FORESTS, WOOD AND CLIMATE CHANGE: CHALLENGES AND OPPORTUNITIES IN THE UNECE REGION

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INTRODUCTION

Forest and wood play an important role in climate change mitigation strategies. This role is little understood and rather different from the strategies usually discussed in the context of climate change, which focus on reducing GHG emissions by limiting use of fossil fuels. Furthermore policymakers in the area of climate change and in the forest sector must address complex, imperfectly understood flows and pathways, with long time lags before results may be expected. In addition, the integrity and sustainability of forests and forest landscapes are dear to the hearts of most citizens of the region, who have showed their reluctance to accept dramatic changes to a feature of the landscape which they consider (usually wrongly) as natural and permanent. (In fact, European forests, with the exception of natural forests in the Russian Federation, are the result of centuries of human influence on and management of an ecosystem which is constantly, but slowly, changing.)

Forest managers and policymakers must adapt to the changing circumstances, but the outcome could be a radically different role and political visibility of the forest sector. The sector may be able to demonstrate, by its response to the climate change challenges, how a sector based on a renewable raw material/energy source can lead the way towards a carbon neutral society.

This paper aims to present, for the use of policymakers outside the forest sector, an overview of the main parameters, options and challenges linking forest, wood and climate change.

CARBON FLOWS RELEVANT TO FOREST AND WOOD

As background for non-specialists, the relevant basic carbon flows are briefly described in simple terms:

- Growing vegetation, including forests, takes CO_2 from the atmosphere through photosynthesis and transforms it into biomass, mostly wood, and releases oxygen, which is necessary for all animal and human life.
- As forests are long lived, slow developing ecosystems, over a tree's lifetime, they accumulate very large stocks of carbon, partly in the form of woody biomass, as well as in forest soils.
- When deforestation occurs, or trees are harvested, the carbon stocked in the wood starts a process towards release into the atmosphere, through combustion or decay.
- In a sustainably managed forest, the volume of carbon released from the ecosystem is equal to or smaller than the volume taken from the atmosphere, making the system "carbon-neutral" or a "carbon sink".
- Almost all UNECE region forests are sustainably managed from the carbon point of view.
- In the UNECE region, very little of the wood harvested is wasted in processing: residues are used as raw material for composite products or pulp, or for energy.
- Recovered wood products, which have already served their first purpose, are increasingly being used as a source of energy or raw material.
- Carbon stock in harvested wood products (HWP) has increased significantly in many countries over the last years and is likely to increase further in some countries, although in a long term perspective HWP stocks will eventually reach a steady state.

FORESTS AND WOOD ARE SIGNIFICANT FOR CLIMATE CHANGE MITIGATION

The carbon stocks and flows connected with forest and wood are very large, much larger than normally realised, and may be influenced by human action in the short to medium term, as evidenced by the following orders of magnitude:

- The total carbon content of forest ecosystems is only 15 per cent less than the amount of carbon in the entire atmosphere.
- Forest ecosystems are the largest terrestrial carbon pool. They store more than 80 per cent of all terrestrial aboveground carbon and more than 70 per cent of all soil organic carbon.
- Carbon emissions from tropical deforestation account for nearly 20 per cent of anthropogenic carbon emissions, second only to fossil fuel use.

- Carbon sequestration by growing forests can offset a significant part of GHG emissions. For instance, the annual increase of carbon in EU27 forests is equivalent to 8.6 per cent of the EU's GHG emissions
- Wood is already by far the most important renewable energy, even in the developed world: for instance, in the EU27, just over 5 per cent of primary energy supply is from wood, much less than from fossil fuels and nuclear, but considerably more than all other renewables combined.

For these reasons, forests and wood are becoming more central to the climate change discussion than in the past, as policymakers realize that forest related issues are neither marginal, nor insignificant.

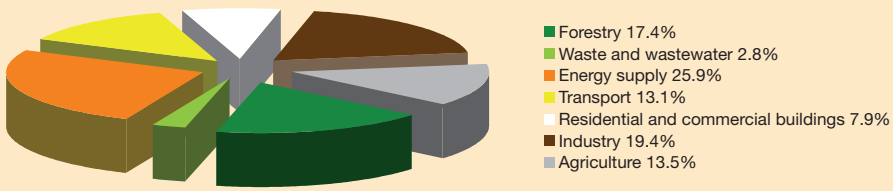
FORESTS WORLDWIDE ARE A MAJOR SOURCE OF CARBON, BUT IN THE UNECE REGION THEY ARE A SINK

Global forest vegetation stores 283 Gt of carbon in its biomass (Europe[22] 43.9, North America 39.2), and an additional 38 Gt in dead wood, for a total of 321 Gt. Soils (down to 30 cm) and litter[23] contain 317 Gt of carbon according to country estimates in this assessment. There are large data gaps for major boreal forests with typically large amounts of soil carbon; thus the figures are likely underestimates. The total carbon content of forest ecosystems for the year 2005 is, therefore, 638 Gt of carbon, which is only 15 per cent less than the amount of carbon in the entire atmosphere. Approximately half of total carbon is found in forest biomass and dead wood combined, and half in soils and litter combined.

Carbon stocks and flows relevant to forests (million tons carbon)	
Forest vegetation, world	283 000
Forest soils and litter, world	317 000
Total carbon content of forest ecosystems, world	638 000
(Total carbon in atmosphere)	750 000
Forest biomass, Ministerial Conference on the Protection of Forests in Europe (MCPFE) region	53 000
Forest biomass, EU27	9 800
Annual net increase of forest biomass, EU27	128
Total annual carbon emissions, all sources, EU27	1 400

Deforestation is one of the main anthropogenic emissions of carbon to the atmosphere, accounting for nearly a fifth of the total. According to the most recent authoritative estimates (Food and Agriculture Organization of the United Nations (FAO) 2005), 13 million hectares (ha) of forest are changed to other land use every year although the net decrease of forest area was smaller, because 4.5 million ha are afforested annually, mainly in China and Europe. As many of these are natural forests, with high accumulated carbon stocks, the carbon release to the atmosphere is very large. According to IPCC, GHG emissions from "forestry" (in fact mainly deforestation) account for 17.4 per cent of the global total, second only to the energy supply sector (25.9 per cent).

Figure 1 Global emissions of Greenhouse Gases by sector, 2003



Source: Intergovernmental Panel on Climate Change, 2007.

Note: Different sectors' share of GHGs caused by man in terms of CO_2 equivalent. Forestry includes deforestation.

[22] *Throughout this paper Europe includes the Russian Federation.*
[23] *In forest terms, "litter" is the leaves and other organic material on the forest floor.*

However, in the UNECE region, the carbon stock in forests is increasing. Since 1990, the total forest carbon stock in Europe increased by 2 billion tons, or an average of 137 million tons of carbon per year:

- Forest area in Europe has grown by 13 million ha over the past 15 years.
- The increase in stem volume of trees in Europe (net annual increment) is 1,350 million m^3/year, while fellings are about 686 million m^3, leading to a steady increase of forest capital/carbon stocks.

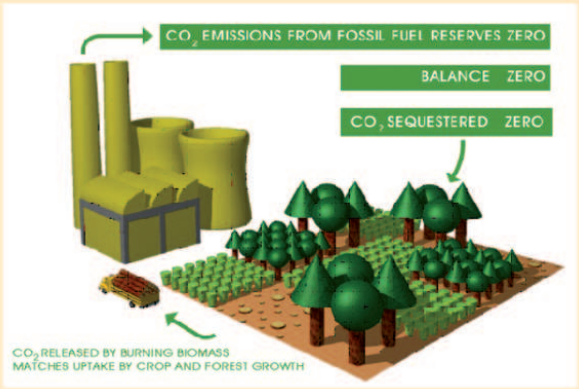
One factor contributing to the increase in wood volume is that forest growth rates have increased in many forest types in Europe. This is partly because of increased input of indirect nitrogen from fertilizer applications through long-range air pollution. From a biodiversity point of view this "eutrophication" of the forest ecosystem is not desirable as it leads, for example, to increases in nitrophilous plant species, while the overall diversity of ground vegetation species decreases.

One factor which negatively influences the rate of increase of the carbon stock is the volume of forest disturbance, in particular by fire, wind and insect damage. Forest fires damage over 1.3 million ha of forests every year in Europe, mostly in the Russian Federation and around the Mediterranean; forest fires have reached unprecedented levels in North America; there have been several major storms in recent years, felling millions of cubic metres of wood. There are regular infestations by insects, some of which become major outbreaks. In Western Canada, the mountain pine beetle is destroying millions of ha of forest, causing major ecological and economic loss, as well as the release of huge quantities of carbon.

USING WOOD FROM SUSTAINABLY MANAGED FORESTS CONTRIBUTES TO MITIGATING CLIMATE CHANGE

However, forests not only store carbon, but also supply wood, which itself stores carbon, and can be used as a substitute for fossil fuels and for non-renewable construction materials such as plastics, steel or concrete. In most cases[24], utilizing wood from a sustainably managed forest, instead of these materials (or fossil fuels), reduces overall GHG emissions, since carbon released when burning wood has already been recovered from the atmosphere while the tree was growing. A completely carbon neutral system, fuelled only by solar energy and photosynthesis, is theoretically possible, even though such a self contained system would be unable to satisfy present energy needs.

Figure 2 Schematic representation of a completely carbon neutral system based on wood energy



Source: Schlamadinger (2007): The role of forests and bioenergy in climate change mitigation. Presentation given at the UNECE/FAO Policy Forum on opportunities and impacts of bioenergy policies and targets on the forest and other sectors. 10 October 2007, Geneva.

In addition, the carbon stored in HWPs is bound for a certain amount of time, as it is not released immediately to the atmosphere once the tree is cut and harvested. Thus there are several, complementary ways in which the forest sector can mitigate climate change: carbon sequestration in the forest, storing carbon in harvested wood products, and use of wood from sustainable sources to replace non-renewable energy and materials.

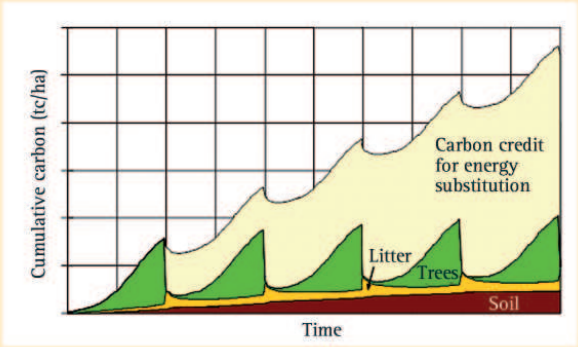
At present, the GHG accounting system put in place for the first commitment period (2008-2012) of the Kyoto Protocol to the United Nations Framework Convention on Climate Change does not provide for accounting for harvested wood products, as consensus could not be reached on which accounting system to use. An important difference between the different HWP accounting approaches is to whom the responsibility for the carbon emissions from HWP is assigned, in particular with respect

[24] *MCPFE 2007: State of Europe's Forests. MCPFE report on sustainable forest management in Europe.*

to trade (to the country where the tree grew, where the product was manufactured or to where it is used?). Among the main principles should be that accounting for HWP or promoting the use of wood must not compromise sustainable forest management domestically or in other countries. This is to avoid a country which consumes wood products claiming credit for wood from deforestation or non-sustainably managed forests, a dramatic example of "leakage".

A "cascaded" use of harvested wood – first for wood products that can be recycled, then for energy – is in most cases preferable to the direct use of wood for energy from the point of view of GHG emissions. Accounting for carbon stored in HWP can be an incentive to use wood as material before using it for energy generation following "cascade" principles.

Figure 3 Cumulative carbon uptake over time with sustainable forest management and use of the wood products to substitute non-renewable materials and energy



Source: Schlamadinger (2007): The role of forests and bioenergy in climate change mitigation. Presentation given at the UNECE/FAO Policy Forum on opportunities and impacts of bioenergy policies and targets on the forest and other sectors. 10 October 2007, Geneva.

FORESTS AND WOOD ARE ONLY PARTLY INTEGRATED INTO THE EMERGING CLIMATE CHANGE REGIME

The present climate change regime through the Kyoto Protocol for the first commitment period recognizes forests' role in reducing GHG emissions through the sequestration of carbon by conserving existing carbon stocks and the enhancement of terrestrial carbon stocks. [25] Forestry is recognized along with other human-induced land use change activities. The substitution of more carbon intensive materials and non-renewable fuels is taken into account in the general accounting mechanisms.

As set out in Article 3.3 of the Kyoto Protocol, changes in GHG emissions by sources and removals by sinks can be used to meet Annex I countries' reduction commitments, if verifiable increases in carbon stocks are measured. However, this only applies to stock changes from land use changes i.e. afforestation, reforestation, and/or deforestation since 1990, so that the steady accumulation of carbon stocks in forests existing in 1990 cannot be accounted for. Under Article 3.4 of the Kyoto Protocol, and as specified by the Marrakech Accords[26] concluded in 2001, countries may choose to account for additional land use, land use change and forestry (LULUCF) (or land use related) activities, including forest management. Twenty-one countries within the UNECE region have opted to account for forest management during the first commitment period of the Kyoto Protocol.[27]

Despite the great importance of carbon release from deforestation, avoided deforestation was not accepted, under the Marrakesh accords, as an eligible CDM activity, due to concerns with regard to carbon leakage, i.e. the generation of increasing carbon emissions from activities not accounted for under the reporting on LULUCF. As a result, the significant mitigation potential of reducing emissions from deforestation and forest degradation cannot at present be accounted for under Kyoto Protocol mechanisms.

[25] *The Marrakesh accords, adopted at the Conference of the Parties to the Kyoto Protocol in 2001, specify which LULUCF activities can be included under the Kyoto Protocol, and establish rules on how these are accounted for during the first commitment period (2008-2011).*

[26] *FCCC/CP/2001/13/Add.1, Decision 11/CP 7, Annex B.*

[27] *As of April 2008: Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Japan, Latvia, Lithuania, Norway, Poland, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Switzerland, Ukraine and United Kingdom.*

The flexible mechanisms under the UNFCCC represent opportunities for the forestry sector:

- The most important mechanism in this group is Emissions Trading. Forest-related credits could also be used in this mechanism, in particular because this is the main way to gain credits for energy from biomass in Annex I countries.
- Through the CDM, Annex I Parties to the UNFCCC, i.e. those nations considered industrialized in 1990, comprising most UNECE member States[28] can invest in forestry projects in developing countries which earn credits with a pre-defined expiration date (temporary and long-term certified emission reductions) which countries can use to meet their national emission reduction requirements set through the Protocol. As of April 2008, though, only one forestry project has been recognized as eligible, and overall the use of CDM credits from afforestation and/or reforestation credits is limited to one per cent of the annual baseline emissions of Annex I Parties.
- Under the CDM, the use of biomass for energy is also recognized, through the reduction in fossil fuel emissions, for example by substituting biomass fuels for fossil-fuels in non-Annex I countries. Clean energy projects, comprising renewable energy along with energy efficiency, at present account for nearly two thirds of the transacted volume in the project-based compliance market.
- Joint Implementation, which allows Annex I Parties to invest in other Annex I countries, represents, from 2008 onwards[29], a major opportunity for the former transition economies in the UNECE region, which can benefit significantly from the financing of investments in renewable energy, comprising biomass and wood energy.

Apart from the Kyoto Protocol mechanisms, a number of voluntary carbon markets have developed during the past years. These include, for example, the Chicago Climate Exchange and the United Kingdom Emissions Trading System. The European Union has also instituted an emissions trading scheme for its member countries as of 2005.

In voluntary markets, forestry projects face fewer restrictions than in the compliance markets under the Kyoto Protocol, and can earn permanent credits. Voluntary carbon projects have been undertaken in the area of reforestation, afforestation, forest conservation and responsible forest management which preserves forest stocks. On a global scale, forestry sequestration projects account for a high proportion of the overall voluntary market with 36 per cent in 2007, followed by renewable energy projects (33 per cent).[30] Most of the demand driving the voluntary carbon markets comes from the developed and more environmentally aware markets in North America and Europe.

Negotiations underway to determine the shape of the second commitment period address two forest-related issues:

- Reduced emissions from deforestation and forest degradation[31] (REDD), which has the potential to reduce the second largest source of anthropogenic carbon emissions, but poses many obstacles. As this does not affect the UNECE region forest sector (except as donors), it is not further discussed here.
- Accounting for harvested wood products, which could encourage the cascade use of wood, provided consensus can be reached on accounting methods.

FORESTS AND FOREST MANAGEMENT IN THE UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE REGION MUST ADAPT TO CLIMATE CHANGE

On all continents, abiotic influences like fire, wind storms and drought, as well as biotic effects such as insect and disease outbreaks, are well known events, whose frequency or severity may be further increasing under the influence of climate change. These events have a significant impact on local forests and in many cases also affect the livelihoods of local populations. The overall picture emerging is one of abrupt negative impacts from a wide variety of causes linked to an altered climate regime, with more subtle, gradual impacts visible only in some locations and for some tree species. Impact of global changes on the growth of the natural forest appears to be variable by region.

Precise future impacts of climate change on forest health, growth and composition are difficult to assess, and use of the global or regional climate change scenarios can only yield approximate images of localized forest futures. Sub-regional projections are still rare and incomplete. In addition, complex interactions between biotic and abiotic factors preclude simple deterministic point estimates in all but the simplest cases.

[28] *Together with Australia, Japan and New Zealand.*

[29] *As of 2008, host countries of projects can gain eligibility for Joint Implementation projects under Article 17 of the Kyoto Protocol, the prerequisite for the creation or transfer of credits. Under the CDM, credits or Certified Emission Reductions have been issued since 2005.*

[30] *Hamilton et al: State of the voluntary carbon markets 2007: Picking up steam.*

[31] *In this context "degradation" means a permanent reduction in the carbon stock per hectare, for instance through selective harvesting of the larger trees.*

Not all climate change is negative for forests: growth may be stimulated by warmer conditions, longer growing seasons and CO_2-fertilization in temperature constrained ecosystems. However, calamities which destroy whole stands of trees (for instance storms, fires and insect infestations) will generate abrupt, large and localized losses with large and immediate impacts on local populations, and possibly significant positive feedbacks to climate change mechanisms. Climate projections suggest an increase in extent and severity of such events. Two other anthropogenic phenomena add uncertainty to long-term prediction of forest health, growth and composition:

- The first is air pollution, mostly through ground-level ozone, a strong phytotoxic agent that interacts with climate change impacts in many complex ways, and through particulate nitrogenous pollutants, the source of nitrogen deposition that may enhance growth as presently appears to be the case in Europe, but may also cause nutrient imbalances.
- The second is invasive species that are often introduced via intercontinental trade. Such invasive pests have already altered many forest ecosystems worldwide.

Observations have shown that forest health is already being affected by climate change or climate-driven events. Such events have caused localized mass mortality that has an impact on livelihoods in addition to providing a positive feedback to climate change. In the future, there will be three possible management approaches for adaptation to climate change: non-intervention; reactive adaptation, and planned adaptation.

Planned adaptation involves multi-level and cross-sectoral approaches. At the community level, planned adaptation may include diversification of forest-based and non-forest based income sources, increased local governance of local forest resources, and general capacity building for the detection and management of climate change impacts. Within the industrial forest sector, planned adaptation may include diversification of product lines to incorporate bio-energy or other emerging forest values and pro-active use of wood products' low carbon footprint as a marketing tool. At the national and global level, planned adaptation may include a timely monitoring and reporting system and the development of tools for vulnerability assessments and adaptation planning. Management might also be increasingly required to look at the global implications of actions, since forests are part of global biogeochemical cycles.

Planned adaptation is a pro-active approach that permits a better use of resources and a potential overall reduction of climate change impacts. Planned adaptation may redefine how and why forestry is done and could be seen as a paradigm change, a move away from a sustainable forest management based on maintaining past patterns of use or possibly past forest conditions, and towards a management of uncertainty and a goal of sustainable livelihoods.

Forest managers need to initiate or intensify monitoring and assessment of productive or protection functions. Monitoring at sub-national and national scales can provide early warning of forest diebacks and of pest and disease outbreaks, and provide managers with an improved capacity to manage uncertainty, coordinate early action, minimize damage, and assist adaptation. Damage assessments on the other hand, can be done post facto to determine impacts of diebacks and outbreak on socio-economic systems, influence policy decisions, and provide a link to decision-making processes.

CHALLENGES FOR POLICYMAKERS

Policymakers for the forest sector and for climate change face a number of challenges:

1. To define the best and most sustainable combination of carbon sequestration in forests, substitution of material and energy, and when to apply it, using the available economic signals.
2. When drawing up national responses to climate change through the forest sector, different strategies including carbon sequestration by forests, storage in wood products, and substitution of fossil fuels and energy-intensive materials could be considered and combined.
3. In particular, they should encourage the "cascade" use of forest products, which is not favoured when high energy prices coincide with low product prices, as in summer 2008.
4. Reconcile the strategies which are desirable from the carbon point of view with the other dimensions of sustainable forest management, notably biodiversity conservation, provision of recreation and economic viability of the sector.
5. Bear in mind the need for global level sustainability, taking account of carbon flows in international trade (carbon footprint). Hence national policies should apply and monitor carbon balances in a holistic manner (Life Cycle Assessment).

6. Ensure that the emerging climate change regime takes full account of the realities and characteristics of the forest sector, chiefly by encouraging consensus forming between the forest and climate change "communities".

7. Many climate change measures assume a small number of economic actors, with considerable capacity for technical innovation and investment: however this is not the cases for the many millions of small scale private forest owners in most European countries and in the United States of America.

8. Identify the risks for forests in their country and develop strategies of risk reduction and risk management.

CONCLUSIONS

In many ways, the forest sector, based on a renewable raw material, produced by a sustainably managed ecosystem driven by solar energy, and easily recovered and recycled, is ideally suited to a carbon neutral or low carbon society. However, the "rules of the game" are becoming so complex and changing so rapidly, that many responsible stakeholders and even some Governments are unable to determine where the national interest lies. There is an urgent need for continued detailed and well-informed discussion of these issues and of the policy instruments which might help to achieve it.

RELEVANT UNECE/FAO ACTIVITIES

Basic data:

- Forest resource assessment (carbon sequestration and storage in forests)
- Forest products production and trade (harvested wood products, substitution of other materials)
- Joint Wood Energy Enquiry (substitution of fossil fuels)

Policy monitoring

- Policy chapter in Forest Products Annual Market Review
- Reporting on qualitative indicators of sustainable forest management
- Database on forest sector policies and institutions (under development)

Policy forums

- Harvested wood products in the context of climate change policy (workshop in September 2008 and policy dialogue during European forest Week, 20-24 October 2008)
- Plenary session on Forest and Climate Change, during European Forest Week, 20-24 October 2008

Analysis

- European Forest Sector Outlook study, 2005
- Papers on wood availability and demand and potential wood supply