European Forestry in the Face of Climate Change

EUSTAFOR Guidelines

eustafor

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Executive summary

The forestry sector plays a substantial role in mitigation and adaptation of climate change. EUSTAFOR as an umbrella organisation for state forest management organisations in Europe represents a significant part of Europe's forests. Through carefully planned and coordinated actions by its members, EUSTAFOR can make an important contribution to the adaptation and mitigation of climate change.

The aim of this paper is to provide guidance to EUSTAFOR's members on how forests can be managed to provide maximum benefits in terms of climate change mitigation and adaptation. The most important factor for the whole system is to increase the increament and not the standing volume. The following options are proposed:

1. Conserving and increasing the forest area through afforestation and reforestation activities. With due consideration of site-specific factors affecting carbon sequestration and release both in short and long term, it is possible to increase carbon pools in biomass and dead organic material.

2. Maintaining or improving carbon balance in existing forests, which can be achieved through:

   2.1 improved harvesting systems that maintain species and site-adapted partial forest cover, minimise losses of dead organic matter or soil carbon by reducing soil erosion and by avoiding slash burning;

   2.2 carefully planned and implemented regeneration, tending and thinning operations. The key is to facilitate quick establishment of new forests, to use improved material when planting and to make use of the wood obtained from thinning;

   2.3 forest fertilization and liming hold the potential to significantly increase the production potential as well as to increase the soil carbon storage;

   2.4 reducing risks related to natural disturbances, such as wind, insect and fire damage and forest dieback. The proneness of forests to natural disturbances can be reduced by the choice of suitable provenances, tree species, thinning regimes, designation of fire breaks and controlling soil humidity.

3. Carbon storage in wood products and substitution effects between wood fuel and fossil fuels, or substitution of wood products instead of energy intensive products, such as steel, aluminium and concrete.

Local management strategies must reflect the differences in specific local conditions and factors. For each region local strategies and optimal combinations can be defined by considering relevant criteria such as carbon balance, biodiversity, economic and social services.

I The role of European Forests

From Dr Gert-Jan Nabuurs, Assistant Director of EFI[1]

With some 174 million ha of forest and other wooded land in the EU27, forests play an important role in the European carbon cycle.

Throughout the history of Europe, these forests have been used as a major supply of energy and food, as well as a grazing opportunity. Until the middle of the 20th century, most European forests were heavily depleted of carbon both in the soil and in the above ground bio-mass due to the harvesting of wood and litter.

Since then, forests have been carefully managed as multipurpose systems for wood production, soil and water protection, recreation and conservation. This

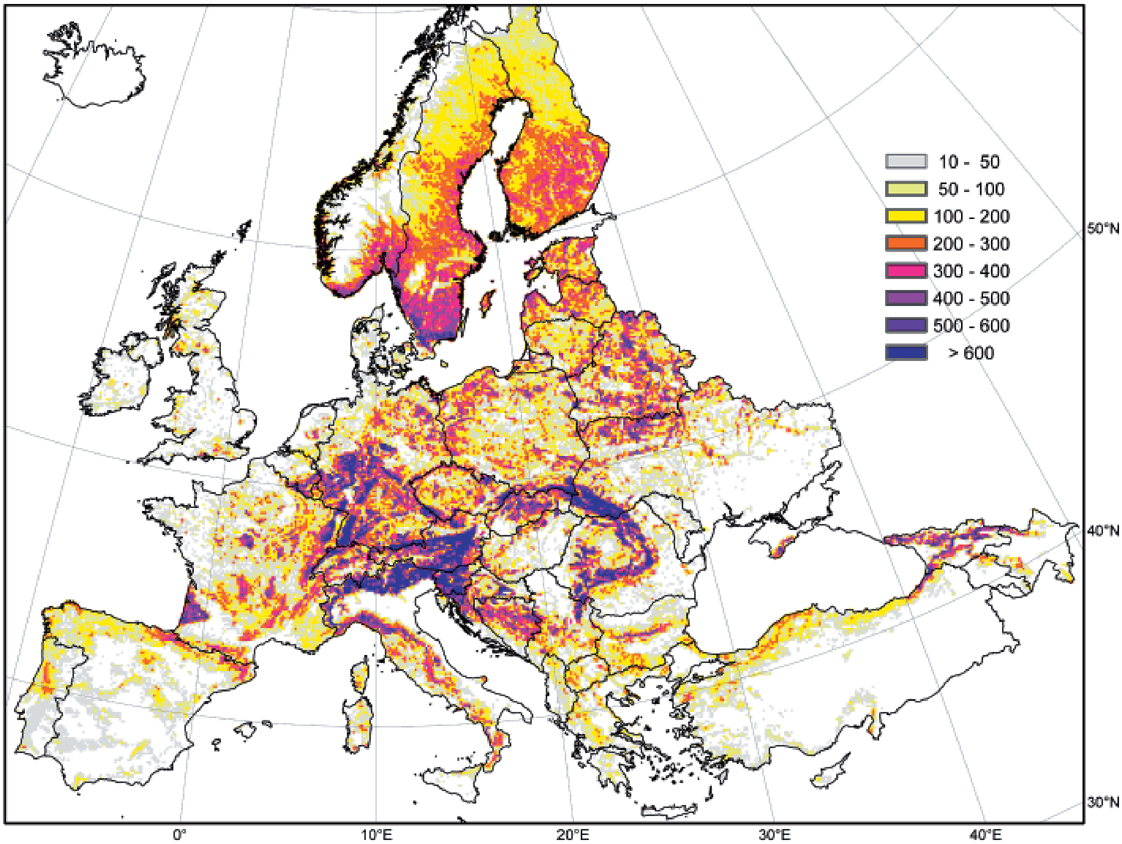


Fig 1: Carbon stock in aboveground forest biomass in 1000 tonnes carbon, oven-dry per 10km by 10km grid-cell.

[1] EFI: European Forest Institute

improvement in silvicultural practice, together with increased fertility, have led to a very significant forest growth across all Europe. This level of growth, together with a harvesting intensity of 60%, mean that these forests currently sequester carbon at a rate equivalent to roughly 10% of EU27 anthropogenic emissions. This is a very significant contribution when compared to the 8% emission reduction target for the EU under the Kyoto Protocol.

European forests belong to the most intensively managed forests in the world. Millions of forest owners make choices in respect of such things as tree species, rotation length and the degree to which dead wood is allowed to occur. These owners therefore play a very significant role in determining the present and future carbon balance of this valuable forest resource. It is this variety in owners, and the variety in ecological circumstances that make the large spatial variation in the current carbon sink (see Fig. 1).

There are indications that this sink capacity could be maintained decades into the future, in accordance with the "buying time" strategy adopted for biogenic sinks. However, the resulting large carbon stocks may also become vulnerable in the near term to losses of carbon from changes in forest management practices such as harvesting after shorter rotations (e.g. for producing biofuel). In addition, drought, windthrow, pathogen attacks and reduced productivity due to climate change, may offset the carbon gains achieved from decades of carbon saving management practices.

European forests have a very important role to play in facing the challenge of climate change. While there is very significant potential to maintain and increase forest carbon sinks, these forests themselves are at risk from the negative affects of climate change. To maximise the potential and minimise the risks, forest owners and managers must devise appropriate local strategies to ensure that we have a sustainable future for our European forests.

The Need for Forest Research

From Dr Gert-Jan Nabuurs, Assistant Director of EFI

The role of European forests in the global carbon cycle may be reasonably understood, but for many forest managers a lot of questions remain. Furthermore the answers to these questions about forest management under climate change will be different across the various regions of Europe. For example:

What specific regional measures are the most beneficial ones, and how to (gradually) adapt my forest management? What are the costs of providing this service to society, what is the likelihood that I get paid for the service, and how does it promote or compromise with other functions of the forest? Are there other objectives that need to be considered e.g. water storage or other forms of adaptation to climate change? Would more intensive management be beneficial, or just the opposite?

What is the economic and ecological effect of more intensive harvesting, slash harvesting, or stump removal (for bio energy) on carbon sequestration? What is the substitution effect of wood products, and through what measures can it be stimulated?

On the opposite: what if I let my forest naturally develop: will the medium term carbon sequestration be counteracted by more natural disturbances in the long term?

These are just few research aspects that point at the need for in depth, regionally specific, research in this field. Forest research, and forest managers should work more closely together in order to solve these questions, and to implement them.

II Background and international context

Climate change is happening and the overwhelming scientific consensus is that it is caused by emissions of greenhouse gases from human activity.

Climate change is affecting the world and our forests in increasing speed and extent. Besides the chances to mitigate climate change by adapted forest management strategies, the EUSTAFOR members have to deal with changes, risks and opportunities that are deriving from the ongoing climate change.

The Kyoto Protocol in its form, valid until 2012, recognises the role of forests as far as sequestrating carbon. But the EU has decided so far to leave forestry out of its Emission Trading System.

The situation was about to change in 2007 when the then forthcoming re-examination of the Emission Trading System directive so called "linking directive"[2], gave member States a clear opportunity to include carbon sequestration capacities of forests in the system via the Joint Implementation (JI) and the Clean Development Mechanism (CDM). The Commission was invited both by the Ministers for Environment during their Council meeting in February 2007 and by the European Council in March 2007 to make formal proposals in this scope.

The legislative package on climate and energy agreed by the European Parliament and the Council in December 2008 seeks to amend the Directive which establishes the EU ETS, but only credits from project types which were accepted by all Member States during the 2008-12 period will be eligible for use: « the Commission has analysed the possibility of allowing credits from certain types of land use, land-use change and forestry ('LULUCF') projects which absorb carbon from the atmosphere. It has concluded that doing so could undermine the environmental integrity of the EU ETS ».

On the other hand, the negotiations of the Kyoto Protocol post-2012 implementation may be redefining the place of forest and forestry.

In 2005, the European Council decided that the global temperature increase has to be limited to 2°C above pre industrial levels. To reach this goal, the EU pursued in the context of international negotiations the objective of a 20%, or if conditions are right, 30% reduction in greenhouse gas emissions (GHG) by developed countries by 2020 (compared to 1990 levels).

As underlined in the IPCC Fourth Assessment (2007), the forestry sector plays a key role in the mitigation of climate change by acting as carbon sinks. In the context of the UNFCCC, forestry represented by a broader LULUCF term, represents the only sector capable of meaningful mitigation actions. In fact, forestry can make a very significant contribution to a low-cost global mitigation portfolio that provides synergies with adaptation and sustainable development.

"In the long-term, sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of timber, fibre, or energy from the forest, will generate the largest sustained mitigation benefit" (IPCC –2007).

The forestry sector cannot solve this problem alone: all other measures (like higher energy effiency, wider use of renewable energy) have to be considered in order to mitigate climate change. Nevertheless it is important that all stakeholders understand that forestry is and has to be a significant part of the mitigation strategy.

At the pan-European level, FOREST EUROPE[3] through the Vienna Resolution addressed the need to enhance contribution of forests to reduce net greenhouse-gas emissions and to encourage sustainable forest management (SFM) practices in carbon sequestration measures.

[2] Directive 2004/101/EC amending Directive 2003/87/EC

[3] the Ministerial Conference on Forests in Europe (MCPFE)

III Guidelines
for carbon conscious forest management

The Guidelines for combating climate change in European state forests (from now on referred to as "the guidelines") form a common framework of recommendations for EUSTAFOR members, focusing on the carbon balance. They come within the framework of the Pan European Operational level Guidelines for sustainable forest management. The guidelines are voluntary and have been developed for the state forests. They support synergies in implementing the United Nations Forum on Forests (UNFF), UNFCCC, CBD, United Nations Convention on Combating Desertification (UNCCD), and other relevant forest-related international commitments.

Locally or regionally adapted solutions will have to be developed to achieve the best results in carbon sequestration while maintaining economic viability and social integrity of forest management.

1. General overview

An extensive body of literature has been produced during the last years about the contribution of the forest sector to greenhouse gas emissions and removals from the atmosphere. Forest regrowth in the temperate zone and parts of the boreal zone leads to an increase in the carbon stocks in forest biomass. In the EU the forested area has expanded in recent years. According to the Annual European Community greenhouse gas inventory 1990–2006 and inventory report 2008 (Submission to the UNFCCC Secretariat), European forests are estimated to have increased as sinks from 344 Mt CO_2 in 1990 to 410 Mt CO_2 in 2008.

Implementing mitigation activities is now possible thanks to the scientific knowledge and existing technologies. Scientific understanding of forest sector mitigation options is sufficient for an immediate implementation. Thanks to appropriate techniques and tools, it is now possible to measure carbon stocks and increment in project areas with increased precision.

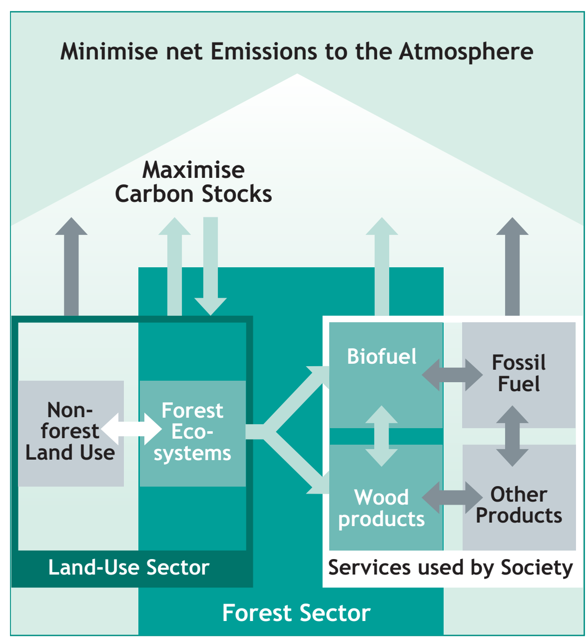


Fig 2: Forest sector mitigation strategies need to be assessed with regard to their impacts on carbon storage in forest ecosystems on sustainable harvest rates and on net GHG emissions across all sectors (IPCC 2007)

In Europe recent analyses show that additional effects of forest mitigation activities could lead to an additionally achievable sink of 90 to 180 $MtCO_2$/yr. Issues in European forestry where mitigation options can be found include afforestation of abandoned agricultural lands, bio-energy from complementary fellings and forest management practices.

Forest mitigation strategies, assessed within the framework of sustainable forest management, include:

- conserving or/and increasing the forest area: reduction of deforestation/degradation and increase afforestation/reforestation activities.
- maintaining or/and increasing the sequestration rate in existing forests (appropriate silviculture techniques, fire management, protection against insects, choosing of ecologically adapted highly productive species …).
- reducing fossil fuel use in forest management activities.
- increasing off-site carbon stocks in wood products and enhancing product and fuel substitution using forest-derived biomass to substitute products with high fossil fuel requirements, and increasing the use of biomass-derived energy to substitute fossil fuels

What are HWP ?

Harvested Wood Products (HWP) are defined as all wood-based material transported from the forest at harvest. Thus products and residues from their manufacture are included, while slash left in the forest is excluded.

Carbon storage in wood products

Wood products have a capacity to store carbon stock that depends on the life span of the product. Wood products in use represent a small stock of carbon, however wood-in-use stocks are growing larger in many countries, and management choices can contribute to further growth in these stocks. The harvested wood decays at rates dependent on their end use. The logged forest may then act as a sink for carbon as it grows at a rate determined by the local soil and climate.

Organising a recycling scheme for wood products with a final energetic use will increase the capacity of our forests for the benefit of CO_2 reduction. It should be the goal to minimize the unused (useless) decay of wood and wood products.

Wood products and fuel wood: substitution effects

Utilization of wood allows reduced use of fossil fuel by utilizing the wood either directly for energy production or replacing energy-intensive products such as steel, aluminum, plaster board… The important impact of an increased use of wood products on the mitigation of climate change is the substitution of more energy-intensive products. Furthermore, forests can serve directly or indirectly as a provider of biomass for bio-energy. This can be in the form of harvest residues, fuelwood, waste within the production process, or discarded products. Through optimized use of forests to substitute non-woody materials and consistent reuse of discarded material for the efficient generation of heat and energy, forests can optimally contribute to the reduction of atmospheric

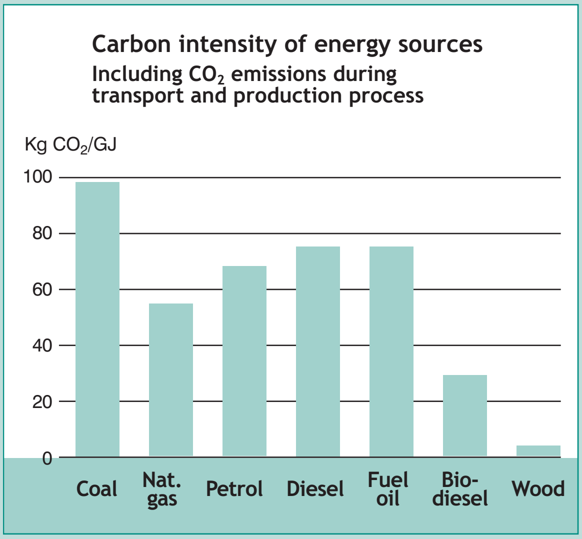


Fig 3: Carbon intensity of energy sources
ECCM (Edinburgh Center for Carbon Management) 2004

CO_2 emissions. Using biomass for bio-energy will not increase carbon stocks in the forest, but will permanently reduce the emissions from fossil fuels within the energy sector.

In an improved system, energetic use will be made of the used wood at the end of its product lifecycle, again replacing coal, oil or gas. Greater emission reduction can be obtained if the lifecycle of a wood product is extended by cascading, in which both material and fuel substitution are utilized.

Increased carbon storage in the biosphere yields benefits, but over time greater mitigation is possible by managing the full life cycle system including the production and use of biofuels and other products.

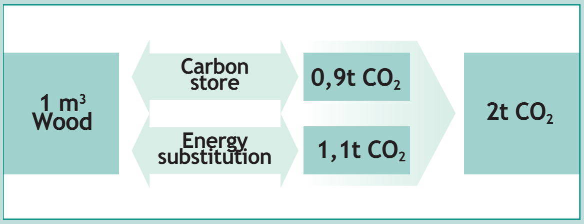


Fig 4: Total CO_2 saving from combined carbon store and substitution effect
Dr A Frühwald, University of Hamburg, Centre of Wood Sience and Technology, October 2002

The above strategies could be very usefully applied in order to mitigate climate change. Managed forests have more chances to participate in the mitigation efforts connected to the limitation of climate change than unmanaged or even pristine forests. Additional sequestration of carbon dioxide in wood products and specifically the substitution effects of wood against other material (brick, concrete, aluminium) dramatically increase the role of forests in the fight against climate change.

Each mitigation activity has a characteristic time sequence of actions, carbon benefits and costs. Relative to a baseline, the largest short-term gains are always achieved through mitigation activities aimed at emission avoidance (e.g., reduced deforestation or degradation, fire protection, and limited slash burning). But once an emission has been avoided, carbon stocks on that forest will merely be maintained or increased slightly. In contrast, the benefits from afforestation accumulate over years to decades but require up-front action and expenses. Most forest management activities aimed at enhancing sinks require up-front investments. The duration and magnitude of their carbon benefits differ by region, type of action and initial condition of the forest.

Reduction in fossil fuel use in forest management activities, forest nursery operations, transportation and industrial production provides additional opportunities similar to those in other sectors and should also be considered.

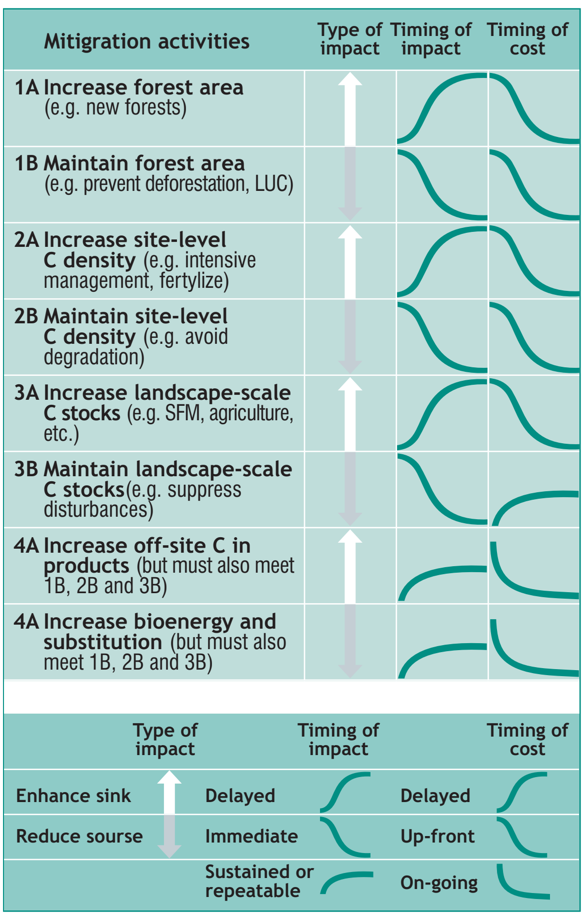


Fig 5: Generalized summary of forest sector options and type and timing of effects on carbon stocks and the timing of costs (IPCC)

2. Afforestation / reforestation activities

Impact of Afforestation/ reforestation on carbon balance

Afforestation typically leads to increases in aboveground biomass and dead organic matter carbon pools, and to a lesser extent, in soil carbon pools. Biomass clearing and site preparation prior to afforestation may lead to short-term carbon losses on that site, but regionally adapted forest practices can limit these carbon losses. On sites with low initial soil carbon stocks (e.g.after prolonged cultivation), afforestation can be characterized by considerable soil carbon accumulation rates (rates of 1 to 1.5 t CO_2/yr). Conversely, on sites with high initial soil carbon stocks, (e.g. some grassland ecosystems) soil carbon stocks can decline following afforestation. Above the ground, accumulation of carbon in biomass after afforestation varies greatly by tree species and site, and ranges globally between 1 and 35 t CO_2/ha/yr.

International agreements about afforestation/ reforestation activities

The need for reduction of carbon dioxide emissions was highlighted in the United Nations Framework Convention on Climate Change (UNFCCC, 1992). The article 3.3 of the Kyoto Protocol and Marrakesh Accord to the UNFCCC obliges Parties to account for net emissions associated with the afforestation and reforestation activities. In addition, these activities can be used for enhancing the effectiveness of the mitigation actions within the Clean Development Mechanism according to the Marrakesh Accord. The Convention on Biological Diversity (CBD) stresses that activities targeted at carbon sequestration should be conducted in accordance with the conservation and sustainable use of biological diversity and the potential impact of afforestation and reforestation on forest biological diversity and other ecosystems should be addressed.

In the Kyiv Resolution on Biodiversity, the European Ministers of Environment agreed to implement the objectives and activities of the Framework for Cooperation between the FOREST EUROPE (formerly MCPFE) and the Environment for Europe/Pan European Biological and Landscape Diversity (EfE/PEBLDS), which included the elaboration of "Recommendations for site selection for afforestation" in the context of the decisions of the UNFCCC and its Kyoto Protocol.

FOREST EUROPE recommendations for site selection for afforestation activities

The Pan-European policy recommendations provide guidance for implementing economically viable, environmentally sound, and socially equitable and culturally acceptable afforestation and reforestation activities and projects. Furthermore, they address specific Pan-European issues in balancing afforestation needs, needs of other land-users and the conservation of sites of high ecological, landscape and cultural value.

The main FOREST EUROPE recommendations for site selection for afforestation activities are the following:

- To use the Pan-European Criteria and Indicators for Sustainable Forest Management as well as the Pan-European Operational Level Guidelines for SFM.
- To ensure that, at the stand and landscape level, afforestation and reforestation projects maintain or improve the provision of ecosystem goods and services and meet biodiversity and sustainable livelihood objectives.
- To ensure that all wood production including short rotation and fast growing plantations is guided by the principles of sustainability.
- To promote the development of afforestation and reforestation projects that benefit both biodiversity conservation and climate change mitigation.
- To promote afforestation and reforestation with native tree species or provenances of species well adapted to site conditions now and in the future.
- To promote afforestation and reforestation projects that also enhance economic and social well-being of local communities, including workers and contractors.

Forest certification

Critical side effects of afforestation projects can be avoided by the world wide accepted certification schemes. By following the certifications rules, the project proves not only its positive climate impacts but also that it is economically, ecologically and socially sound.

Deforestation and afforestation/reforestation in developing countries

Deforestation in the tropics (Africa, Asia, and South America) is responsible for a significant amount (around 20%) of the global CO_2 emissions. European State forest managers can provide their competence via international aid projects to improve public forest management in developing countries with long-term objectives to halt deforestation, forest degradation and to expand forest area.

3. Maintaining or improving carbon balance in existing forests

Management can influence the carbon balance in forests. Forest management activities influence carbon pools, fluxes, and productivity on-site, either directly by, e.g. transferring carbon from ''live growing stock'' to the ''product'' pools (e.g. thinning, final harvesting), or indirectly by altering growth conditions of trees (e.g. liming, fertilizing, balancing local hydrological conditions). The effects can be instantaneous (e.g. thinning), or slowly ''evolving'' (e.g. fertilization). Activities may affect the current stand (e.g. thinning regime), or future stands (e.g. regeneration), or they are transient (e.g.minimizing site preparation, planting). Economic considerations are typically the main constraint, because retaining additional carbon on site delays revenues from harvest.

Furthermore, the impacts of an activity may be clear at the stand scale, but may be different at the landscape scale. The Landscape-level carbon stock changes are the sum of stand-level changes, and the impacts of forest management on carbon stocks ultimately need to be evaluated at the landscape level.

Soil emissions

In general, a forest stand acts as a carbon source for some years after final harvest or thinning. In this period, the rate of decomposition of slash on the ground is higher than accumulation of carbon in the vegetation and soil. Furthermore, the soil temperature may go up in the open spaces, and the decomposition of soil organic matter may increase. Regeneration regimes can be characterized by a degree of canopy cover removed in one cut. This can range from a selection silvicultural system (e.g. nature oriented management) to a clearcut.

Forest management activities to increase stand-level forest carbon stocks and increment include harvest systems that maintain species and site-adapted partial forest cover, minimize losses of dead organic matter (including slash) or soil carbon by reducing soil erosion, and by avoiding slash burning and other high-emission activities.

Moderate drainage can lead to increased carbon accumulation. Drainage of non-mineral forest soils, and specifically of bogs, may lead to substantial carbon loss due to enhanced respiration. Drainage of forest soils will be limited to maintain stand stability and specifically to secure young stands. Choosing of adapted species can help to reduce drainage necessity.

Regeneration regime

Planting or sowing of site-adapted and/or improved material after harvest or natural disturbances accelerates tree growth and, consequently, increases carbon sequestration. Natural regeneration, including permanent forest cover, can be used effectively as well. Regional possibilities for different regeneration methods should take into account climate change considerations.

Tending (weed control)

Tending is defined as all management activities in the forest after regeneration up to the moment of the first (commercial) thinning. Trees and weeds cut in tending operations are usually not removed from the site. Part of the decomposition of their foliage, stems, and roots increases soil carbon content. Additionally weed control by, e.g. soil scarification, could result in the loss of soil carbon due to accelerated decomposition of organic material and wind and water erosion. Nevertheless scarification could be positive in the long run thanks to increased increment and increased carbon sequestration. Tending practices of young stands have to be regionally adapted and include considerations of soil fertility and carbon fluxes.

Thinning

Thinning is an active reduction in stem number during the rotation of a stand. The aims of thinning include enhancing the growth of the remaining trees, obtaining early income from wood production, influencing the tree species composition or forest structure, and selecting for stem quality. Thinning can roughly be characterized by type (systematic or selective), direction of approach (from below or from above), recurrence interval, and intensity.

The appropriate thinning regime needs to take into account the following different objectives:

- to enhance the production of harvestable biomass,
- to enhance carbon sequestration in forests,
- to enhance forest stand stability (snow, storm, fire) and following that production capacity.

Changing climate will affect the given species composition and growths to the better or worse. While in the boreal forests in Europe an increase of growth might occur, in the southern part of Europe change in growth and species composition might be hurtful to the forest owner and society. Already weak growth and high fire danger might require more intense thining strategies and change of species composition towards less productive species. The reduction of the actual level of growth per hectare will not only affect the income of the owner but it will also influence the provision of all forest functions. In some areas, future site fertility will be defined by average periods of summer drought. A higher reduction of stem might result in a higher production of grass and weeds and connected to a higher fire danger. The intensity of forest management activities will rise.

Relations between management and the carbon balance

Maximization of wood substitution can also conflict with attempts to optimize carbon sequestration in forests. Normally, the maximization of (time-averaged) carbon stocks in a system composed of managed forest ecosystems and solid wood products leads to a longer forest rotation period with lower biomass production and lower substitution potential (but increased risks for fire or storm could point to shorter rotation periods). The relation between rotation period and maximal carbon stock is complex.

Carbon sequestration in forest biomass is a limited option because it can reduce the net CO_2 emission only as long as the carbon stocks in a forest area are increasing. Saturation of biomass stocks will eventually take place, and the stock level must then be preserved to avoid any release of stored carbon. Increased harvesting from existing forests will lower the average growing stocks, and thus reduce susceptibility to storms, an adaptation measure. The most important factor for the whole system is to increase the increment and not the standing volume. Increment that increases over time, producing more harvestable wood that can be used, while maintaining or even expanding a substantial carbon stock in the forest, would be the best option.

Substitution, on the other hand, is a sustainable option that can be utilized continuously, leading to permanent and cumulative emission reductions. This increased attention for biomass for bio-energy will influence the strategy on how to make optimal use of the forest in combating the greenhouse effect.

Regarding greenhouse gas emissions and uptake, one has to be aware of the difference between decay of organic material in unmanaged forests and use of wood in managed forests including extended lifecycle of wood materials and substitution effects.

Forest fertilization and liming

Fertilization is the artificial application of nutrients to the forest. Its aim is to increase biomass production, to compensate for nutrient losses due to the removal of logging residues for bio-fuel and nutrient leaching, to counteract imbalances caused by acid deposition (sulphur, nitrogen), and to improve stress tolerance. Depending on the situation and aim, fertilization can be done with pure N, mixtures of for example NPK, in the form of liming or wood ash application.

The effect of fertilization depends on the nutrient state of the forests. Boreal forest ecosystems in Europe are usually nitrogen limited and a single nitrogen application of 150kg N / ha can effect an increase in carbon sequestration of 10 to 25 t CO_2/ha, this effect lasts for 8 to 10 years. Bergh et al. (2005) calculated that the biomass production potential in Norway spruce forests in Sweden could be increased by 100–300%. In

Central Europe the substantial net carbon sequestration by many temperate forests appears to be partly determined by the additional input of N induced by human activities: nitrogen is no longer a limit due to atmospheric input. In parts of Denmark, and Central and southern Europe other elements such as P, K and Mg can increase the growth rate of forests on mineral soils.

A meta-analysis showed that overall fertilization increased soil carbon storage due to increased litter production and reduced soil respiration.

Nevertheless, the potential benefits of carbon sequestration can be diminished where increased use of fertilizer causes greater N_2O emissions.

Reducing risks to natural disturbances

Wind damage: Management activities to reduce wind damage are to increase the stability and to decrease the size of the stock at risk. Important options for increased stability are the following: carefully designed thinning regimes, adapted rotation periods and carefully planned fellings in order to minimize the length of exposed edges.

Tree species choice also plays a decisive role in stand stability. Especially Norway spruce and Sitka spruce are known to be sensitive to wind throws on certain sites.

Reducing the stock of the forest estate that is under risk would for example involve a choice for shorter rotations, where stands are harvested before they are exposed to wind risk. Avoiding wind damage clearly has not only stand level aspects, but also landscape level aspects.

Management activities connected to rotation age are driven by general and local environmental and economic considerations, wood market requirements and forest owners' wishes.

Insect damage: Climate changes affect the ecological sitution in the forest and specifically the resistance of trees against insect attacs.

Spruces are known to be more vulnerable to bark beetle damages in case of hot, dry summers. The expected changes in climate affect the forest ecosystems in two ways: firstly, it will increase insect fertilty (up to three generations of bark beetles per year will form a sizeable danger), and secondly, it will decrease the chances of trees to fight against the attacs by producing resin and drowning the beetles.

Similar mechanisms increase the expected damages by insects browsing on the needles of pines in our European forests. The expected situation will lead to changes in species composition of forests both for needle and broadleaved trees.

Fire damage: The main influence forest management can have to decrease forest fire risk is by manipulating the fuel characteristics.

A very important measure is to disrupt the continuity of the fuel, both within stands (open forest) and between stands (fire breaks, variation in stand characteristics). Planning at the landscape level is very important. Futhermore, a more intense harvesting regime (production of fuel wood for instance) might in some areas reduce fire risk.

The amount of fuel can be reduced by prescribed burning, or by active removal. Other management options are to manage the forest to create an open structure

(combined with removal of felling debris) or to change tree species to less flammable species. Tilman et al. (2000) found a fire suppression effect of 1.8 Mg C / ha / year over a 35-year period in an oak savannah in Minnesota. This increase was mainly attributed to increased carbon stocks in woody vegetation and litter; effects on soil were not significant. Apart from these more direct effects of fire suppression, the long-term impacts on succession are more significant, but difficult to quantify.

Dieback: The release of greenhouse gas by human activities results in global warming. In Southern Europe, climate change is very likely to have negative impacts by increasing risk due to more frequent heat waves. Depending on the species, apply a more dynamic silviculture could lower the basal area (lower Leaf Area Index) and reduce water stress. A substancial increase in humidy level in soils (especially in drained forest soils) could lead to dieback and decrease of increment, which is why it is also important to control humidity level.

Advantages of species mixture: Some studies indicate the importance of the choice of locally adapted species. The general changes in forest ecosystems functionning that are likely to occur or are already occuring should be taken into account as far as possible (longer growing season, shift to the North of species range …). Identify the species-site combination threatened by climate change and carefully choose species and provenance (using provenances and species in their optimal ecological conditions). Favouring species mixtures, as opposed to monocultures, helps to achieve ecosystem plasticity and resilience which in turn brings about meaningful adaptation and mitigation benefits.

Species mixture: impact on forest production

A positive effect of species mixture on forest production may occur when species make different use of available resources, either in space or in time. Differentiation in time can be achieved by mixing species with different growth patterns. Differentiation in space can be achieved by mixing species with different shade tolerance within a stand, or by mixing group-wise or stand-wise at the landscape level.

Nota Bene: The above paragraphs are based on recent scientific publications (see the list below).

Nabuurs, Thurig, Heidema and al. ; *Hotspots of the European forests carbon cycle* ; Forest Ecology and Management 256 (2008) 194–200

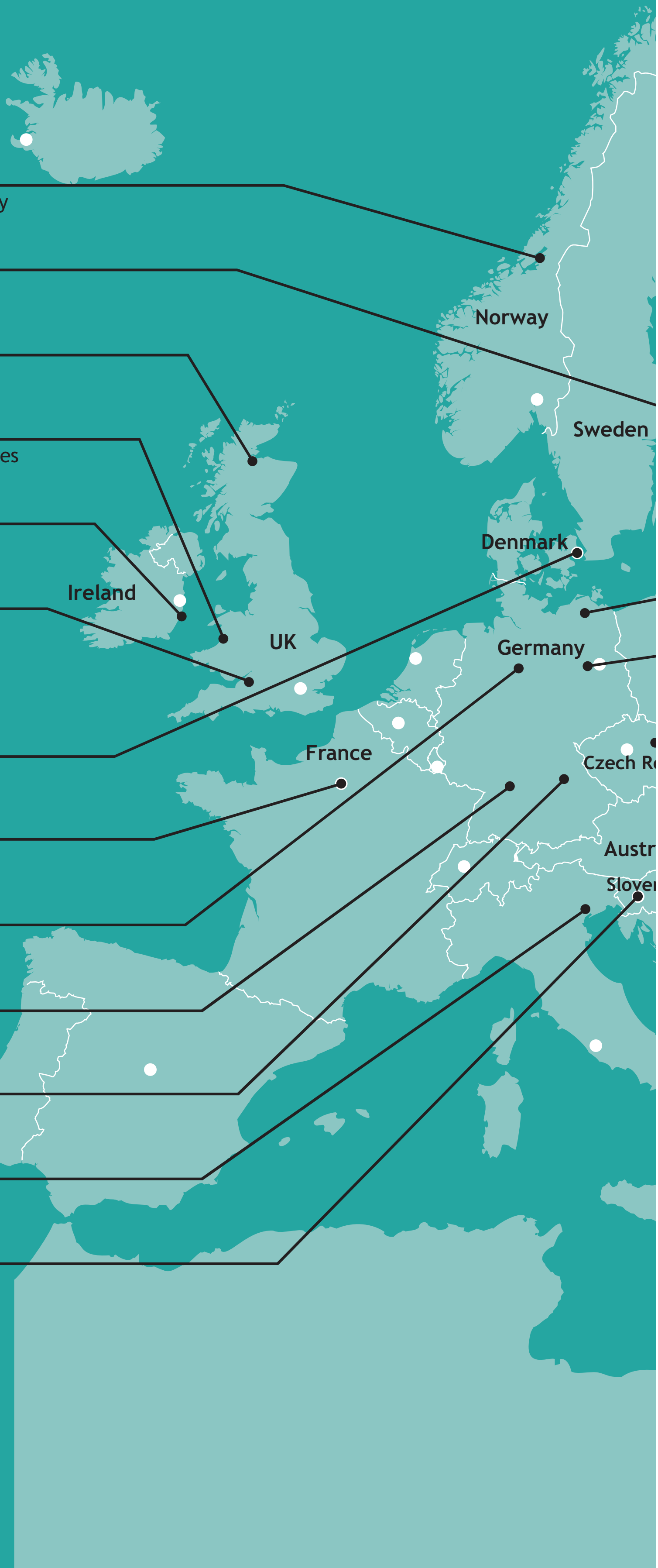
Gustavsson, Pingoud and Sathre ; *Carbon dioxide balance of wood substitution: comparing concrete- and-wood-framed buildings* ; Mitigation and Adaptation Strategies for Global Change (2006) 11: 667–691 _C Springer 2006

IPCC, 2007 ; *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (METZ B., DAVIDSON O.R., BOSCH P.R., DAVE R., MEYER L.A. (eds)), ; Cambridge University Press ; 2007; 851p.

Tupek, B., G Zanchi, P J. Verkerk, G Churkina N Viovy, J K. Hughes, M Lindner. 2010 ; *A comparison of alternative modelling approaches to evaluate the European forest carbon fluxes* ; Forest Ecology and Management 260: 241-251

Zanchi, G., N Pena, and N Bird. 2010 ; *The upfront carbon debt of bioenergy* ; Joanneum research. Graz. 54 p

Members



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Pobox 433, Th.Sommerschields gate 5, 7801 Namsos Norway
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Sveaskog AB
Torsgatan 4, SE-10522 Stockholm Sweden
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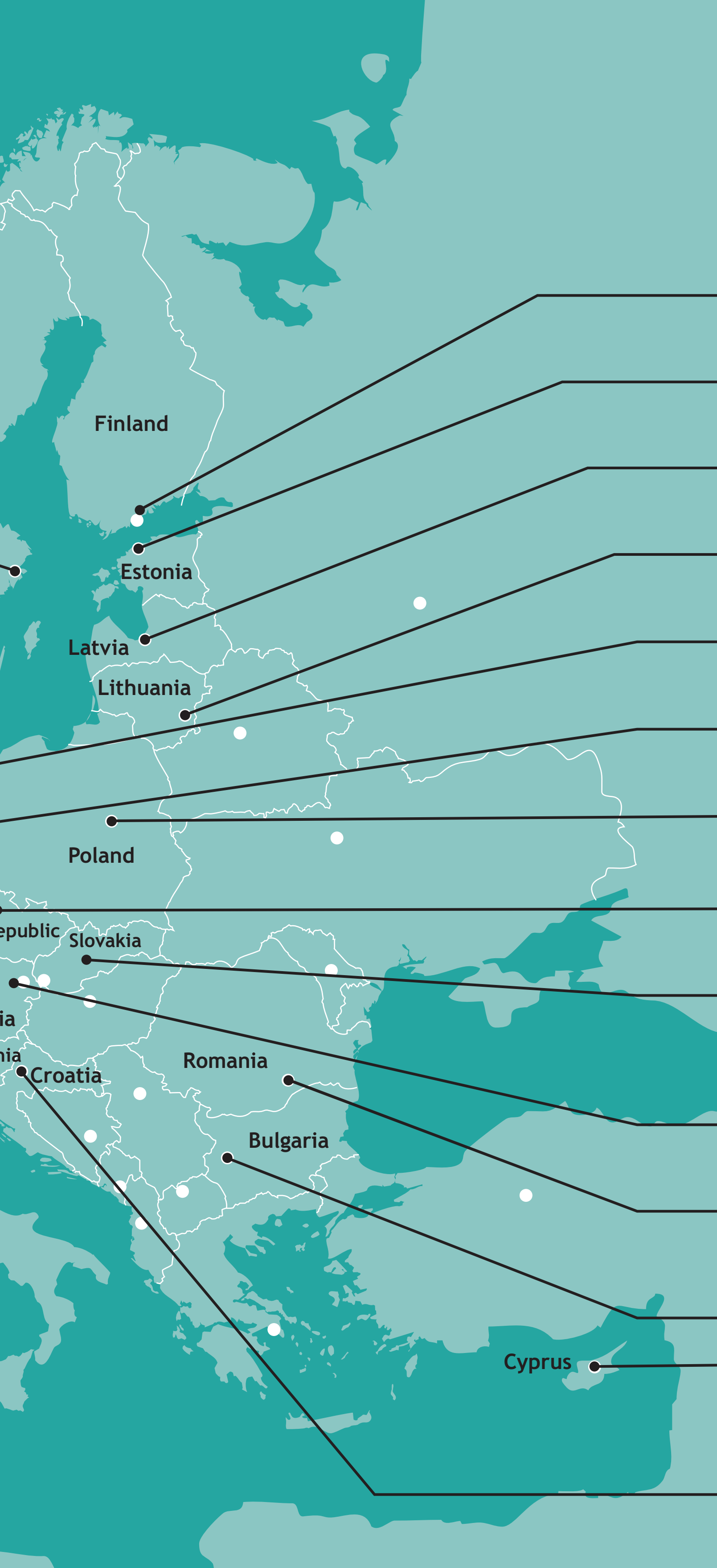

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IV Examples of best practice
relating to mitigation and adaptation activities in forestry across Europe

The following chapter provides information and examples on the adaptation and / or mitigation activities that individual members of the EUSTAFOR are currently carrying out. It does not attempt to evaluate the effectiveness of activities nor does it compare countries' activities with each other. Economic and political circumstances and the interpretation of relevant European as well as domestic frameworks are distinctively different in each country. In addition, the structure, size, etc. of the forestry and timber sectors in member states is also country-specific. Therefore a comparison of the activities would not be appropriate.

Climate change has already had an effect on forestry, e.g. altered species viability, increased wind blow and pest / disease incidences but also increased annual increment, and therefore informed actions are needed without delay.

Most of the submitted information was on adaptation activities, these activities ranged from technical solutions for maintaining the carrying capacity of forest soils and roads, to educational campaigns and knowledge transfer, to identifying and mapping the levels of vulnerability of forest species to water stress, to developing the woodfuel resource and to protecting forests against fires. However, most partners were involved in adjusting their woodland management practices by for example, moving from monocultures to mixed-species stands, adjusting species range and ratio as well as altering thinning and harvesting practices.

Mitigation projects included activities such as optimising carbon storage in forest biomass and soils, establishing 'carbon sinks' methodologies, afforesting degraded agricultural land, increasing forests' annual increment, improving the hydrologic balance of forest soils and devising emission trading schemes.

Some of the activities outlined in the case studies, though very innovative and appropriate for the initiating member, would not be transferable to other countries for various reasons.

Some projects have set up public- private partnerships with other sectors and hence placed forestry into a much bigger context of land-use.

The outcomes of many of the activities will only become apparent in the long-term (>10 years). Considering the current emphasis on 'quick wins' and short-term thinking it might be difficult to maintain the financial longevity of some of the projects. Emission Trading Schemes for forestry could provide a solution in some cases by providing a lasting income to forest / project owners.

Brief outline of individual case studies

Table below provides a brief outline of each case study with detailed information on activities / best practice (in alphabetical order).

Country: Austria
Activity: Adaptation
Key words: Vulnerability, Adaptive management schemes
Contact: Alexander Horst
Brief description of the activity: ADAPT project

The project aims to evaluate the vulnerability of sustainable forest management strategies concerning climate change. Objectives are to

a.) Identify site/stand conditions where the current sustainable forest management regime is vulnerable to climate change;

b.) Propose optional adaptive management schemes for vulnerable site/stand conditions; and

c.) Transfer knowledge on vulnerabilities and adaptive options to operational staff of ÖBf AG. Nine different soil types in 25 bioclimatic regions were included in the analysis. Different vulnerability indicators such as productivity, timber/carbon stocks, biodiversity, disturbances, tree species' conditions in their fundamental niche, silvicultural flexibility and cost intensity were chosen and forest performance assessed.

Results to date show high forest vulnerability, particularly by the second half of the 21st century (39.6% of the assessed forest area). The study has highlighted the importance and potential advantages of timely adaptation to maintain the provision of wood products / services within a sustainable forest management scheme.

Temporary and temporal vulnerability as well as remaining vulnerabilities within adapted programmes emphasise the importance of adaptive management cycles in addressing climate change. The chosen approach will allow ÖBf AG to integrate effects of climate change in the company's multiple forest management objectives and its organisational preferences, and spread risk.

Country: Bavaria (Germany)
Activity: Mitigation / Adaptation
Key words: Vulnerability, adaptive management schemes, mixed-species forests
Contact: Kay Müller
Brief description of the activity: Integrated forest management programme

This programme covers three parts:

- Adapting forest management practices that are based on continuous change being the norm rather than the exception and support the creation of 'elastic', mixed-species forests that are adapted to climate change. These new practices will be integrated into existing forest management and planning.

- Ensuring that woodfuel related harvesting and management practices are sustainable and have no bad effects on forest soils and tree growth.
- Scenarios on risk for different tree species – 'Maps for the future'.

Approximately 90,000 ha have already been converted from pine monoculture stands into mixed-species stands, predominately by specific management of natural regeneration of spruce, beech and fir. The current programme covers additional 165,000 ha of which 2/3 will be afforested through natural regeneration and 2,000 ha are replanted annually as a mosaic of small blocks. Consequently, the entire public estate will be converted to mixed-species/-aged forests within the next 25 years. Results on adapting management and harvesting practices in relation to woodfuel will be available in the near future.

The 'Maps for the future' are based on climate scenarios. They describe risks, e.g. reduced water availability, for different tree species looking 50-100 years into the future. Monitoring of the project is carried out annually and once per decade by comparison of in-house data on species composition in state forests. During the annual species inventory, the 41 administrative sections of BaySF and the Biomass Department are introduced to the new management programme.

Country: Finland
Activity: Adaptation
Key words: Soil protection
Contact: Johanna Leinonen
Brief description of the activity: Maintaining the carrying capacity of forest soils and roads

Finland is situated in the boreal coniferous zone. Half of the timber stock consists of pine (*Pinus sylvestris*) and other common species are spruce (*Picea abies*), downy birch (*Betula pubescens*) and silver birch (*Betula pendula*).

This project aims to address the decreasing carrying capacity of forest soils and roads as this causes serious problems for continuous and flawless timber haulage. The objectives of the project are to:

a) Improve the carrying capacity of the forest machines.

b) Strengthen the structure of the forest roads.

The outcome of the project is a guaranteed timber supply to the timber processing industry under a continuously changing harvesting and haulage environment.

Finnish timber is supplied all year round. As winters are getting shorter due to climate change timber haulage cannot rely on the frozen ground to the degree it did in the past. More timber haulage has to be carried out on soft ground/soils resulting in deep depressions on timber haulage tracts and breakdown of forest roads. Therefore increasing haulage costs are the implication of shorter winters. The problems typically occur on more fertile, moist/wet soils across Finland and hence this is a country-wide adaptation initiative.

Improvement of the carrying capacity of forest machinery and strengthening road constructions are proposed as possible solutions.

The project activities are continuously developed following the principle of 'learning by doing'. For example, road maintenance/construction does not involve the development of any new technology but simply requires the strengthening of the frames of the roads as ice and frost cease to provide structural support. The development of forest machinery is carried out in collaboration with the machinery manufacturer Ponsse and is based on engineering and continuous testing. Once tests indicate that improvements have been achieved the machinery is trialled during standard production work.

Country: France
Activity: Example Mitigation
Key words: Improvement of carbon balance, Carbon sinks, Carbon methodologies
Contact: Marianne Rubio
Brief description of the activity: The Carbon Forestry project

The project aims to provide an answer to how 'Forestry practices by the forest and wood-based sector could optimise carbon storage and result in reductions of greenhouse gas emissions'. Objectives are:

a.) Strengthening knowledge about the carbon balance of forest management,

b.) Identifying silvicultural options which improve the carbon balance in forests,

c.) Establishing 'carbon sinks' methodologies that could be used as a basis for remuneration through 'carbon values'.

ONF selected ten pilot forest projects corresponding to the most representative forestry management types in France. INRA-AgroParisTech's Laboratory for the Study of Forestry and Wood Resources translated existing models on growth into carbon sequestration data. INRA demonstrated that growing naturally regenerated forests on agricultural soil or grass lands enabled carbon storage whatever the forestry management.

The silvicultural management scenarios which are favourable to increasing carbon sink in wood products are those enabling the production of large quantities of quality wood, destined for the construction or secondary processing sectors.

Country: France
Activity: Example 1 Adaptation
Key words: Adaptive management schemes, regional guidance, thinning regimes, harvesting criteria
Contact: Marianne Rubio
Brief description of the activity: Haute Normandie

Regional guidance on thinning regimes and new harvesting criteria. This project aims to redefine the harvest criteria in accordance with silvicultural practices and changes in productivity. This means that the rotation period for:

a.) Beech will be reduced to 100 years (currently it is 120-140 years),

b.) For oak (*Quercus petrae*) it will be reduced to less than 200 years.

While preparing the regional forest management planning directives for state forests (DRA) and the regional forest management schemes for community-owned forests (SRA), ONF conducted an overall review including effects of climate change on forestry in this region.

Currently, 60,980 ha of public forests are located in the Haute Normandie and as a result of the review recommendations included:

a.) Redefinition of harvest criteria,

b.) Application of a more dynamic thinning regime. The DRA/ SRA for the Haute Normandie were agreed in 2006 and the guidelines are in the process of being implemented.

Country: France
Activity: Example 2 Adaptation
Key words: Adaptive management schemes, management plan
Contact: Marianne Rubio
Brief description of the activity: A management plan for 'Bord Louviers', Haute Normandie

The objective of this initiative is to include recommendations on adaptation to climate change in the management plan of the forest of 'Bord Louviers'. The management plan now aims to increase the quantity of Quercus petrae from 21% to 35% as beech, currently the most frequent / economically important species in this forest, will presents a risk in the future with regards to climate change.

Country: France
Activity: Example 3 Adaptation
Key words: Vulnerability
Contact: Marianne Rubio
Brief description of the activity: Identification and cartography of the level of vulnerability of the forest species in Alsace to water stress, using a synecological approach.

This project aimed to define:

a.) The ecological niche of 32 functional forest types and the main forest species with respect to water stress,

b.) Species sensitivity to water stress. A predictive mapping system for the main forest species in Alsace taking into account climate change was devised.

The results of the study established:

a.) The vulnerability thresholds of each species,

b.) The ecological spectrum of dispersal for each species population, forming an operational type

Findings from the project also indicated for example,

- The future of beech / beech-fir stands seems to be compromised.
- Fir will subsist in stationary climax situations but the competitive capacity of beech will be considerably diminished.
- Post-pioneer tree species will be able to regenerate more freely, especially the sessile oak whose growth could be naturally facilitated, as soon as beech has been weakened.

The findings of this project will be included in the ONF silvicultural guidance and could lead to a progressive change in the composition of forest stands.

Country: Latvia
Activity: Adaptation /Mitigation
Key words: Vulnerability, Adaptive management schemes, Mitigation options
Contact: Ainars Grinvalds
Brief description of the activity:

Approximately 47% (2.9 million ha) of Latvia is covered by forests of which 585 million m^3 is standing timber (2006). Conifer stands are the most typical forests (59% of the total area) for the conditions of Latvia.

The aims of the research project are to:

a.) Understand how climate change will influence forests and forestry in Latvia

b.) Understand the measures needed to ensure forests and management strategies are climate change proofed

The research project was commissioned by 'Latvijas Valsts Meži' (Latvia's State Forests company). The research will a.) Identify the factors that influence forestry exposed to climate change and b.) Assess the carbon balance in managed forest stands and wood products. The research findings will aim to provide guidance on the positive or negative role of sustainable forest in mitigating against climate change. The research will be completed by 2015.

The content of the research programme was influenced by organisational and environmental factors.

Country: Lower Saxony (Germany)
Activity: Adaptation
Key words: Vulnerability, Adaptive management schemes
Contact: Reinhard Ferchland
Brief description of the activity: The aim of the research is to provide information that can be used to ensure forestry in Lower Saxony is adapted to future climate change and resources are invested in most critical areas first.

Project outcomes include:

- The development of a list of priority activities concerning forest regeneration.
- Recommendations for new species for forests in Lower Saxony.
- Review of currently preferred species with reference to soil and future climate situations.

Based upon forest soil (specifically water capacity) and regional climate data, site capacity will be compared to known needs of selected species. Based on the findings, the distribution of currently grown and recommended species will be checked and be revised accordingly for future plantings.

Country: Poland
Activity 1: Adaptation & Mitigation – Regulatory scheme
Key words: Policy, Regulations, Guidelines
Contact: Adam Pogorzelski
Brief description of the activity: Forest regulations is the backbone of pro-climatic practices and actions

Forest policy and legislation is a backbone of the overall managerial approach in natural resources stewardship. In Poland, several key legal documents have been introduced or amended over the past two decades. Those critical to supporting pro-climatic activities are: the Forest Act (1991), the State Forest Policy (1997), National Program for the Forest Area Enlargement (1995), as well as the State Forests - National Forest Enterprise (NFE) internal NFE's regulations, in particular Order #11 (1995). All these pieces of policy and legislation clearly promote ecological values in forest management. They also emphasize a need for balance between multiple functions forest ecosystems are delivering to society, including environmental, social and economic needs. A good example is Article 8 of the Forest Act, an overarching piece of legislation; it explicitly names the principles that guide the country's forest managers. The four principles entail a requirement to protect all national forests, to maintain and manage the forest resources sustainably, and to continuously enlarge the forest base.

The above legal fabric is critically important for forest practitioners especially in justifying expenses not directly contributing to economic gain. In practice, this means an increase and consolidation of the forested areas as well as incorporation of multiple silvicultural activities that result in greater forest ecosystems resiliency.

Country: Poland
Activity 2: Mitigation – The National Afforestation Program
Key words: Aspect 2: Forest cover, Afforestation
Contact: Adam Pogorzelski
Brief description of the activity: The National Afforestation Program continues to be the critical element of mitigation efforts

A long-term National Afforestation Programme was set up in the end of 1990s. As a result, a number of afforestation projects has been undertaken and it will continue up until 2050, when the total country's forest cover is to reach 33%.

In addition to an increase in forest cover, further outputs of the programme are an increase of a) CO_2 sequestered by forest ecosystems, and, b) the amount of biomass available for commercial purposes.

Even though this initiative has focused on the afforestation of abandoned agricultural land, it also deals with other types of degraded lands.

Since 1990, a total area of more than 350 000 ha of mostly agricultural land has been afforested. Since 1945, the country's forest cover grew by almost 50% or over 2.5 M ha.

Newly afforested areas are regularly monitored by the State Forests Service, while the privately afforested areas are monitored by local government representatives. The latter often engage the State Forests staff to conduct monitoring activities.

Country: Poland

Activity 3: Mitigation – Intensity of Harvest Operations

Key words: Harvest Rate, Cut-to-Increment, SFM

Contact: Adam Pogorzelski

Brief description of the activity: The rate of harvest remains to be a key measure of sustainability; it revolves at about 55% for Poland

A critical and most convincing indicator of sustainable forest management is a utilization ratio, or a share of annual cut to increment.

In Poland, it has ranged between 50-60% over the past two decades. As a result, total volume of the country forest resources is systematically growing. Since 1998, an average volume per hectare grew from 203 to 234 m^3/ha. The total volume of standing timber rose by at least 81% over the past four decades. At present, the total standing volume of merchantable timber is estimated to be equal to 1.9 billion m^3.

Country: Poland

Activity 4: Adaptation – Stand Structure Conversion

Key words: Naturalization, Remodelling, Conservation, Conversion

Contact: Adam Pogorzelski

Brief description of the activity: Stand species composition and vertical structure remodelling is commonly undertaken in Poland

Species composition remodelling in coniferous stands has been widely adopted in majority of over 430 NFE's districts. This effort is dictated by the tone of the national forest legislation, policies and guidelines. The conversional activities objectives include:

- Establishing more resilient stands by adjusting species composition;
- Increasing the share of deciduous species;
- Establishing multilevel stand structure;
- Contributing to greater biodiversity at local and national levels.

Historically, broadleaves accounted for 13% of Polish forests in 1945 and its share increased to 23% in 2008. Modification of the past forest management practices, i.e. reviving and restructuring forest stands, is primarily an adaptation effort. This may not directly contribute to increased carbon sequestration, but it stabilises ecosystems and, hence, it is equally important from a mitigation perspective. It should also be viewed as a catalyst for the other elements of a climate change action plan as modified silvicultural activities lead to increased stand resilience, carbon storage and forest sustainability. Ultimately, it all contributes to strengthening social, ecological and economic values of forests.

Country: Poland
Activity 5: Adaptation – Natural Regeneration in Silviculture
Key words: Forest Renewal, Genetics
Contact: Adam Pogorzelski
Brief description of the activity: Promoting natural regeneration helps to preserve a local pool of genes.

The primary objective for the natural regeneration promotion is preservation of indigenous pool of genes in an area. Promotion of natural regeneration as a silvicultural practice began about 20 years ago. Before that it used to be a marginal renewal method. The total annual area regenerated annually systematically increases. Some forest districts regenerate over 20-30% of the area requiring renewal on an annual basis. The most successful species that regenerates on its own is Scotch Pine. Other species involve spruce, oak and beach.

Country: Poland
Activity 6: Adaptation & Mitigation – Hydrological Balance Enhancement Program
Key words: Water Retention, Hydrological Balance
Contact: Adam Pogorzelski
Brief description of the activity: Hydrological balance is actively enhanced through infrastructural investments.

Water retention and hydrological balance enhancement program was established by the Polish State Forests at the end of the last century. Ever since, hundreds of small dams and ponds have been built across the country. The program aims to restore degraded and drained peat lands, increase water retention potential of damaged peat soils and to counteract floods and droughts in forest ecosystems. It involves hundreds of individual country-wide projects run by forest districts annually.

Improving hydrologic conditions and stabilizing groundwater levels leads to healthier ecosystems, greater vitality and resilience of forests, and increased forest production which could also be associated with increased carbon sequestration levels. Restoration of rare wet and boggy sites reduces water stress at a national scale, improves the fire resistance of ecosystems and increases the productivity of agriculture and forestry. Restoration and maintenance of peat lands result directly in a) reduced greenhouse gas emissions and b) increased carbon storage. All hydrological activities in forests comply with Polish Water Law and other regulations.

Country: Poland
Activity 7: Mitigation – Forest Productivity Restitution
Key words: Productivity Restoration, Growth Potential
Contact: Adam Pogorzelski
Brief description of the activity: Damaged stands are revitalized on a project-by-project basis.

Activities to restore forest productive potential weakened by natural disasters are directly financed by EU's EFRROW fund. The objectives of those post-disturbance ecosystem productivity restoration activities are:

- To revive damaged stands of all age classes and precious forest nature sites.
- To prepare forest seeding material.
- To integrate fire prevention systems in forested areas.

The program is implemented in two schemes;

1) Restoration effort undertaken on areas struck by natural disasters. The affected areas are selected by the Ministry of Environment. The implementation of activities and restoration of destroyed forest potential pertains only to forest areas damaged by natural disasters (e.g. windbreaks) or biotic factors;

2) Introduction of preventive measures on areas representing the highest risk of forest fire.

Country: Poland
Activity 8: Mitigation – Forest Fire Prevention
Key words: Forest Fires, Combustion Factors
Contact: Adam Pogorzelski
Brief description of the activity: Fire prevention systems and activities are a key mitigation practice.

Forest fires prevention contributes to:

- Sequestration of carbon in wood, forest plants and soils;
- An increase of carbon storage that enhances ecological and socio-economic values of forests.

In the short term, the program involves ground and air patrolling in periods of increased fire threat, as well as regular fire prevention monitoring; forest fire information system and cooperation of local authorities in fire fighting actions.

In the long term, forest fires prevention program entails activities such as improvement of forest fire detection systems, construction and maintenance of relevant infrastructure on the ground, and maintenance and upgrading of firefighting equipment. An important enhancement of the program is provided through the implementation of species composition conversion (Aspect 4) as well as water retention (Aspect 6) programs. A more favorable fuel structure and hydrological balance significantly reduces likelihood of ignition and, consequently, forest fires.

Country: Romania
Activity: Mitigation
Key words: Afforestation, JI project, Carbon trading scheme
Contact: Ciprian Pahontu
Brief description of the activity: Afforestation of degraded agricultural land.

Aims of the programme include

a.) Afforest degraded agricultural land and establish a basis for long-term sustainable forest management;

b.) Provide baseline information for the development of a carbon trading scheme;

c.) Provide rural employment and create opportunities for downstream wood utilisation by the local communities and in the alternative energy sector. Afforestation has taken place in seven counties using a range of species / species combinations, totally 6,728 ha, and measuring of CO_2 abatement from these newly established sites has commenced. An educational campaign to inform the local communities about the programme has been carried out.

Country: Sweden
Activity: Mitigation
Key words: Increment, Mitigation options, Carbon methodologies, HWP
Contact: Hans Winsa
Brief description of the activity:

The project is carried out in partnership between seven organisations.

The project objectives relating to forestry include:

a.) Increase the increment by 1% per year provided by 40,000 ha (owned by Sveaskog) and 2,000 ha privately owned forest, amounting to approximately 1,500 m^3 per year;

b.) Develop and test new forest management models that are compatible with emission trading schemes,

c.) Establish a base line and develop methods for high quality Measure, Report and Verification (concerning a new emission trading scheme);

d.) Increase the volume of harvested woodfuel, including branches and stumps;

e.) Develop usable bio-nutrients from domestic waste.

V Conclusion

Forest management activities can increase stand-level forest carbon stocks and increments through different options like reducing risks to natural disturbances, planting and sowing after disturbances, minimizing losses of dead organic matter or soil carbon ...

The driving force for carbon sequestration is photosynthesis. Forest management practices that are able to optimize photosynthesis and to harvest the produced biomass have to be used. Forest sector activities can influence carbon fluxes by:

- storing carbon in forests and in forest products,
- substituting fossil fuels with bioenergy,
- sustainably using wood products in place of more greenhouse gas-intensive materials like steel, aluminium and concrete.

Carbon sequestration will be one of the goals that drive forest management decisions. Within each region, local solutions have to be found that strive to integrate goals, thereby aiming at sustainable forest use.

Developing optimal regional strategies for climate change mitigation involving forests (possibly with adaptation) will require complex analyses of the trade-offs (synergies and competition):

- between forest conservation and harvesting forests,
- among utilization strategies of harvested wood products (to maximize the substitution of non-woody material).

Nevertheless there is still a real need for additional research on forest ecosystems and the greenhouse gas balance.

The EUSTAFOR working-group on forestry and climate change

The EUSTAFOR General Assembly decided to create a working-group on climate change in 2009. The strategic objective of this working-group is to promote the major and positive role of forests and forestry in the climate change mitigation and adaptation and to propose practical solutions to maximise the value of forestry in regard to climate change issues.

This workgroup acts as a focus point gathering and making available information on changes and strategies developed by the scientific community and the member organisations. It supports the improvement of knowledge about effects of climate change on European forests to be expected and the political process to promote the positive impact of forestry on climate change mitigation.

The working-group was asked to make available general guidelines and knowledge derived from scientific work with recommendations for EUSTAFOR members on carbon conscious forest management with a special focus on mitigation and adaptation to climate change.

The group also provided its members a conduit for sharing existing knowledge and information, and for developing an understanding of the current level of adaptation/mitigation actions undertaken by public forest estate organisations. Dr Gesa Reiss, co-ordinator of the England Forest Industries Partnership (EFIP), joined the working group temporarily to provide support by collating relevant information and writing up the case studies. A questionnaire was emailed to members of the climate change working group in November 2009 with the aim to gather information on examples of best practice relating to mitigation and adaptation activities in state forestry across Europe.

This document was prepared by the EUSTAFOR working group on forestry and climate change.

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EUSTAFOR
in short

Represents commercially orientated state forest companies, enterprises and agencies which have sustainable wood production as a major concern. It currently has 27 members including 9 non voting associate members (observers).

The members represent one third of EU forest area including large protected areas and most member organisations are certified (FSC, PEFC). Annual harvest is approx. 115 million m^3 and together the organisations employ more than 100 000 persons.

The goal of EUSTAFOR is to promote the common interest of state forests in the EU in the scope of their sustainable development. The association supports and strengthens state forest organisations in Europe to maintain and enhance economically viable, socially beneficial, culturally valuable and ecologically responsible sustainable forest management.

Our mainobjectives are:

- To analyse and investigate the existing framework conditions within EU, in order to create the preconditions for sustainable management of state forests;
- To facilitate and expand an exchange of ideas and contacts between the state forest organisations of Europe;
- To keep its members regularly informed on topics and issues that concern the whole of Europe.