92 | 1994–1999 | EU15 | Exact values not visible |
| | Distributions by type of afforestation of the planted areas | 1994–1999 | 8 | Broken down by broadleaves, conifers, mixed stands and fast-growing species |
| | Total area afforested under 2080/92, percentage of total forest area, share of the net annual increase of forest area in Europe | 1994–1999 | EU15 | Data not available at the country level |
| **Report to Parliament and the Council on the application of Regulation (EEC) no 2080/92**[viii] | Achievements and total afforested area under 2080/92 | 1993–1996 | EU12 | Broken down by conifers and broadleaves |
| **EFFE final report**[ix] | Subsidized afforestation measures in Europe in the public and private sectors | 1990–1999 | 12 countries and 2 regions | Data quality differs strongly from country to country |
| **Incentives to expand Forest cover: a framework for Canada**[x] | Overview of afforestation efforts around the world | Variable | World | |
| | Description of national and EU policies and incentives programs for the purposes of afforestation and reforestation in Europe | Variable | Europe and 11 case studies | It is mainly a descriptive report but it provides some figures and values about afforested area, forest area development and used species groups |
| **NEWFOR Symposium**[xi] | Overview of afforestation processes in Europe | - | EU | |

| | | | | |
|---|---|---|---|---|
| **UNFCCC GHG inventories**[xii] | Afforestation area | 2003–2006 | - | Some countries report afforestation areas on the reports |
| **Questionnaire to national authorities** | Afforestation activities in the country (area, tree species) | Different time periods | Sent to 44 countries, 26 responded | The detail of information provided differs between countries |

[i] FAO(2006) Global Forest Resources Assessment 2005. Available at: http://www.fao.org/forestry/foris/webview/forestry2/index.jsp?siteId=101&sitetreeId=16807&langId=1&geoId=0

[ii] Corine land Cover, © EEA, Copenhagen, 2006

[iii] UN-ECE/FAO, Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand, (industrialized temperate/boreal countries), UN-ECE/FAO Contribution to the Global Forest Resources Assessment 2000, Main Report, United Nations New York and Geneva 2000. Geneva Timber and Forest Study Papers, No. 17. ISBN 92-1-116735-3.

[iv] Ministerial Conference on the Protection of Forests in Europe, Liaison Unit Vienna, State of Europe's Forests 2003, The MCPFE Report on Sustainable Forest Management in Europe, Vienna 2003. ISBN 3-902073-09-8

[v] Food and Agriculture Organization of the United Nations, State of the World's Forests 2003, Rome 2003, pp. 132ff

[vi] Gold, S. 2003. The development of European Forest Resources, 1950 to 2000: a better information base. UN-ECE/FAO. Geneva Timber and Forest Discussion Paper 31

[vii] Institute for Forestry Development, Evaluation of the Community aid scheme for forestry measures in agriculture of Regulation No 2080/92, Final Report, Auzeville 2001. AGRI/2001/33002-00-00-EN

[viii] Report to Parliament and the Council on the application of Regulation (EEC) No 2080/92 instituting a Community aid scheme for forestry measures in agriculture [COMM(1997)630, 28.11.1997]

[ix] Evaluating Financing of Forestry in Europe (EFFE) (contract number QLK5-CT-2000-01228), coordinated by the European Forest Institute (EFI).

[x] Incentives to Expand Forest Cover: A Framework for Canada, Phase 1, Chapter C, Europe, pp. 51–86. The report was prepared by Rory Gilsenan, University of Victoria, BC, Canada, and produced for Natural Resources Canada/Canadian Forest Service as part of Action Plan 2000's FAACS (the Feasibility Assessment of Afforestation for Carbon Sequestration) initiative.

[xi] NEWFOR – New Forests for Europe: Afforestation at the Turn of the Century. Proceedings of the Scientific Symposium, February 16-17, 2000, Freiburg, Germany. EFI Proceedings No. 35. Ed. N. Weber.

[xii] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3734.php

## 5.2. Land use change in the European Union in 1960-1990

In recent decades, land use in the EU has been affected by several changes. Agricultural land use decreased while the share of urban areas and forests increased. These land use changes are connected with economic changes in Europe after the Second World War: the service and the light industry sectors gained importance, and the intensification of agricultural practices resulted in abandonment of marginal agricultural land. Land abandonment and the de-industrialisation process have been the driving forces of secondary succession processes.

FAOSTAT data indicates that the agricultural area in the EU-15 has decreased by 20.9 M ha (or -12.7 %) over the period 1961-1994, whereas the forest area has increased by 12.0 M ha (or +11.8 %). The greatest change in forest area occurred between 1961 and 1975 and continued at a lower rate. On the other hand, urban areas increased more at the end of the last century to the detriment of agricultural areas that decreased at a constant rate throughout the period. It must be stressed that the data are difficult to compare along the time series because of changes in the definition of forest over time. After 1994, the FAO definition of forest was modified (minimum crown cover from 20 % to 10 %). In addition, different definitions have been applied at the national level and often the national figures have been adapted through estimation to match the FAO definitions before and after 1994 (Gold 2003).

A large amount of forest expansion occurred in the Mediterranean region: more than 70 % of forest expansion occurred in the southern EU countries due to farm abandonment and rural emigration processes (Mazzoleni et al. 2004), and also as a consequence of EU enlargement and the decoupling of support from agricultural production (Pezaros and Unfried 2002).

### *5.2.1. Quantitative overview of forest area change and afforestation in Europe*

According to the latest figures from the Forest Resources Assessment 2005 (Table 2), the forest area of Europe (47 countries and territories)[3] is approximately 1,001,394,000 ha (figures for 2005 based on extrapolations from the latest data available), and the annual rate of change of forest area was an increase of approximately 661,000 ha $yr^{-1}$ for the period 2000–2005 and 877,000 ha $yr^{-1}$ for the period 1990–2000. If Turkey and Cyprus are included as part of Europe, the total forest area is 1,011,742,000 ha and the annual rate of change was 685,000 ha $yr^{-1}$ for the period 2000–2005 and 916,000 ha $yr^{-1}$ for the period 1990–2000 (FRA2005). The whole Russian territory is included in these estimates, since no distinction between European and Asian Russia is provided in the FRA reports. Excluding Russia, the forest area in Europe is much smaller (202,952,000

[3] Europe, as defined in FRA2005, includes 47 countries and territories: Albania, Andorra, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Channel Islands, Croatia, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Gibraltar, Greece, Holy See, Hungary, Iceland, Ireland, Isle of Man, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, San Marino, Serbia and Montenegro, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Ukraine, United Kingdom.

ha) but with comparable increasing rates of approximately 782,000 ha $yr^{-1}$ for the period 2000-2005 and 885,000 ha $yr^{-1}$ for the period 1990–2000. The contribution of afforestation to the extension of forest area varies between countries. Figure 2 presents available information on forestry in broad categories. Table 2 contains the figures for forest area from TBFRA2000, MCPFE2003, and FRA2005 for the 47 countries and territories counted as part of Europe for FRA2005 plus Turkey and Cyprus. Figures for the EU-25 are also reported.

Table 3 summaries all the data available on forest area change and human-induced afforestation from different data sources, including responses to the questionnaire. A number of countries only provided information on afforestation, while others also reported information on planted species (see "quality of answer" in Table 3).

**Table 2.** Forest area in Europe according to different data sources.

| Country/ Area | Forest area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Forest area (1000 ha) | | | | | | | Annual rate of (1000 ha yr$^{-1}$) | |
| | TBFRA2000 | | MCPFE2003 | | FRA2005 | | | | |
| | Area | Period | Area | Period | 1990 | 2000 | 2005 | 1990-2000 | 2000-2005 |
| Albania | 1 030 | *1995* | 1 030 | *2001* | 789 | 769 | 794 | -2 | 5 |
| Andorra | | | | | *16* | *16* | *16* | *0* | *0* |
| Austria | 3 840 | *1992–1996* | 3 840 | *1994* | 3 776 | 3 838 | 3 862 | 6 | 5 |
| Belarus | 7 865 | *1994–1997* | 7 865 | *1994* | 7 376 | 7 848 | 7 894 | 47 | 9 |
| Belgium | 646 | *1997* | 667 | *2000* | 677 | 667 | 667 | -1 | 0 |
| Bosnia and Herzegovina | 2 276 | *1995* | 2 273 | *1995* | 2 210 | 2 185 | 2 185 | -2 | 0 |
| Bulgaria | 3 590 | *1995* | 3 588 | *1995* | 3 327 | 3 375 | 3 625 | 5 | 50 |
| Channel Islands | | | | | 1 | 1 | 1 | 0 | 0 |
| Croatia | 1 775 | *1996* | 1 775 | *1996* | 2 116 | 2 129 | 2 135 | 1 | 1 |
| Cyprus | 117 | *1996* | 172 | *1999* | 161 | 173 | 174 | 1.2 | 0.2 |
| Czech Republic | 2 630 | *1995* | 2 630 | *1995* | 2 630 | 2 637 | 2 648 | 1 | 2 |
| Denmark | 445 | *1990* | 486 | *2000* | 445 | 486 | 500 | 4 | 3 |
| Estonia | 2 016 | *1996* | 2 010 | *1996* | 2 163 | 2 243 | 2 284 | 8 | 8 |
| Faeroe Islands | | | | | n.s. | n.s. | n.s. | 0 | 0 |
| Finland | 21 883 | *1991–1996* | 22 032 | *1996* | 22 194 | 22 475 | 22 500 | 28 | 5 |
| France | 15 156 | *1997* | 15 156 | *1997* | 14 538 | 15 351 | 15 554 | 81 | 41 |
| Germany | 10 740 | *1987* | 10 740 | *1987* | 10 741 | 11 076 | 11 076 | 34 | 0 |
| Gibraltar | | | | | 0 | 0 | 0 | 0 | 0 |
| Greece | 3 359 | *1992* | 3 359 | *1992* | 3 299 | 3 601 | 3 752 | 30 | 30 |
| Holy See | | | | | 0 | 0 | 0 | 0 | 0 |
| Hungary | 1 811 | *1996* | 1 873 | *2001* | 1 801 | 1 907 | 1 976 | 11 | 14 |
| Iceland | 30 | *1998* | 30 | *1998* | 25 | 38 | 46 | 1 | 2 |
| Ireland | 591 | *1996* | 624 | *2001* | 441 | 609 | 669 | 17 | 12 |
| Isle of Man | | | | | 3 | 3 | 3 | 0 | 0 |
| Italy | 9 857 | *1995* | 9 855 | *1995* | 8 383 | 9 447 | 9 979 | 106 | 106 |
| Latvia | 2 884 | *1997* | 2 884 | *1997* | 2 775 | 2 885 | 2 941 | 11 | 11 |
| Liechtenstein | 7 | *1995* | 7 | *1995* | 6 | 7 | 7 | n.s. | 0 |
| Lithuania | 1 978 | *1996* | 2 034 | *2001* | 1 945 | 2 020 | 2 099 | 8 | 16 |
| Luxembourg | 86 | *1994–1997* | 86 | *1994–1997* | 86 | 87 | 87 | n.s. | 0 |
| Macedonia | 906 | *1995* | | | 906 | 906 | 906 | 0 | 0 |
| Malta | 0.35 | *1996* | 0.347 | *1996* | n.s. | n.s. | n.s. | 0 | 0 |
| Moldova | 324 | *1997* | 322 | *1997* | 319 | 326 | 329 | 1 | 1 |
| Monaco | | | | | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 339 | *1992–1996* | 361 | *1992–1996* | 345 | 360 | 365 | 2 | 1 |
| Norway | 8 710 | *1994–1996* | 8 713 | *1994–1996* | 9 130 | 9 301 | 9 387 | 17 | 17 |
| Poland | 8 942 | *1992–1996* | 9 088 | *2001* | 8 881 | 9 059 | 9 192 | 18 | 27 |
| Portugal | 3 383 | *1995* | 3 308 | *1995* | 3 099 | 3 583 | 3 783 | 48 | 40 |
| Romania | 6 301 | *1995–1997* | 6 301 | *1995–1997* | 6 371 | 6 366 | 6 370 | 0 | 1 |
| Russian | 816 538 | *1993* | 810 367 | *1998* | 808 950 | 809 268 | 808 790 | 32 | -96 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Federation | | | | | | | | | |
| San Marino | | | | | n.s. | n.s. | n.s. | 0 | 0 |
| Serbia Montenegro | 2 894 | *1995* | | | 2 559 | 2 649 | 2 694 | 9 | 9 |
| Slovakia | | | | *2001* | 1 922 | 1 921 | 1 929 | n.s. | 2 |
| Slovenia | 1 099 | *1996* | 1 143 | *2001* | 1 188 | 1 239 | 1 264 | 5 | 5 |
| Spain | 13 509 | *1990* | 13 656 | *1990* | 13 479 | 16 436 | 17 915 | 296 | 296 |
| Sweden | 27 264 | *1992–1996* | 27 293 | *1998–2001* | 27 367 | 27 474 | 27 528 | 11 | 11 |
| Switzerland | 1 173 | *1993–1995* | 1 173 | *1993–1995* | 1 155 | 1 199 | 1 221 | 4 | 4 |
| Turkey | 9 954 | *1996* | 10 027 | *1999* | 9 680 | 10 052 | 10 175 | 37 | 25 |
| Ukraine | 9 458 | *1996* | 9 460 | *1996* | 9 274 | 9 510 | 9 575 | 24 | 13 |
| United Kingdom | 2 469 | *1995* | 2 751 | *1995–1999* | 2 611 | 2 793 | 2 845 | 18 | 10 |
| **Total** | 1 007 875 | | 998 979 | | 999 160 | 1 008 315 | 1 011 742 | 916 | 685 |
| **EU25** | 135 044 | | 136 048 | | 134 947 | 142 367 | 145 589 | 743 | 645 |

Note: The difference between data sources can mainly be explained by different time reference periods and differences in forest definitions.


**Figure 2.** Availability of information about afforestation in Europe.

**Table 3.** Forest area change and afforestation rates in Europe according to different data sources.

| Country | Forest area change (ha yr$^{-1}$) | Reference period | Source | Afforestation (ha yr$^{-1}$) | Reference period | Source | Notes | Questionnaire | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Answered | Quality of answer |
| Albania | -2000 | 1990–2000 | FRA2005 | 5000 | 1951–1990 | TBFRA2000 | | No | |
| | 5000 | 2000–2005 | FRA2005 | | | | | | |
| | -7800 | 1957–1995 | TBFRA2000 | | | | | | |
| Andorra | - | - | - | - | - | - | | No | |
| Austria | 6000 | 1990–2000 | FRA2005 | 410 | 1995–2002 | Questionnaire | | Yes | Area |
| | 5000 | 2000–2005 | FRA2005 | 1000 | 1986–1996 | TBFRA2000 | | | |
| | 7700 | 1986–1996 | TBFRA2000 | 83 | 1993–1996 | Report to Parliament 2080/92 | | | |
| Belarus | 47000 | 1990–2000 | FRA2005 | 600 | 1988–1997 | TBFRA2000 | Uncertain data | No | |
| | 9000 | 2000–2005 | FRA2005 | | | | | | |
| | 256200 | 1988–1994 | TBFRA2000 | | | | | | |
| Belgium | -1000 | 1990–2000 | FRA2005 | 310 | 1980–2000 | Questionnaire | | Yes | Average annual afforestation rate, share of tree species for Walloon |
| | 0 | 2000–2005 | FRA2005 | 479 | 1991–1998 | Incentives to Expand Forest Cover | Data for Flanders; Wallon region excluded | | |
| | -1260 | 1982–1997 | TBFRA2000 | 113 | 1991–2000 | EFFE report | Data for Flanders | | |
| | 100 | 2000 | MCPFE2003 | 1689 | 1990–1999 | EFFE report | Data for Wallon | | |
| | | | | 100 | 1988–1997 | TBFRA2000 | | | |
| Bosnia and Herzegovina | -2000 | 1990–2000 | FRA2005 | 245 | 2000–2003 | Questionnaire | | Yes | Area, share of conifers/ broadleaves |
| | 0 | 2000–2005 | FRA2005 | | | | | | |
| | n.s. | 1990–1995 | TBFRA2000 | | | | | | |
| Bulgaria | 5000 | 1990–2000 | FRA2005 | 2980 | 1999–2003 | Questionnaire | | Yes | Area |
| | 50000 | 2000–2005 | FRA2005 | 12500 | 1990–1995 | NEWFOR | The area of artificial stands decreased of 12500 ha yr$^{-1}$ in the period 1990–1998 | | |
| | 20380 | 1985–1995 | TBFRA2000 | 8580 | 1996–1999 | NEWFOR | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | -9463 | 1990–1998 | NEWFOR | 7500 | after 2000 | NEWFOR | Planned afforestation rate after 2000 | | |
| Croatia | 1000 | 1990–2000 | FRA2005 | 1374 | 1986–2003 | Questionnaire | | Yes | Area, tree species |
| | 1000 | 2000–2005 | FRA2005 | 2000 | 1986–1996 | TBFRA2000 | | | |
| | 2000 | 1986–1996 | TBFRA2000 | | | | | | |
| Cyprus | 120 | 1990–2000 | FRA2005 | 160 | 1980–2003 | Questionnaire | | Yes | Area |
| | 20 | 2000–2005 | FRA2005 | | | | | | |
| | 0 | 1980–1998 | TBFRA2000 | | | | | | |
| | 5000 | 1990–2000 | MCPFE2003 and State of World's Forest 2003 | | | | | | |
| Czech Republic | 1000 | 1990–2000 | FRA2005 | 1000 | 1986–1995 | TBFRA | | No | |
| | 2000 | 2000–2005 | FRA2005 | 556 | 1996–1999 | EFFE report | | | |
| | 500 | 1986–1995 | TBFRA2000 | 1154 | 1990–2003 | 4th national Communication | | | |
| | 1000 | 1990–2000 | MCPFE2003 and State of World's Forest 2003 | | | | | | |
| | 556 | 1990–1999 | EFFE report | | | | | | |
| Denmark | 4000 | 1990–2000 | FRA2005 | 1640 | 1990–1999 | Questionnaire (DFLRI) | | Yes | Area, tree species (DFLRI), proportion of the different tree species and type of afforestation (DFNA) |
| | 3000 | 2000–2005 | FRA2005 | 1430 | 1989–2002 | Questionnaire (DFNA) | | | |
| | 980 | 1976–1990 | TBFRA2000 | 1900 | 1990 | TBFRA2000 | | | |
| | 3000 | 2000 | MCPFE2003 | 926 | 1993–1996 | Report to Parliament 2080/92 | | | |
| | | | | 1532 | 1994–1999 | Evaluation 2080/92 | | | |
| | | | | 1848 | 1990–2004 | UNFCCC | | | |
| Estonia | 8000 | 1990–2000 | FRA2005 | 500 | 1987–1996 | TBFRA2000 | | No | |
| | 8000 | 2000–2005 | FRA2005 | 0 | 1990–2000 | EFFE report | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 12500 | 1988–1996 | TBFRA2000 | | | | | | |
| | 18780 | 1958–1999 | EFFE report | | | | | | |
| Finland | 28000 | 1990–2000 | FRA2005 | 9200 | 1970–2001 | Statistical Yearbook | | Yes | Area |
| | 5000 | 2000–2005 | FRA2005 | 9000 | 1987–1996 | TBFRA2000 | | | |
| | 8000 | 1980–1986 | TBFRA2000 | 44 | 1993–1996 | Report to Parliament 2080/92 | | | |
| | 71000 | 1996 | MCPFE2003 | 3800 | 1995–1999 | EFFE report | MCPFE2003: questionable | | |
| | | | | 76000 ha | | EFFE report | | | |
| France | 81000 | 1990–2000 | FRA2005 | 14405 | 1993–2002 | Questionnaire | From Questionnaire: 14405 ha $y^{-1}$ of artificial regeneration and 97698 ha $y^{-1}$ of natural regeneration | Yes | Area |
| | 41000 | 2000–2005 | FRA2005 | 10777 | 1991–1998 | Indicators for Sustainable Management of French Forests | | | |
| | 61600 | 1987–1997 | TBFRA2000 | 9200 | 1987–1997 | TBFRA2000 | | | |
| | 82900 | 1991–1998 | Indicators for Sustainable Management of French Forests | 7225 | 1993–1996 | Report to Parliament 2080/92 | | | |
| | 112102 | 1993–2002 | Questionnaire | 4612 | 1994–1999 | Evaluation 2080/92 | | | |
| | | | | 25874[m] | 1990–1998 | EFFE report | | | |
| Germany | 34000 | 1990–2000 | FRA2005 | 8850 | 1990–1999 | EFFE report | Regional data are also available | Yes | Area, broadleaved-conifers (1993–2001) |
| | 0 | 2000–2005 | FRA2005 | 4200 | 1987–1996 | TBFRA2000 | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 22000 | 1961–1987 | TBFRA2000 | 4653 | 1993–1996 | Report to Parliament 2080/92 | | | |
| | | | | 4875 | 1993–1996 | GAK dataset | | | |
| | | | | 4508 | 1994–1999 | Evaluation 2080/92 | | | |
| Greece | 30000 | 1990–2000 | FRA2005 | 2271 | 1994–1999 | Questionnaire (NAGREF) | Afforestation reported in the questionnaire refers to activities under Reg. 2080/92 in Northern Greece | Yes | Area, tree species (under Reg 2080/92) |
| | 30000 | 2000–2005 | FRA2005 | 4140 | 1991 | Questionnaire (NSSG) | | | |
| | 30000 | 1964–1992 | TBFRA2000 | 1562 | 2001–2003 | Questionnaire (NSSG) | | | |
| | | | | 1559 | 1993–1996 | Report to Parliament 2080/92 | | | |
| Hungary | 11000 | 1990–2000 | FRA2005 | 8489 | 1994–2002 | Questionnaire | | Yes | Area , tree species (2001/2002) |
| | 14000 | 2000–2005 | FRA2005 | 6300 | 1987–1996 | TBFRA2000 | | | |
| | 7200 | 1990–1996 | TBFRA2000 | 5000 | 1990–1999 | NEWFOR | | | |
| | 10000 | 2001 | MCPFE2003 | 20000 | 2000–2035 | NEWFOR | Planned afforestation | | |
| Iceland | 1000 | 1990–2000 | FRA2005 | 1370 | 1993–2002 | Questionnaire | | Yes | Area, tree species |
| | 2000 | 2000–2005 | FRA2005 | 600 | 1990–1998 | TBFRA2000 | Afforestation count for all forest area change | | |
| | 600 | 1990–1998 | TBFRA2000 | | | | | | |
| Ireland | 17000 | 1990–2000 | FRA2005 | 16538 | 1990–2002 | Questionnaire | | Yes | Total forest area and broken down between ownership and forest type, afforestation broken down between |
| | 12000 | 2000–2005 | FRA2005 | 20307 | 1994–1999 | Evaluation 2080/92 | | | |
| | 17000 | 1987–1996 | TBFRA2000 | 17000 | 1987–1996 | TBFRA2000 | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 18000 | 2001 | MCPFE2003 | 17886 | 1990–1997 | Incentives to Expand Forest Cover | | | |
| | 11619 | 1990–2000 | Corine Land Cover | | | | | | |
| Italy | 106000 | 1990–2000 | FRA2005 | 10675 | 1990–2000 | Questionnaire | | Yes | Area, by regions |
| | 106000 | 2000–2005 | FRA2005 | 14644 | 1994–1999 | Evaluation 2080/92 | | | |
| | 30000 | 1980–1995 | TBFRA2000 | 8300 | 1980–1990 | Questionnaire | Under Reg. 269/79 | | |
| | 133333 | 1985–2000 | Questionnaire (NFI) | 10800 | 1994–1998 | Questionnaire | Under Reg.2080/92 | | |
| | 26500 | 1985–1997 | Questionnaire | | | | | | |
| Latvia | 11000 | 1990–2000 | FRA2005 | 467 | 2000–2002 | Questionnaire | | Yes | Area, tree species |
| | 11000 | 2000–2005 | FRA2005 | 0 | 1988–1997 | TBFRA2000 | | | |
| | 12700 | 1988–1997 | TBFRA2000 | 289 | 1998–1999 | NEWFOR | | | |
| Liechtenstein | 100 | 1990–2000 | FRA2005 | 0 | 1975–1995 | TBFRA | | No | |
| | 0 | 2000–2005 | FRA2005 | | | | | | |
| | 80 | 1975–1995 | TBFRA2000 | | | | | | |
| Lithuania | 8000 | 1990–2000 | FRA2005 | 1450 | 1987–1996 | TBFRA2000 | | No | |
| | 14000 | 2000–2005 | FRA2005 | | | | | | |
| | 4800 | 1987–1996 | TBFRA2000 | | | | | | |
| | 12000 | 2001 | MCPFE2003 | | | | | | |
| | 9230 | 1990–2003 | Kairiukstis | | | | | | |
| Luxembourg | 100 | 1990–2000 | FRA2005 | 4 | 1994–2002 | Questionnaire | | | Area, tree species |
| | 0 | 2000–2005 | FRA2005 | | | | | | |
| | 4 | 1994–2002 | Questionnaire | | | | | | |
| Macedonia | 0 | 1990–2000 | FRA2005 | | | | | No | |
| | 0 | 2000–2005 | FRA2005 | | | | | | |
| | n.s. | 1990–1995 | TBFRA2000 | | | | | | |
| Malta | n.s. | 1990–2000 | FRA2005 | 0 | | Questionnaire | | Yes | Tree species |
| | n.s. | 2000–2005 | FRA2005 | | | | | | |
| | 0 | 1993–1996 | TBFRA2000 | | | | | | |
| Moldova | 1000 | 1990–2000 | FRA2005 | 1976 | 1993–2002 | Questionnaire | | Yes | Area, tree species |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1000 | 2000–2005 | FRA2005 | 1200 | 1988–1997 | TBFRA2000 | | | |
| | 650 | 1988–1997 | TBFRA2000 | | | | | | |
| Netherlands | 2000 | 1990–2000 | FRA2005 | 1200 | 1985–1995 | TBFRA2000 | | No | |
| | 1000 | 2000–2005 | FRA2005 | 1625 | 1993–1994 | Report to Parliament 2080/92 | | | |
| | 1000 | 1988–1996 | TBFRA2000 | 896 | 1990–1999 | EFFE report | | | |
| | 1210 | 1996–2000 | National Statistics | 1246 | 1990–1999 | EFFE country report | Fast growing species included | | |
| | | | | 620 | 1990–2000 | UNFCCC | Net-afforestation (deforestation-afforestation) | | |
| Norway | 17000 | 1990–2000 | FRA2005 | 0 | 1987–1996 | TBFRA2000 | | No | |
| | 17000 | 2000–2005 | FRA2005 | 20000 [a] | 1990–2000 | EFFE report | No possible separation between reforestation and afforestation | | |
| | 31000 | 1980–1996 | TBFRA2000 | | | | | | |
| Poland | 18000 | 1990–2000 | FRA2005 | 19857 | 1996–2002 | Questionnaire | | Yes | Area |
| | 27000 | 2000–2005 | FRA2005 | 14450 | 1992–1998 | EFFE report | | | |
| | 11000 | 1987–1996 | TBFRA2000 | 10000 | 1987–1996 | TBFRA2000 | | | |
| | 18000 | 1990–2000 | MCPFE2003 and State of World's Forest 2003 | 18550 | 1995–2000 | Report from University of Poznan | | | |
| | | | | 32000 | 2006–2010 | Report from Univ. of Poznan (projected) | | | |
| | | | | 40000 | 2011–2020 | Report from Univ. of Poznan (projected) | | | |
| | | | | 34000 | 2001–2020 | Report from Univ. of Poznan (projected) | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Portugal | 48000 | 1990–2000 | FRA2005 | 26385 [a] | 1987–1999 | Questionnaire | Under afforestation programmes; rate of burnt area in the same period about 47750 ha $yr^{-1}$ | Yes | Area, tree species |
| | 40000 | 2000–2005 | FRA2005 | 27518 | 1994–1999 | Evaluation 2080/92 | | | |
| | 57000 | 1985–1995 | TBFRA2000 | 29000 | 1985–1995 | TBFRA2000 | | | |
| | 15000 | 1982–1995 | MCPFE2003 | | | | | | |
| Romania | -500 | 1990–2000 | FRA2005 | 576 | 1995–2002 | Questionnaire | | Yes | Area, (groups of) tree species |
| | 400 | 2000–2005 | FRA2005 | | | | | | |
| | 15000 | 1955–1990 | TBFRA2000 | | | | | | |
| Russian Federation | 32000 | 1990–2000 | FRA2005 | 77000 | 1981–1985 | NEWFOR | | No | |
| | -96000 | 2000–2005 | FRA2005 | 14600 | 1991–1995 | NEWFOR | | | |
| | -1100000 | 1988–1933 | TBFRA2000 | 22000 | 1997 | NEWFOR | | | |
| | 135000 | 1990–2000 | State of World's Forest 2003 | 270900 | 1990–2000 | FRA2005 | | | |
| | | | | 306620 | 1990–1999 | UNFCCC | | | |
| Serbia and Montenegro | 9000 | 1990–2000 | FRA2005 | 5500 | 1990–1997 | TBFRA2000 | | No | |
| | 9000 | 2000–2005 | FRA2005 | 2785 | 2000–2002 | Statistical Pocket Book of Serbia and Montenegro | | | |
| | -1450 | 1979–1995 | TBFRA2000 | | | | | | |
| Slovakia | 3701 | 1991–2001 | Forests in Slovakia 2002 | 2600 | 1970–2003 | Questionnaire | Contrasting information on the forest area change after 2000 | Yes | Area |
| | -100 | 1990–2000 | FRA2005 | 300 | 1987–1996 | TBFRA2000 | | | |
| | 1600 | 2000–2005 | FRA2005 | | | | | | |
| | 7000 | 1988–1996 | TBFRA2000 | | | | | | |
| | 18000 | 1990–2000 | State of World's Forest 2003 | | | | | | |
| | 4000 | 2001 | MCPFE2003 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Slovenia | 5000 | 1990–2000 | FRA2005 | 0 | 1986-1996 | TBFRA2000 | Conversion of agricultural land to forest forbidden by law. EFFE report: 1470 ha yr-1 of reforestation in 1994–1999 | Yes | No data on afforestation, data for natural succession only |
| | 5000 | 2000–2005 | FRA2005 | 1470 | 1994–1999 | EFFE report | | | |
| | 2200 | 1986–1996 | TBFRA2000 | | | | | | |
| | 8000 | 2001 | MCPFE2003 | | | | | | |
| Spain | 296000 | 1990–2000 | FRA2005 | 75000 | 1994–1999 | Forest Plantations in Spain (Reg. 2080/92) | | No | |
| | 296000 | 2000–2005 | FRA2005 | 61904 | 2000–2001 | Forest plantations in Spain (Reg. 1257/99) | | | |
| | 86000 | 1970–1990 | TBFRA2000 | 68801 | 1994–1999 | Evaluation 2080/92 | | | |
| | | | | 48031 | 1993–1997 | EFFE report (Reg. 080/92) | | | |
| Sweden | 11000 | 1990–2000 | FRA2005 | 1720 | 1992–2001 | Questionnaire | | Yes | Area, (groups of) tree species |
| | 11000 | 2000–2005 | FRA2005 | 2000 | 1987–1996 | TBFRA2000 | | | |
| | 600 | 1985–1996 | TBFRA2000 | | | | | | |
| Switzerland | 4000 | 1990–2000 | FRA2005 | 1000 | 1985–1995 | TBFRA2000 | | No | |
| | 4000 | 2000–2005 | FRA2005 | | | | | | |
| | 4300 | 1983–1995 | TBFRA2000 | | | | | | |
| Turkey | 37000 | 1990–2000 | FRA2005 | 47060 | 1950–2004 | Questionnaire | Afforestation rate since the 50s | Yes | Area, species (1992–2004) |
| | 25000 | 2000–2005 | FRA2005 | 48729 | 1992–2004 | Questionnaire | | | |
| | 46000 | 1963–1996 | TBFRA2000 | 66000 | 1987–1996 | TBFRA2000 | | | |
| | 16000 | 1999 | MCPFE2003 | | | | | | |
| Ukraine | 24000 | 1990–2000 | FRA2005 | 3216 | 2001–2003 | Questionnaire | | Yes | Area, tree species |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 13000 | 2000–2005 | FRA2005 | 13800 | 1987–1996 | TBFRA2000 | | | |
| | 31000 | 1988–1996 | TBFRA2000 | | | | | | |
| | 50000 | 1970–2000 | NEWFOR | | | | | | |
| United Kingdom | 18000 | 1990–2000 | FRA2005 | 15136 | 1994–2004 | Questionnaire | | Yes | Area, broadleaved/conifers |
| | 10000 | 2000–2005 | FRA2005 | 23513 | 1994–1999 | Evaluation 2080/92 | | | |
| | 20000 | 1980–1995 | TBFRA2000 | 18000 | 1986–1995 | TBFRA2000 | | | |
| | 17000 | 1995–1999 | MCPFE2003 | | | | | | |

[m] The afforestation rate includes reforestation, i.e. restoring forest through planting of trees on forest areas that are degraded or temporarily unstocked.

# 6. DISCUSSION

## 6.1. Data deficiencies

This report has reviewed the available information on afforestation and forest area change in European countries. While there are several data sets available from different sources, it is not always easy to interpret the information, because of the varying definitions of forest and afforestation are applied and the heterogeneous nature of many data sets including, for example, different reference periods. Additionally the majority of data are derived from national inventories which are not conducted in regular coordinated intervals across Europe. If standard reference years are applied, it is therefore necessary to interpolate and often extrapolate information after the last available inventory year with unknown uncertainties.

Nevertheless, this review allowed general trends to be highlighted in different countries. At the same time several gaps and inconsistencies in the information have been recognized.

The data sources range from qualitative to quantitative data and the most detailed are produced by international entities such as FAO, United Nations Economic Commission for Europe (compilations of national forest inventory statistics) and EEA (remote sensing based land use classification/Corine data). The adoption of similar definitions and criteria in the same database gives the advantage of more harmonized data sets all over Europe that provide more consistent information. Parallel or additional data can be obtained from the agricultural sector. The reports on actions inside the Common Agricultural Policy promoting afforestation on agricultural land can give additional information about forest plantations but they often do not give a complete overview of the area afforested within each country.

Several inconsistencies in the comparisons of different databases were identified. In some cases the trends are different, or opposite according to different sources as regards afforestation rates as well as forest area change in a country (for example, Russian Federation). The differences can sometimes be explained by the fact that the data refer to different reference periods. In other cases the reasons are not so obvious. For example, inconsistencies may result from separate responsibilities of national entities which gather and manage the data, so that the information is not harmonized at the national level. Other problems can be connected to the adaptation of national definitions of the criteria elected by international bodies. The definition of forest varies between countries and the harmonization at the European level requires the adjustment to an international definition which may introduce additional errors.

The most important gap in the information is often the lack of separation between forest area change due to natural forest expansion or afforestation activities. The only data

source that provides data on forest area change and the rate connected to planting or seeding is the TBFRA 2000. However this data includes some inconsistencies regarding forest area references between different categories. In addition, the data are not reported for some important countries where forest area change is significant (Spain, Italy, Greece). For these reasons the analysis presented in this report can only discuss trends for afforestation in Europe and give an idea about intensity of afforestation activities but does not provide a complete set of consistent quantitative data. Another deficiency is that the forest area change is usually a net balance without specifying deforestation, afforestation and natural succession as separate processes. Moreover, in the FRA2005 there is a separate data set on the change of plantation forest, but because of a lack of an internationally accepted definition of plantation forests, the increase in plantation forests does not necessarily imply afforestation activities, because natural forests may be converted to plantations and vice versa.

Limited information is provided about the species in the expanding forest areas or that are used in plantations although it is sometimes possible to obtain data on the share of conifers and broadleaves. Additional information about species was obtained from some countries through the questionnaire submitted to national bodies.

The evaluation reports about activities financed under the CAP usually give only partial information, since afforestation programmes can also be developed in the private sector (for example, in Ireland) or because the reports only give information about a single policy action. The figures reported by different sources from the agricultural sector are not collected and harmonized in a unique database and the data often do not correspond to the trends reported in the forestry sector. One of the reasons is that the definition of forest plantation in the agriculture sector is often different from the definition of forest applied within the same countries. In addition the activities financed under the same Regulation can be totally different in different countries. For instance, the activities in Italy financed under Regulation 2080/92 consisted mainly in fast-growing plantations (poplars) that can be reconverted to cropland. On the other hand, in Spain afforestation was financed under the same Regulation in marginal land already abandoned.

## 6.2. Main findings

Due to the limits of the data sources, it was not possible to calculate reliable forest area change and afforestation rates for the different countries, however general trends have been identified concerning forest expansion or shrinking and afforestation (Fig. 2). Similar time periods were considered in order to compare afforestation rates and forest area changes from different data sources.

Trends in forest area in Europe are described in the UNECE/FAO report "The development of European Forest Resources, 1950 to 2000: a better information base" where TBFRA and FRA data were harmonised to obtain a comparable time series over the entire period. A general increase in forest area, broken down by region, is reported for across Europe. According to the report, the most significant development was observed between the end of the Second World War and the 1970s, when substantial economic and land-use changes occurred. However, the forest area is still increasing even if at a slower rate.

Some differences were identified in the harmonized dataset between different regions. The lowest increasing rate was observed in Northern Europe[4] and in the CIS sub-region (Russian Federation) where the overall increase in forest area was roughly five per cent over the analysed period, however most of this increase was concentrated in the first 20 years when intensive afforestation programs and abandonment of agricultural areas took place. Since this time, the forest area in these regions has remained relatively constant . A similar trend was observed, but at a higher rate in the first decades (20 % increase in forest area), was observed in Central and Eastern Europe[5]. The Southern European countries[6] had a total increase of 16 % with higher rates in the first period, but still significant in the more recent years because of abandonment of agricultural area. According to FRA2000, in the period 2000 to 2005, the forest area increased by 0.8 % per year in Greece, 1.1 % in Italy and Portugal and 1.7 % in Spain. The highest rates of increase were observed in Western Europe[7], where the forest area increased by 30 % from 1950 to 2000 at a relatively constant rate over the whole period. The causes of forest expansion are similar across the countries: intensive afforestation programs (for example in UK, Ireland) or abandonment of agricultural land (for example in France in recent years). According to FRA2005 (non-harmonised data) the forest area in Europe increased at a 0.09 % annual rate in the period 1990 to 2000 and at a 0.07 % annual rate in the period 2000 to 2005.

Different proportions of forest area change are ascribable to afforestation activities. As reported in the harmonised dataset, the afforestation programs were mainly developed after the Second World War. Afforestation is still implemented, but at very different rates across Europe. In the following paragraphs a data comparison on afforestation and forest area change rates is developed in order to identify the general afforestation trends in Europe.

In the Mediterranean region, except for Turkey, afforestation has a minor role in comparison to natural succession. The percentage of forest area change due to afforestation varies between countries and according to different data sources, ranging from about five per cent of forest area change to 50 % (in Portugal). The share of forest

4 Denmark, Norway, Finland, Sweden
5 Albania, Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Former Yugoslavia
6 Greece, Italy, Portugal, Spain, Turkey
7 Belgium, France, Germany, Ireland, Luxemburg, The Netherlands, Switzerland, United Kingdom

area in this region is about 25–40% of total land area. As reported in several studies (see Chapter 3 and 4.1), forest expansion in this area mainly occurs due to natural succession on abandoned agricultural land.

In Austria, Bulgaria, Lithuania, Germany, Serbia and Montenegro, Slovakia, Switzerland and Ukraine afforestation also occurs together with land abandonment. The share of afforestation in total forest expansion in these countries ranges between 5–45 %.

In the Baltic region (Belarus, Estonia, Latvia), the afforestation rate is very low (less than five per cent of forest area change), despite the fact that forest area is actively increasing. This also occurs in Slovenia where the conversion of cropland to forest is not practiced. The forest percentage of land area here is around 40–55% (TBFRA 2000).

In other countries, forest area change is mainly connected to afforestation activities, while natural forest expansion does not exist or is very limited. According to the figures reported or the judgement of national expertises, Czech Republic, Iceland, Ireland, Finland, Hungary, Netherlands, Poland and UK have an afforestation rate that accounts for all the forest expansion. In some of these countries an active afforestation policy has been promoted in the past to increase forest resources (for example in Ireland where the forest resources are quite limited according to TBFRA 2000) and some of them are also forecasting intensive afforestation programs for the future. For example, a significant afforestation rate was reported for Hungary in the past and intensive forest planting is also planned for the future (20000 ha yr-1 in 2000–2030). Afforestation activities are also programmed for the next decades in Ireland and Poland.

Variable data are reported for the Nordic countries (Denmark, Finland, Norway and Sweden). In Sweden, for instance, the forest area generally changes at a slow rate and afforestation shows different trends in different periods; before 1990 afforestation rate was larger than forest area change and after 1992 the afforestation counted for only 15 % of forest area change. This could indicate a time lag between afforestation and the point in time when the newly established forest is classified as a forest in the land inventories. The forest expansion in Sweden (and similarly in Finland) in the 1990s is largely a result of the peatland drainage and afforestation programs of the 1960–1980s. In Norway a tendency to reduce afforestation activities (1000–15000 ha/yr) seems to coincide with an increase of land abandonment on marginal lands in more recent years (Petter Nilsen, personal communication).

On the other hand, it must be stressed that deforestation processes can occur at the same time as afforestation activities, as observed in the Netherlands (Nabuurs et al. 2005). In Moldova, Turkey and in minor extent in Croatia the afforestation rate is higher than forest expansion which suggests that deforestation processes are simultaneously taking place in those countries. In some countries, the forest area decreases despite of afforestation

policies promoted by the government. According to some sources, deforestation occurred in Albania, Belgium, Bosnia and Herzegovina, Romania and Russia, but data from other sources or referring to other periods report a constant or increasing forest area. For instance according to FRA2005 the forest area in Albania decreased by -2000 ha y-1 in 1990–2000 while it increased by 5000 ha y-1 in 2000–2005. For the period of 1951–1990 an afforestation rate of 5000 ha y-1 was reported by TBFRA2000.

Forest area change is generally negligible in small countries (Malta, Liechtenstein, Luxemburg), Cyprus and Macedonia. In other areas the data on afforestation were not available or the trends were uncertain because of differences in the figures presented by different data sources.

The afforestation trends presented above are in line with figures reported by the Commission on the activities financed by the Regulation 2080/92 in 1993–1999 (du Breil de Pontbriand 2000) which reported nearly 90,0000 ha afforested on agricultural land, of which over 80 % occurred in Spain, Portugal, United Kingdom and Ireland. An average cost of 1550 €/ha for planting was reported for the EU-15. Additional costs are connected to maintenance premiums (830 €/ha) and compensation for loss of income (2700 €/ha).

Within the afforestation programmes promoted in the CAP, the initial expectations have mainly not been fulfilled and the areas planted are below the initial targets. The report on Regulation 2080/92 confirms that the potential role of afforestation in agricultural areas was considerably over-estimated in the 1980s, since environmental, economic, social and legal constraints were not taken into account. Based on this experience it may be questioned whether the estimated emission reduction targets of 14 $MtCO_2$ from afforestation/reforestation in the EU-15 (Herold 2006) are realistic.

The questionnaire submitted to national entities provided some information on which species were planted in afforestation programs however the accuracy of the data differs greatly between countries. In several cases no information on species was provided, while other countries reported the number of hectares planted per species or per plant category.

Comparisons of the actual forest composition in each country showed that in most cases the afforestation programs tend to favour the increase of broadleaves (Fig. 3). In a small number of countries (30%), the percentage of conifer plantations was higher than the average forest composition in these countries. These countries are mainly those with economies in transition (Bosnia and Herzegovina, Croatia, Romania, Turkey) where timber production is still the main forest function, so that plantation of productive species is still encouraged.

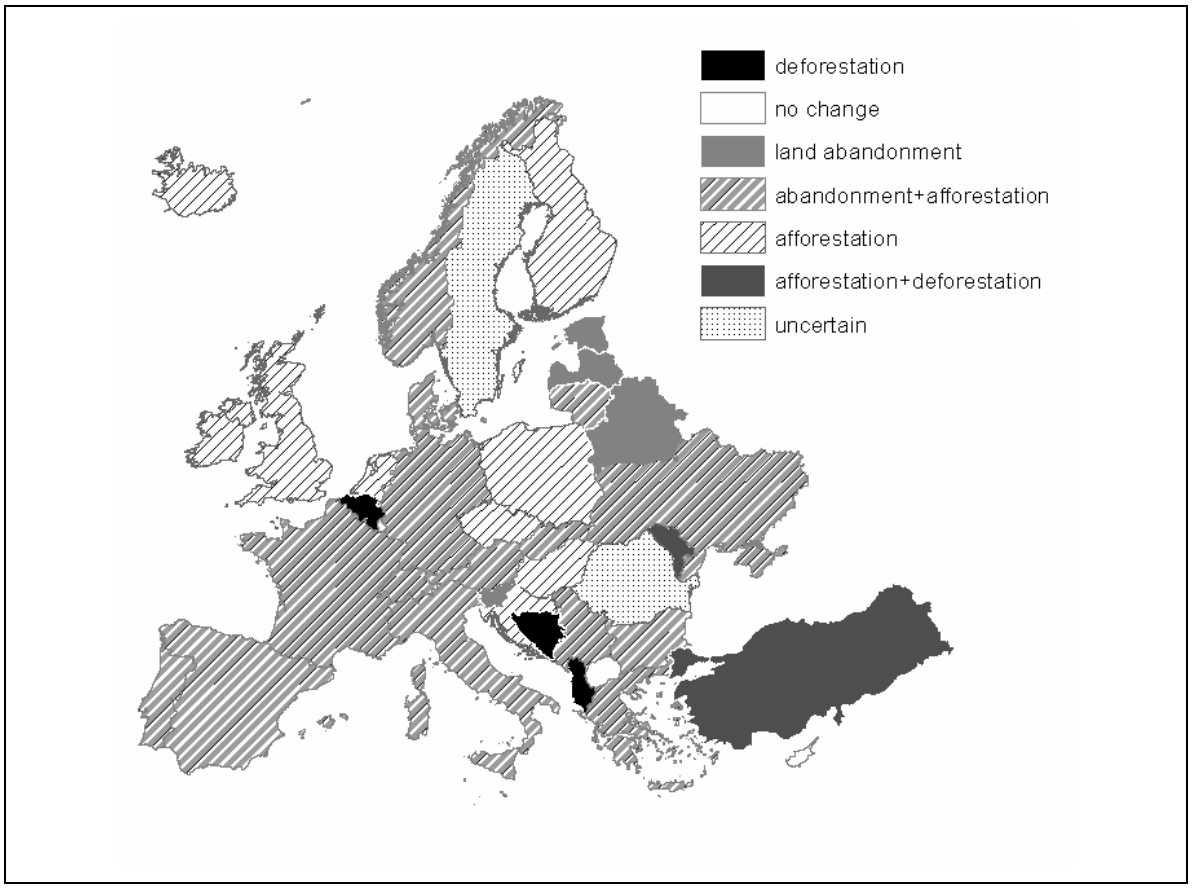


**Figure 3.** Afforestation rates in Europe**.** In some countries, afforestation activities represent all the forest area expansion (afforestation), while in others the increase is partially due to afforestation and partially to natural succession (abandonment + afforestation). In several Baltic countries almost all the forest area change can be ascribed to natural reforestation (land abandonment). Although afforestation programs are developed all over Europe, deforestation processes do occur in some areas. In a few countries, afforestation occurs together with slight deforestation processes, since the afforested area is larger than forest area increase (afforestation + deforestation). In others, the forest area decreases even if planting activities are developed (deforestation). In other areas the trends are uncertain (uncertain). In a very limited number of areas, no forest area change or afforestation activities are seen (no change).

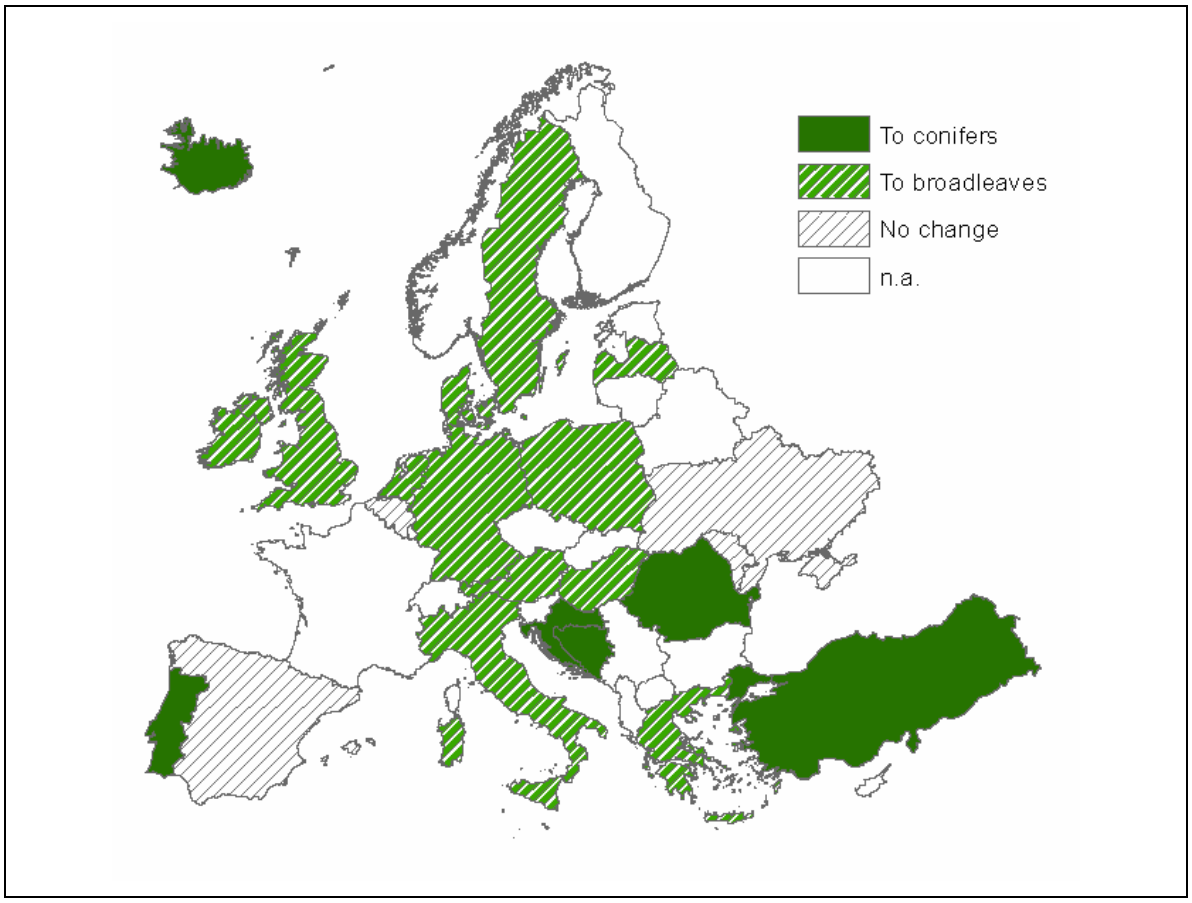


**Figure 4.** Data on species composition in afforestation activities**.** The composition rate of conifers and broadleaves in plantations was compared to forest composition rates in the country in order to understand the qualitative changes in forests produced by afforestation programs. In some countries the forest composition is not modified by plantations (No change), while in others broadleaves (To broadleaves) or conifers (To conifers) are favoured. In several countries data were not available (n.a.)

## 7. CONCLUSIONS, OUTLOOK AND RECOMMENDATIONS

High political and scientific interest in afforestation activities shows that the role of forest area increase in GHG mitigation as well as the influence of forest composition on biodiversity is becoming recognised more and more. The information about forest area change and plantations in Europe is reported by different data sources and a review of available information was needed to understand quantitative and qualitative trends in the forestry sector and to point out gaps and inconsistencies in the monitoring system.

In this report, trends about forest area change and afforestation have been drawn from the different available data sources. In Europe a general increase of forest area is reported, but trends differ between regions. Contradictory information is reported for deforestation processes. Whereas some data sources report forest area decrease in Russia and Romania, others report forest expansion for the same time period. The highest increases in forest area were reported for the Western European countries, in particular for Ireland and the United Kingdom, and for the Mediterranean area (Greece, Italy, Spain, Portugal). Other regions, like the Scandinavian countries, show a more stable forest area in the last decades following a significant increase after the Second World War. However the forest area changes or stable conditions can be due to different processes. Forest expansion in the Mediterranean area is mainly connected to natural succession on abandoned agricultural land, while intensive afforestation programs have been responsible for the forest area change in the UK, Ireland, Hungary and Iceland. Afforestation programs in Southern Europe took place mainly after the Second World War (1950–1970) and have been significantly reduced in the last decades. A stable forest area is sometimes connected to the absence of afforestation activities, for example in the Nordic countries, but it can also be the result of a balance between afforestation and deforestation processes. An example is represented by Belgium where deforestation due to the expansion of urban areas is offset by new afforestation in rural areas. Reports on activities financed within the Common Agricultural Policy confirm the afforestation trends in different regions, but they show also that the rates were lower than the initial expected targets.

Afforestation activities often have a role in improving forest biodiversity by modifying the species composition of the forest. The trend towards increasing the share of broadleaves in the forest can be supported with afforestation of broadleaved and mixed species stands. This is especially the case in the most developed European countries where the environmental and social role of forests is becoming more and more important. On the other hand, the planting of conifers is still sustained in economies in transition where timber production can be important for the national economy.

Several gaps and inconsistencies were recognised in the available data sources. The main problem in reporting on afforestation activities was connected to the deficiency of separation between forest area change due to afforestation and to natural succession.

Reported afforestation rates are often inconsistent between different data sources mainly due to the use of different definitions of afforested area. The data on species composition is also scarce and often limited to the share of conifers and broadleaves.

The value of information about forest expansion could be enhanced with improved communication and harmonisation between different entities responsible for data collection and processing. Uniform definitions of forest and plantation should be developed in order to obtain more consistent data, especially between the datasets developed in the agricultural sector and in the forestry sector. Additional efforts should be made to integrate the data on forestry activities promoted within the CAP. A clear separation between natural forest expansion and afforestation activities and more detailed information on the composition of new forests would enable better interpretation of results for the purposes of policy making in the context of GHG mitigation and biodiversity conservation.

Some recommendations can also be provided on the type of afforestation activities that should be promoted in order to make more progress in meeting the Kyoto Protocol and Biodiversity Convention commitments. Most of the European countries expressed the intention to exclude the agricultural measures of Art. 3.4 for the First Commitment Period (cropland and grazing land management, revegetation) because of high uncertainties in the carbon sequestration potential. Therefore LULUCF activities within Europe will mainly be represented by forestry measures. Unlike forest management, there are no limits to the credits that can be accounted for afforestation and reforestation, so these two activities might assume the most important role between LULUCF activities at the European level in terms of carbon sequestration and required investments. According to the results presented in this report, there may be a large amount of land suitable for new forests. Afforestation should be promoted where the competition with other uses is lower, as in marginal land, in order to encourage permanent land use changes. Costs could be reduced through the promotion of natural vegetation expansion that often occurs in marginal agricultural areas (for example, inclusion of abandoned areas in land use planning). Natural succession should be sustained only when negative effects have been taken into consideration (increased fire risk, erosion, loss of biodiversity, etc.). Multifunctionality of afforestation activities should always be promoted. Afforestation is usually not competitive with measures in other sectors when a single aim is taken into consideration but it can be effective when multiple services are promoted. For this reason, social, economical and environmental aspects of afforestation activities should be evaluated.

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