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Study of the Effects of Globalization on the Economic Viability of EU Forestry

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Executive Summary

Globalization is not a purely contemporary phenomenon. According to Chanda (2007) it has "worked silently for millennia without being given a name." Indeed, globalization processes are continuously evolving, driven by the economic aspirations of millions around the globe—the more people involved, the faster the globalization is.

This study's goal is to analyze the effects of globalization—defined as the integration of economic activities, primarily via markets—on the economic viability and global competitiveness of the European Union (EU) forest sector, in particular forestry. It covers the entire EU, including the accession and the western Balkans countries, from the present to 2030. It also includes a (limited) review of cultural, social, and political globalization.

For consistency, a coherent analytical framework concept was used throughout the study. The study consists of a literature review, an appraisal of the main globalization factors and related indicators, and analytical work using formalized computer models developed by IIASA. One of the study's objectives was to identify commonalities and differences in the current status and development of forestry in different European regions. Analyses were carried out for specific regions as defined in *Table 1*.

Table 1. Regional Types of Forestry in the EU27 and indices for overall globalization based on KOF Index of Globalization.

	Overall globalization	
	1994	2004
Type 1: Globalized regions/ Nordic–Baltic	78.9	87.4
Type 2: Wood production oriented regions/Central Europe	76.6	87.2
Type 3: Plantation-oriented/ (mainly) "Atlantic Rim" Western Europe	78.5	86.2
Type 4: Broader, multifunctional forestry oriented regions/Western Europe	77.6	85.1
Type 5: Urban society service influenced regions/Northwestern Europe	82.4	84.9
Type 6: "Countries in transition" regions/Eastern Europe	46.5	68.1
Type 7: Low forest management intensity regions/ Southern Europe	66.5	80.3

In terms of regional globalization trends, there was substantial overall development in globalization between 1994 and 2004 in different EU regions *(Table 1)*. However, economic globalization was especially rapid in the "Countries in transition" and countries with "Low forest management intensity" which still lag behind the other regions in general globalization development. More detailed analysis shows that a high degree of overall general globalization implies simultaneous development of economic, social, and political globalization.

Competition has become more intense in the forest sector to keep pace with the globalization of world markets. It is informative to see how the EU forest sector has handled the recent increase in globalization, by examining, for example, the development of global export shares From 1985 to 2005 the EU25 substantially increased its global export shares in all export categories of industrial roundwood, sawnwood, wood-based panels, newsprint, printing and writing paper. However, it made losses in pulp and paper and paperboard. Instead of just being traded, the pulp is used in integrated mills for higher value-added production of different paper grades. The paper losses are in low value-added grades, while shares of high value-added grades have increased.

It can thus be concluded that:

- Globalization has been favorable to the development of the EU forest sector.
- It is not only the impact factors (wood costs, energy costs) that decide competitive position in a globalized world, but also know-how, quality, logistics, institutions, etc.

Forest sectors have not yet faced the changes judged necessary for radical change and economic progress in a globalizing world (McGahan, 2004), for example, in basic technology breakthroughs and dramatic marketing changes. EU25 forest sector companies have, to date, adapted to globalization by using strategies similar to those of their competitors. Soft characteristics such as know-how, logistics, institutions, education etc., have made it possible for the EU25 to reap gains from globalization. But will this be sufficient in the future?

An analytical package of models, developed at IIASA, were used for scenarios analysis regarding the future impacts of ongoing globalization processes. Five specific scenarios were developed and used in the analysis. The overall conclusions of the analysis are as follows:

1. **The competitiveness of the European forest sector will remain robust** across a large variety of different development scenarios. However, Europe is not a global growth powerhouse like, for example, Latin America and Russia. *The fate and direction of its competitiveness is determined mostly outside Europe,* where projections are more uncertain. The EU must monitor these to set appropriate policies for its own forest sector.

2. **Global wood supply will become tight** because of current over-harvesting in several regions, increased environmental concerns, and climate change effects (e.g., insect outbreaks in Canada). The model analysis shows that Russia and Africa will substantially increase their role as wood suppliers. The EU should encourage Russia to become a trusted partner in the global forest sector and encourage sustainable forest management of existing resources in Africa.

3. **South America is almost certain to become a high-growth region** with its vast land resources and risky but more calculable investment conditions than countries like Russia, China, or African nations. However, political uncertainties remain.

4. **Global bio-energy development will be crucial** for the development of the conventional forest industry in Europe and will likely be furthered by European policies. Our modeling shows that economies of scale will be important for bio-energy sector competitiveness. The conventional forest sector, with its considerable experience in managing large amounts of wood raw material, could be an important partner of the energy sector.

5. **Most scenarios show a future renaissance for European sawmilling** due to growing global demand, higher energy prices, and the economic and environmental advantages of wood use for construction.

6. **Globalization will drive the production of higher value-added paper and paperboard** products in the EU.

7. **The Nordic–Baltic and Central regions will be centers of gravity** of the EU forest sector in a globalized world.

8. **The Southeastern European region forest sector will enjoy substantial future growth** because of increased productivity and lower production costs.

9. **The strong upward shift in consumer demand for paper and paperboard (and sawnwood) will continue,** mainly in China, India, Southeast Asia, and South America. European forest industries, as technology and business leaders, will be challenged by such growth potentials and these will attract European companies to invest in regions with growing demand.

10. **There will be a shift in supply** to fast-growing plantations and remaining wood baskets like Russia and Africa. An major concern will be raw material supply.

11. Tighter wood supply, competition from the energy sector, and increased demand in emerging economies, will cause **a substantial increase between 2005–2030 in the demand for forest raw material and industrial forest industry products**. Prices will increase most in what are today regarded as low-cost regions. Prices will also become more similar across regions because of globalization, possibly increasing mean profitability for EU forestry.

The study also investigated the responses in the different EU regions to globalization, as follows:

1. Overall, there is little concrete response to globalization and little innovation activity, especially in small forest holdings.
2. Large forest holdings respond mainly to price competition in globalized commodity markets, mainly by cutting cost through outsourcing and restructuring.
3. Innovations are incremental and follow existing paths and traditional supply-side approaches. Customers and consumers have little influence in terms of improvements to products or services.
4. Any institutional innovations, a potentially important response to globalization, are trend-follower initiatives based on forestry as an efficient raw-materials supplier. There is little strategic, future-oriented, and systematic response to the opportunities and threats of globalization to EU forestry.

Responses to globalization in the EU to date have been wood-focused, with innovations lacking in terms of developing higher value-added wood products and non-timber products and services. There are virtually no comprehensive globalization-oriented innovation policies for the forestry sector in EU countries. A strong focus on traditions, limited emphasis on the future, and avoidance of risks remains.

The study also carried out a **literature review** of lessons learned on responses to globalization in other sectors. The following results are of interest:

- Globalization causes increased intra-industry rather than inter-sectoral trade and specialization based on comparative advantage.
- Risk-averse respondents to globalization often become anti-globalization.
- For markets to function, active governance of trade is necessary; governments need to solicit public support for economic openness.

- Globalization seems to be driven primarily by a reduction in the costs of trade. This results in higher efficiency and productivity as firms face foreign competition.

There is no single explanation or easy-fix normative perspective as to how the EU forest sector can remain competitive under increased globalization. However, the obvious threats and opportunities are identified in *Table 2.*

Table 2. Cross-matrix of opportunities and threats of globalization factors: Forestry and forest industry

		Forestry	
		Opportunity	Threat
Forest industry	**Opportunity**	• Sustainable resource supply • Wood-based bioenergy/biomaterials—polyproduction • Better business relationships, including business intelligence • Productivity gains through increased technology use, including logistics • Biotechnology R&D breakthroughs • Domestic/regional outsourcing of production to enhance productivity • Stable global institutions and regulatory and operational frameworks (e.g., Kyoto) • Public support for renewable resources, green image of wood	• Foreign direct investment (FDI) outside region (forest industry relocation) • Low import barriers for industrial raw material • Import competition for raw material/ globalization of natural resource sourcing • Job losses due to productivity gains • International/global outsourcing of component production • Global institutions and regulatory and operational frameworks (e.g., WTO) are increasingly imperative to encourage FDI abroad
	Threat	• Greater raw material scarcity leading to higher prices • Wood-based bio-energy • Alternative non-production-oriented business models • Policies that restrict wood use but are viable business models for forestry (recreational services, some carbon sequestration) • Increasing demands on forests for environmental protection and recreation, with viable business models to provide these	• Rising import competition pressure for parts, components, or finished products • Reduced export-competitiveness • Declining forest industry profitability • Policies increasingly regulating SFM, but with little scope for developing market-based solutions and experimentation • Urban population increasingly viewing forests as ideally untouched nature; non-economically viable management increasingly sought • Climate change • Continued low public and private R&D

The study has identified four possible strategic options for adapting to and benefiting from globalization based on the threats and opportunities discussed above:

Option 1 = Cease active income- or profit-oriented forestry
Option 2 = Diversify into alternative and niche income streams
Option 3 = Become cost-competitive in global commodity market
Option 4 = Pursue technological and business model innovation

There is no easy-fix strategy for staying competitive in the forest sector with increased globalization. A successful strategy would be a portfolio of the above options with adaptations for different regions of the EU. An assessment of suitable strategic options for the seven types of forestry in regions of the EU discussed earlier is presented in *Table 3.* Their implementation will have both positive and negative implications to globalization factors and dimensions in the different regions of the EU, as illustrated in *Table 4.*

Table 3. Strategic options to respond to globalization and their regional suitability (increasing number of stars indicating increasing suitability).

	Option 1: No commercial operation	Option 2: Niche/ diversify	Option 3: Commodity competitive-ness	Option 4: Next-generation products
Type 1: Globalized regions/Nordic–Baltic		*	**	***
Type 2: Wood production-oriented regions/Central Europe		**	***	**
Type 3: Plantation-oriented/(mainly) "Atlantic Rim" Western Europe		*	***	*
Type 4: Broader, multifunctional forestry oriented regions/Western Europe		**	***	**
Type 5: Urban society service-influenced regions/Northwestern Europe	**	***		*
Type 6: "Countries in transition" regions/Eastern Europe		**	***	
Type 7: Low forest management intensity regions/Southern Europe	**	***		**

Table 4. Effects of adaptation options on globalization factors and globalization dimensions

Globalization factors	Option 1: No commercial operation	Option 2: Niche / diversify	Option 3: Commodity competitive-ness	Option 4: Next-generation products
Investment	Considerably decreasing	Stable or decreasing	Increasing (continuous/ considerable investment);	Considerably increasing (strategic and risky)
Economic activity—productivity, added value	Considerably decreasing	Stable or decreasing	Considerably increasing	Stable or increasing (short term)
Employment	Considerably decreasing	Stable or increasing	Decreasing	Stable (short term)
Trade	n/a	Stable	Stable or increasing	Stable or increasing
Technology, know-how	Decreasing	Increasing	Increasing	Considerably increasing

Globalization dimensions				
Policy	n/a	n/a	n/a	n/a
Society	Likely neutral response	Likely neutral or positive response	Likely negative response	Likely neutral response
Environment	Likely positive except for health risks	Likely neutral or positive	Likely negative or neutral	Likely neutral (short term)
Resources (energy, raw material)	Likely negative	Likely neutral or positive	Likely positive	Likely positive

Supporting Strategic Adaptation through Forest Policies

To sum up, long-term benefits of globalization come with what can be major short-run costs, which must be reduced if production is to remain viable. The producers themselves must search for effective and efficient ways of competing in a global market. Governments can help by fostering an open international trading system and retraining and relocation of workers displaced from industries that are declining or shedding labor because of technical change. They can also protect industries with subsidies, tariffs, and import quotas or prohibitions. The EU could achieve self-sufficiency by removing competition but by foregoing the short-run adaptation costs, the EU would also forfeit the long-run gains of specialization and technological change and, inevitably, trading partners would retaliate with their own trade restrictions. Gains from trade go beyond the static gains of specialization; they are also dynamic because globalization demands technological change and high productivity both from firms that enter export markets *and* from firms that hope to survive import competition.

It is the producers themselves who must search for effective and efficient ways of competing in a global market. Governments can aid this process by promoting open and orderly markets at home and abroad, by facilitating the retraining and relocation of workers who are displaced by technological change or competitive imports, and by fostering enabling environments for competitiveness and innovation.

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Abbreviations Used in This Document

BRIC	Brazil, Russia, India, China
CAP	Common Agricultural Policy
CEE	Central and Eastern Europe
CEI-Bois	Confederation Européenne des Industries du Bois
CEPF	Confederation of European Forest Owners
CH	Switzerland
CIS	Commonwealth of Independent States
CO_2	Carbon dioxide
COST	European Cooperation in the field of Scientific and Technical Research
EAGGF	European Agricultural Guidance and Guarantee Fund
EEA	European Environment Agency
EFISCEN	European Forest Information Scenario Model
EFSOS	European Forest Sector Outlook Study
EFTA	European Free Trade Association
ETTS V	European Timber Trends and Prospects 5
EU	European Union
EU	European Union
EU FBI	EU Forest-based industries
FAO	Food and Agriculture Organization
FAO FRA	Food and Agriculture Organization Forest Resources Assessment
FDI	Foreign direct investment
FTP	Forest Technology Platform
GDP	Gross domestic product
GEO	Global Earth Observation
GFCF	Gross fixed capital formation
GHG	Greenhouse gas
GIS	Geographic information system
GMO	Genetically modified organism
GPS	Global positioning system
GVA	Gross value added
IEA	International Energy Association
IFC	International Finance Corporation
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISIC/NACE	International Standard Industrial Classification/European Statistical Classification of Economic Activities
IT	Information technology
ITC	Information technology and communication
ITTO	International Tropical Timber Organization
M&A	Mergers and acquisitions
MAI	Mean annual increment
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MDF	Medium-density fiberboard
MER	Market exchange rates

MNE	Multinational enterprise
Mtoe	Millions of tons of oil equivalent
NFRI	National Forest Research Institute
NGO	Non-governmental organization
NWFP	Non-wood forest products
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
OSB	oriented strand board
PMP	Positive mathematical programming
Ppp	Purchasing power parity
R&D	Research and development
RoW	Rest of World
SFM	Sustainable forest management
SODEF	*Société de Développement de l'Economie Forestière*
SPM	Summary for Policy Makers
SRES	Special Report on Emissions Scenarios
TFP	Total factor productivity
TNC	Transnational Companies
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNECE	United Nations Economic Commission for Europe
UNFCC	United Nations Framework Convention on Climate Change
USSR	Union of Soviet Socialist Republics
WSIS	World Summit on Information Society
WTO	World Trade Organization

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I. Detailed Analysis Framework Specification

1. Regional/Forestry Typology

The regional/forestry typology is based on the following parameters:

- Relative "openness" to globalization, for example, relative share of external trade, characteristic trade routes and volumes, innovation absorption capacity, and derived similarities in how these factors are affecting different regions of the European Union (EU);
- Production characteristics (forest characteristics including forest types, characteristics, and intensity of production regimes, especially level of knowledge and technology, characteristic products, and volumes);
- Consumption/customer characteristics (type and size of industry, end-user characteristics (e.g., recreation);
- General regional characteristics and other political, environmental, and social factors.

The typology distinguishes five different basic regions. The regional types are: Mediterranean region, Southeastern European region, Central Eastern European region, Nordic, and Northwestern Europe. Some countries or regions are described as mixed type (e.g., the Baltic countries are Nordic/Eastern European), where necessary. This yields a total of seven regional typologies, as described in the matrix below (*Table 1*).

Table 1. The seven regional typologies on which this study is based

	Examples of regions	**Production characteristics**	**Relative "openness" to globalization**	**Consumption/customer characteristics**	**General regional characteristics; other political, environmental and social factors**
Raw-material-production-oriented regions in Central Europe supplying sawmilling/pulp–paper industry, and related supply regions	Austria, Bavaria, South Tyrol, Czech Republic, parts of Hungary, Slovenia	Alpine-Carpathian production conditions in increasingly continental climate conditions: - high growing stock (underutilized resources); - average growing conditions (annual increment); - production-oriented forestry but mobilization is hampered by resource pattern and fragmented forest ownership	- forest-based industries are minor but recognized contributors to GDP and employment - medium international production and trade integration - low-production-value chain integration along value chain - investment by industry characterized by replacement investment, limited new capacities - comparatively weak to average competitiveness - comparatively fragmented industries	Wide social acceptance of production-oriented forestry, considerable and growing emphasis on other forest products than wood, particularly non-wood forest products and services (including hunting)	Many regions are in the traditional "multifunctional forestry/sustainable yield tradition," to which a number of "countries in transition" are gradually converging as they become increasingly well integrated in economic and political terms
Globalized pulp and paper industry-oriented, raw-material-production-oriented regions in Nordic countries and related supply regions in the Baltic States	Finland, Sweden, Estonia, Latvia, Lithuania, parts of Poland	Nordic climatic conditions. Highest forest cover in Europe. Tight demand–supply balance reflected by significant wood import, particularly from Russia and the Baltic countries. Baltics: Rapid increase of harvest volume in 1990s. Limited potential to expand local harvest	- forest based industries are important and recognized contributors to GDP and employment - high to very high international production and trade integration (export-oriented) - comparatively high-production value chain and integration along value chain - investment by industry characterized by replacement investment, limited new capacities except in the Baltics - competitiveness leaders, global players through global M&A	Forest and related industries are "part" of national identity, broad social identification and acceptance of production-oriented forestry, considerable and growing emphasis on other forest products than wood, particularly non-wood forest products and services (including hunting)	Leading economies in Europe, with increasingly strong integration of Baltic economic region, which has become increasingly well integrated in economic and political terms

Table 1. The seven regional typologies on which this study is based (continued)

	Examples of regions	Production characteristics	Relative "openness" to globalization	Consumption/customer characteristics	General regional characteristics other political, environmental, and social factors
Production regions based on plantations, mainly supplying to pulp/paper forest industry in "Atlantic Rim" Western Europe	Scotland, Ireland, northern Portugal, northern Spain, Southwest France	Atlantic climate conditions; British Isles: Increasing softwood supply based on planted sitka spruce. High wood growth rates	Forest based industries are seen as important for rural development and are often promoted as such. New recognized contributors to GDP and employment in a few countries only	Forests for production are not "part" of grown identity in several regions. There is varying support for and identification with production-oriented forestry, strong and growing emphasis on aspects other than forest production values, particularly recreational and environmental	High regional political support to development of the sector, including regional industry
Broader, multifunctional forestry- oriented regions with industries catering mainly to domestic consumption in Western and Central Europe	Large parts of France, Germany, Poland (in some characteristics only)	Expansion potential in wood harvest, but mobilization is hampered by resource pattern and fragmented forest ownership	Large producers in terms of volume of forest products and consumers. Domestic industry at different stages of concentration with a tendency to be under considerable competitive pressure from export-oriented competitive leaders	Large consumer countries considerably influence volumes of consumption. In general, large support to balanced multifunctional forestry with a trend toward increasingly favoring a services-oriented forestry model over a raw-material-production one	

	Examples of regions	Production characteristics	Relative "openness" to globalization	Consumption/customer characteristics	General regional characteristics other political, environmental, and social factors
Regions dominated by restitution issues, "countries in transition," little, broken, private forestry tradition, weak infrastructure and not competitive domestic forest industries in Eastern Europe	Slovakia, Hungary, Romania, Bulgaria, Poland (certain characteristics only)	Often (until recently) significantly underutilized forest resources; forest expansion potential exists if there is more intensive forest management, better infrastructure and technology	- forest based industries are recognized as contributors to GDP and employment but underdeveloped - limited but growing production capacity, - considerable and growing foreign investment - low but fast-growing trade integration, growing export - very low level of technology and infrastructure standards, - low but fast-growing level of competitiveness, based on cheap resources and labor - highly fragmented industries	Acceptance of production-oriented forestry, low level of social mobilization or consumer voice movements to influence forest or forest-based industry developments	Formally classified as "countries in transition," but with rapid economic and political integration
Regions dominated by low forest-management intensity (if any), comparatively high importance of non-wood forest products; forest fires in Southern Europe	Greece, Italy (except northern Italy), southern France, southern Spain, southern Portugal	Mediterranean climate conditions; limited and/or low-value forest resources. Large share of non-commercial species, scattered resource, and frequent forest fires. Little or no production-oriented forest management	- forest-based industries are not recognized as contributors to GDP and employment - little production capacity, import-based - limited investment by industry - low-level competitiveness, partly fragmented industries	Ignorance regarding forests as production sites; recognition of forests as unproductive space and partly as non-wood goods collection and recreational; forest fire is a major issue	Fire is a major issue

2. Scenario Description on the Basis of Existing Scenarios

The basic scenario framework and associated models used in scenario runs are presented here. It should be stressed that this is the generic scenario framework with respect to economic, demographic, technology, energy, and land-use developments. As such, it deals with long-term socio-economic and environmental development to allow the relative geographical competitiveness of the forest sector to be analyzed in the context of the effects of globalization. The specific globalization aspects (scenarios) will be superimposed on to this general framework. These globalization scenarios were formulated during the execution of scenario-related tasks and are based, among other things, on the conclusions and findings from previous tasks.

2.1. An Overview of Scenario Framework: Qualitative Narratives and Quantitative Assumptions for Models

The scenarios used in the analysis are based on qualitative narratives as well as quantitative data (and assumptions). Before presenting the numerous input assumptions, we provide the qualitative scenario “narratives” or “storylines.”

The blending of qualitative and quantitative scenario characteristics is a comparatively recent methodological improvement in the scenario literature (mainly developed for the scenario exercise for the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC). We draw heavily from this here). To date, this literature has been characterized by the (largely separated) coexistence of qualitative scenario “narratives” with quantitative model-based “number crunching” scenario descriptions (for a review of these two scenario streams see Nakicenovic and Swarts, 2000). *Figure 1* displays the Integrated Modeling Framework and the location of models within that was employed to generate the generic scenarios.

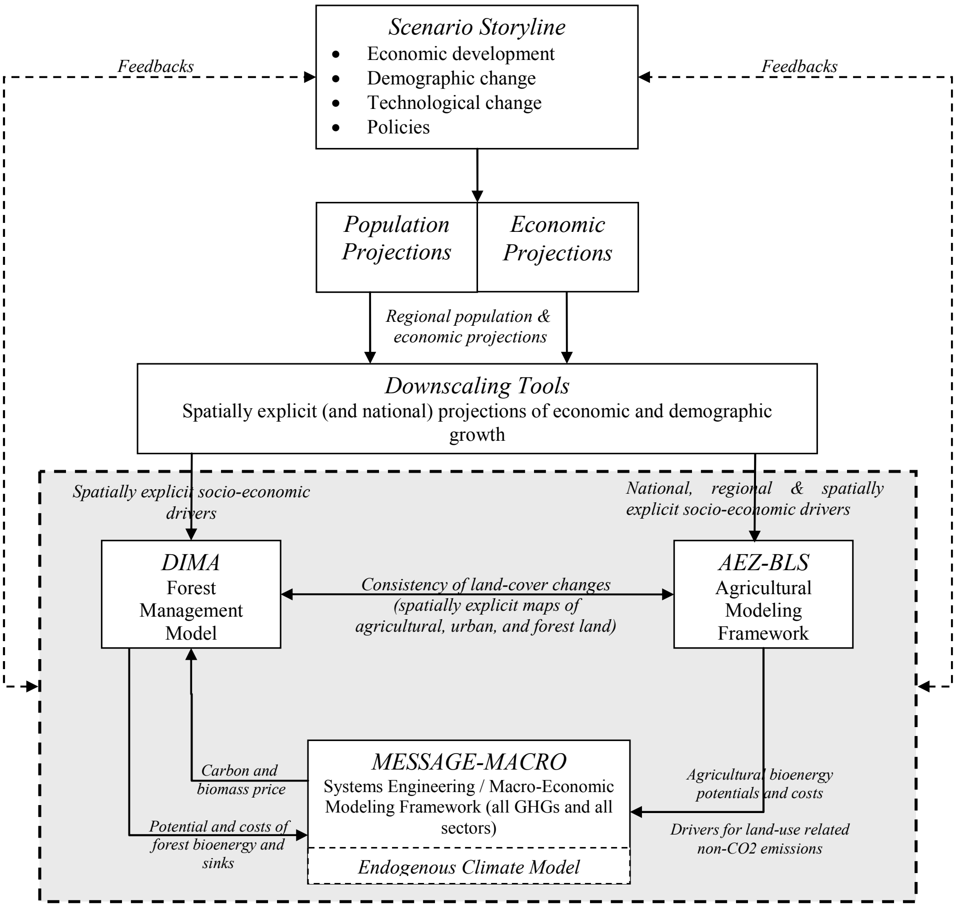

Figure 1. IIASA Integrated Assessment Modeling Framework
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2.2. Scenario "Storylines": SRES

Italics represent quotations from the original SRES storylines as presented in the SRES Summary for Policy Makers (SPM) (Nakicenovic and Swarts, 2000).

2.2.1. A2 (A2r)

The A2 storyline describes a very heterogeneous world. Fertility patterns across regions converge only slowly, which results in a continuously increasing global population.

The resulting "high population growth" scenario adopted here is 12 billion by 2100—lower than the original "high population" SRES scenario A2 (15 billion). This reflects the most recent consensus of demographic projections toward lower future population levels as a result of a more rapid recent decline in the fertility levels of developing countries. As in the A2 scenario, fertility patterns in our A2r scenario initially diverge as a result of an assumed delay in the demographic transition from high to low fertility levels in many developing countries. This delay could result both 1) from a reorientation toward traditional family values as a result of disappointed expectations of modernization in a world of "fragmented regions"; and 2) from economic pressures caused by low income per capita, whereby large families provide the only means to economic sustenance on the farm as well as in the city.

Only after an initial period of delay (to 2030) are fertility levels assumed to converge slowly, but they show persistent patterns of heterogeneity from high (some developing regions, such as Africa) to low (such as in Europe). *Economic development is primarily regionally oriented, and per capita economic growth and technological change are more fragmented and slower than in other* [scenarios]. Per capita growth in gross domestic product (GDP) in our A2r scenario mirrors the theme of a "delayed fertility transition," in that potentials for economic catch-up only become available once the demographic transition is resumed and a "demographic window of opportunity" (favorable dependency ratios) opens (i.e., after 2030). As a result, in this scenario "the poor stay poor" (at least initially) and per capita income growth is the lowest among the scenarios explored, converging only extremely slowly, both internationally and regionally. The combination of high population and limited per capita income growth yields large internal and international migratory pressures for the poor who seek economic opportunities. Given the regionally fragmented characteristic of the A2 world, it is assumed that international migration is tightly controlled through cultural, legal, and economic barriers. Therefore, migratory pressures are primarily expressed through internal migration into cities. Consequently, this scenario assumes the highest levels of urbanization rates and largest income disparities, both within cities (e.g., between affluent districts and destitute *favelas*) and between urban and rural areas.

Given the persistent heterogeneity in income levels and the large pressures to supply enough materials, energy, and food for a rapidly growing population, supply structures and the prices of both commodities and services remain different across and within regions. This reflects differences in resource endowments, productivities, and regulatory priorities (e.g., for energy and food security). The more limited rates of technological change resulting from the slower rates of both productivity and economic growth (reducing R&D as well capital turnover rates) translate into smaller improvements in resource efficiency across all sectors. This leads to high demands for energy, food, and natural resources and a corresponding expansion of agricultural lands and deforestation. The fragmented geopolitical nature of the scenario also results in a significant bottleneck for technology spillover effects and the international diffusion of advanced technologies. Energy supply is increasingly focused on low-grade, regionally available resources (primarily coal), with post-fossil technologies (e.g., nuclear) being introduced only in regions that are poorly endowed with resources.

2.2.2. B1

The B1 storyline…describes a convergent world with [low global population growth] *that peaks in mid-century and declines thereafter* [to some 7 billion by 2100], *but with rapid changes in economic structures towards a service and information economy, with reduction in material intensity and the introduction of clean and resource efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity.*

Given that the latest demographic projections confirm a world population level of 7 billion by 2100 as a qualified lower bound to the uncertainty of future population growth, we retain the original SRES population scenario here. Fertility levels converge toward sub-replacement levels, which lead to a decline in global population in the second half of the 21st century. However, regional differences in fertility patterns are not assumed to disappear entirely in this scenario. The theme of converging demographic patterns is also mirrored in the economic growth outlook of the scenario, for which the core characteristic is one of a conditional convergence to the prevailing economic productivity frontier. Hence, it is assumed that per capita GDP growth is the highest of the scenarios analyzed. Moreover, incomes are assumed to converge both internationally and domestically, given a favorable institutional environment domestically (e.g., stable institutional and efficient regulatory settings) and internationally (international development cooperation, and free flow of knowledge and technologies, enhanced by dedicated transfer mechanisms). The concept of *conditional convergence* is key in this scenario. As economic growth increasingly accrues from service- and information-intensive activities, traditional industrial and locational comparative advantages are reduced and high human capital (education) moves to the forefront providing a "level playing field" for initially poorly endowed regions to catch up to the productivity frontier. Per capita incomes are thus converging, but only conditionally as a result of investments in human capital and a general trend toward pushing the productivity frontier to the ever-higher service- and information-intensive economic activities that are assumed extant in this scenario.

Distributive policies, both domestically and internationally (in line with the EU regional cohesion fund model) also play a major role. As a result, the scenario assumes policy-driven comparatively high convergence rates in per capita income differences, both internationally and domestically. This ultimately blurs the traditional distinction between urban wealth and rural poverty and leads to a substantial reduction in economic incentives for rural-to-urban migration (and hence the lowest urbanization rates of the scenarios analyzed). While developing regions thus may reach, and even surpass, the *current* productivity (and income) levels of the most advanced regions, their growth nonetheless remains conditional on the growth rate of the overall productivity frontier and thus on the absolute productivity (and income) levels achieved in the leading regions. Hence, international differences in productivity levels also prevail in this scenario, even if at much lower levels than in the other scenarios explored.

No systematic "economic overtake" is assumed in the scenario. The emphasis on information-intensive and "dematerialization" of economic growth also implies that, assuming continued development of modern communication infrastructures (such as the Internet), the importance of "space" (i.e., locational advantages, especially of urban agglomerations) diminishes significantly. "Distance" no longer necessarily acts as a defining characteristic of economic transaction costs, access to knowledge, and availability of technology. Combined with the assumed global availability of clean and high-efficiency production technologies for food, raw materials, energy, and manufacturing, differences in resource and environmental productivities are reduced significantly.

2.2.3. B2

The B2 storyline…describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing population at a rate lower than in A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1… storyline.

By design, the B2 scenario is an intermediary scenario, characterized by "dynamics as usual" rates of change, inspired by historical analogies where appropriate (e.g., shifts in food preferences), but also departing from historical contingencies (e.g., growth in information technology and communication [ITC] and other technologies). World population growth is assumed to reach some 10 billion by 2100, based on the United Nations (UN) central projection that underlies the original SRES scenario and is also retained here. The UN scenario assumes strong convergence in fertility levels toward replacement levels, ultimately yielding a stabilization of world population levels. Like total population size, urbanization rates in this scenario are assumed to be intermediary, bridging the more extreme scenarios A2r (high) and B1 (low). The economic growth outlook in B2 is regionally more heterogeneous, with per capita income growth and convergence assumed to be intermediary between the two more extreme scenarios A2r and B1. This largely reflects 20th century historical experiences, without assuming large discontinuities, such as economic decline or "lost decades" of economic development for any particular region. It is assumed that the dynamics of income growth are tightly correlated with rates of social modernization, as reflected, for instance, in the dynamics of the demographic transition. In low-income regions where this transition has progressed further and more dynamically, per capita productivity (income) growth is also assumed to be higher (e.g., China). In lagging regions (e.g., Africa), it is assumed that economic catch-up is delayed until the demographic transition accelerates. Peaks of per capita income growth are therefore assumed to coincide with the fertility transition metric (second derivative of population growth). Given a more modest technology outlook, resource endowments and differences in income levels result in only slowly converging differences between domestic and international demands, productivities, and prices. For instance, regions endowed with large energy resources, such as the Middle East, would experience continued low energy prices and thus more lavish energy-use patterns compared to import-dependent regions such as Japan or Western Europe. These would continue to push the energy productivity frontier along its historical "high efficiency" trajectory. Consequently, the resulting food, energy, and resource demands are also intermediary between the two more extreme scenarios A2r and B1.

2.3. Scenario Quantifications

2.3.1. Demographic and economic development

A distinguishing feature of the scenarios reported here is that they consider demographic and economic development not as autonomous processes but as (partly) interlinked. These linkages, however, do not operate in a deterministic or one-directional sense, such that, for example, a given rate of demographic transition and its resulting window of demographic opportunity would automatically translate into a particular rate and pattern of economic growth, or vice versa. Instead, these linkages operate at a conditional level, that is, they are subject to variations in accordance with a given scenario feature, as described in each respective "storyline."

Scenarios B1 and A2r describe the more extreme manifestations of the demographic–economic development nexus, whereas scenario B2 displays less-pronounced linkages. In B1 a rapid demographic transition from high to low fertility leads to a low total population projection. This, combined with the assumed high levels of education and free access to knowledge, capital, enables developing countries especially to make full use of their demographic window of opportunity. Rates of economic growth accelerate with the progress of demographic transition and are assumed to peak at the window of demographic opportunity (the maximum of the second derivative of population growth). In turn, accelerated rates of modernization, as reflected in economic development catch-up, also feed back into demographic development, which maintains the rapid mortality and fertility transitions characteristic of the B1 scenario. Conversely, scenario A2r, with its delayed demographic transition, is intended to illustrate the "downside" of the demographic–economic development linkages explored in the scenarios. The assumed delayed demographic transition in A2r leads not only to a high population projection but also to a delay in the potential to fully use the demographic window of opportunity for development catch-up. This, combined with the more fragmented geopolitical outlook that limits free access to knowledge and technology, makes the corresponding economic growth rates much lower in an A2r world. This results initially in an even further divergence of income differences between "North" and "South."

In terms of adopting numerical scenario values (summarized in *Table 2*), we analyzed the corresponding scenario literature in detail (Nakicenovic *et al.,* 2006), updating earlier analyses (Nakicenovic and Swarts, 2000). For population (see *Table 3*), we retained the original SRES low.

Table 2. Taxonomy of scenarios

Uncertainty type	*Factors affecting uncertainty*	*A2r*	*B2*	*B1*
		Classification of scenarios: high (H), medium (M), low (L) relative to reach other		
Emissions (magnitude of cumulative carbon)	Population size	H	M	L
	Income	L	M	H
	Resource-use efficiency	L	M	H
	Technology dynamics, fossil	M	M	L
	Technology dynamics, non-fossil	L	M	H
	Emissions	**H**	**M**	**L**
Vulnerability	Population size	H	M	L
	Urbanization	H	M	L
	Income	L	M	H
	Vulnerability	**H**	**M**	**L**
Target (for stabilization)	Exogenous input			
	Scale of required reduction	**H**	**M**	**L**

Table 3. Scenario baselines: Population and GDP

		Population, million			GDP(mer) billion $(1990)		
		North	South	WORLD	North	South	WORLD
1990		1271	3990	5262	17437	3430	20866
2020	A2r	1430	6384	7814	32512	13258	45770
	B1	1440	6177	7617	34124	18017	52140
	B2	1404	6268	7672	31420	17981	49401
2050	A2r	1536	8708	10245	52422	47703	100125
	B1	1504	7200	8704	56074	79569	135644
	B2	1370	7997	9367	46227	63153	109380
2100	A2r	1663	10724	12386	84971	104256	189227
	B1	1448	5608	7056	100418	227932	328350
	B2	1316	9105	10421	75698	163494	239192

(B1) and medium (B2) scenarios, as they agree closely with the most recent demographic projections from the United Nations (2005) and IIASA (Lutz and Sanderson, 2001; O'Neill, 2005). Global population grows from some 6 billion in 2000 to some 9 billion by 2050 (8.7 and 9.3 billion in B1 and B2, respectively) and grows to between 7 (B1) and 10.4 (B2) billion by 2100. The original SRES A2 scenario, with its projected population of some 15 billion by 2100, appears high in comparison with most recent projections that have generally shifted levels of future population downwards (for a review, see O'Neill, 2005). Therefore, in our revised A2r scenario we use a modified IIASA projection for the "high population" growth quantification. The scenario is characterized by an assumed delay in the demographic transition of some two to three decades, which leads to a world population of around 10 billion by 2050 and 12.4 billion by 2100. A comparison of the world population scenarios reported here with the original SRES study and the most recent population projections from IIASA and the UN is shown in *Figure 2*.

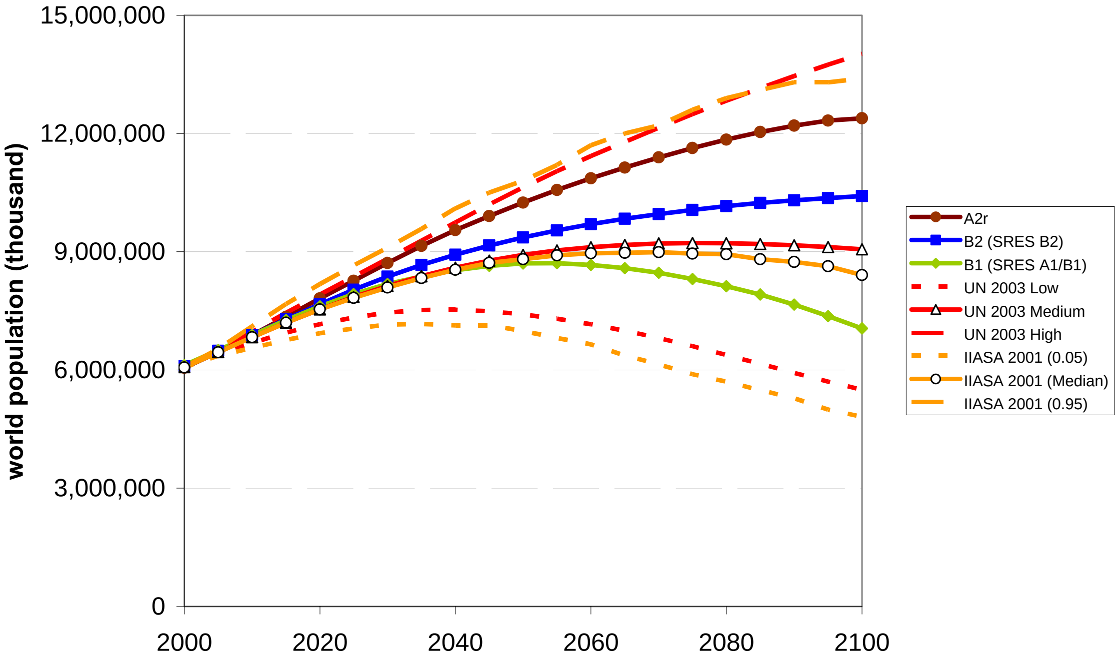

Figure 2. World population: Scenarios presented here in comparison to the recent demographic literature. See the electronic version of this report for colored figures.

Global economic output (GEO) is estimated at 27 trillion US$(1990 value) at market exchange rates (MERs) in the year 2000. By 2050, GEO ranges between 106 (A2r), 119 (B2), and 150 (B1) trillion US$. By 2100 the corresponding scenario range is between 204 (A2r), 270 (B2), and 392 (B1) trillion US$, corresponding to an increase between a factor of 7 to 14 over a time period of 100 years. This compares with an estimated factor of growth of 18 in GEO over the past 100 years (1900–2000) according to the estimates of the economist Angus Maddison. From this perspective, all our scenarios are squarely within historical experience and also not particularly bullish when compared to a more recent update of a review of the scenario literature (Nakicenovic *et al.,* 2006) (see *Figure 3*).

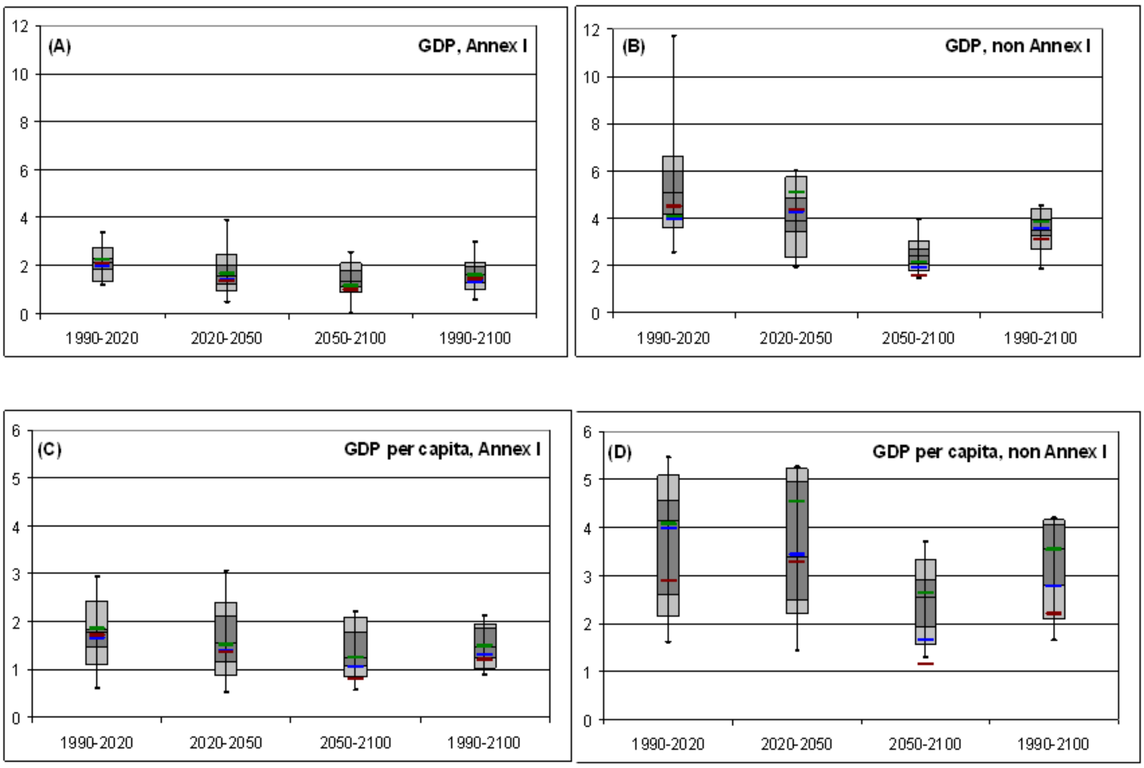

Figure 3. Economic growth rates (percent per year) for total GDP (top panels) and GDP per capita (bottom panels) and for UNFCC Annex-1 (i.e., industrialized, left panels) and non-Annex-1 (i.e., developing, right panels) countries. Scenarios presented here (A2r brown, B2 blue, and B1 green) in comparison with statistics derived from the scenario literature (Nakicenovic *et al.,* 2006). See the electronic version of this report for colored figures.

Conversely, per capita GDP growth patterns portray a somewhat different pattern, in which scenario B1, by design, describes an extremely affluent world in which income disparities also decline substantially, although absolute differences in per capita GDP continue to persist across regions over the entire 21st century (Grübler *et al.,* 2006). Thus, even in a scenario of assumed gradual conditional convergence in per capita income, there is no convergence in absolute income differences. Per capita income (at some US$4,560 [1990 value] and calculated with MERs) in B1 could approach a challenging US$55,000 by 2100, which represents a 12-fold increase over the 21st century.

Scenario B2 is more conservative, with a projected per capita income of some US$25,000 by 2100 (or an increase by a factor of 5.8). Scenario A2r, finally, represents the lower side of the economic growth outlook of our scenarios: per capita GDP would grow to some US$16,000 by 2100 or by a factor of 3.7 over a period of 100 years. To put these numbers into perspective: Maddison's estimate of world per capita GDP growth between 1900 and 2000 is a factor of 4.8. Scenarios B1 and A2r are, therefore, again squarely within historical experience, with B1 being above and A2r below historical experience, a categorization that also applies when the scenarios are compared to the future scenarios literature (see *Figure 2).*

In comparison to our earlier published scenarios (Grübler *et al.,* 1996; Nakicenovic and Swarts, 2000), which reported economic output using two alternative measures to convert national currencies into a common denominator (MERs and purchasing power parities [PPPs]), the present study considers GDP calculated using 1990 MERs only. There are two reasons for this. Assessing the feasibility and costs of climate stabilization, taking into consideration all intersectoral linkages and feedbacks, requires an economic conversion metric commensurate with international comparative advantage (e.g., it must be able to assess the relative economics of land-based biomass or forestry product production). It also requires an endogenous representation of international trade in forestry products (for the stabilization scenarios examined), which dictates the use of MERs. (The use of PPP conversion rates to determine international comparative advantage and trade is quite simply methodologically flawed.) A second reason to refrain from reporting PPP estimates of GDP is methodological. Given that the models used in our analysis are formulated at the level of regional aggregates (e.g., all of Latin America is considered as a single region), the use of PPPs entails intricate index number and aggregation problems across countries and/or regions and over time. These are best addressed by detailed bottom-up aggregations of scenarios formulated at the national level, which we have developed for this study (Grübler *et al.,* 2006). A reformulated and recalibrated model to calculate PPP scenarios "bottom up" is under development and will be reported in due course.

2.3.2. Technology, resource efficiency, and energy and land use

Above, we formulated the basic drivers of demand in the scenarios, including population and income. We now address the interlinked issues of resource availability, efficiency, and the corresponding technologies that "intermediate" between demand and supply.

To represent their salient uncertainties, we again follow the basic scenario taxonomy introduced above, which ranges from conservative (A2r), through intermediary (B2), to optimistic (B1). (See *Table 4* for energy and land use)

A general feature of our scenarios, consistent with our interpretation of economic and technology history, is that rates of productivity growth and technology growth are interrelated. In other words, in scenarios of high macroeconomic productivity, growth as reflected in per capita incomes (B1), the productivity of resource use, and rates of technological innovation are also high. In turn, the rapid capital turnover rate that results from high economic growth enables a rapid diffusion of new technology vintages, which renders the high productivity and efficiency scenario storyline internally consistent. Scenario A2r maintains the same scenario logic, which represents, with its lower productivity, efficiency, and innovation rates, the "slow progress" mirror image of the B1 scenario. It is important to emphasize the two-way linkages and interdependencies of these variables, which lead to complex patterns in the scenarios that defy simplistic linear scaling perceptions. In our view, it is precisely the nature of these complex, non-linear relationships that makes a scenario analysis with formal models a necessity, both to achieve internally consistency and to provide an informed basis for policy debates.

Table 4. Main resource use in the scenarios: energy (exajoules [EJ]), and forest and agricultural land (in hectares [ha]).

	2000	2020	2050	2100
Primary energy (EJ)				
A2r	402	628	1173	1742
A2r-stab.*	402	595–628	926–1162	1162–1644
B1r	402	596	953	1041
B1r-stab.*	402	554–594	857–945	986–1012
B2r	402	616	930	1288
B2r-stab.*	402	567–584	798–829	1017–1046
Forest land (Mha)†				
A2r	4217	4242	4244	4234
A2r-stab.	4217	4251	4284	4438
B1r	4217	4300	4410	4636
B1r-stab.	4217	4302	4419	4679
B2r	4217	4273	4358	4517
B2r-stab.	4217	4287	4381	4620
Agricultural land (Mha)†				
A2r	1540	1719	1617	1780
A2r-stab.	1540	1722	1616	1779
B1r	1540	1609	1651	1601
B1r-stab.	1540	1609	1651	1601
B2r	1540	1615	1677	1682
B2r-stab.	1540	1612	1676	1680

*Range across all stabilization levels. †Values refer to the intermediate stabilization level of 4.5 W/m^2; model calculations for agricultural land-use extend to 2080 (and are kept constant thereafter).

Note that the different sectoral models analyzed do not always include the full range of the three baseline and 11 mitigation scenarios explored with the MESSAGE–MACRO model. For instance, the scenarios illustrate that higher economic growth does not necessarily translate into a proportional growth in energy demand. This is best illustrated by comparing the energy intensity (energy use per unit of GDP) across our scenarios (*Figure 4*). *Ceteris paribus,* intensities are lowest in the B1 scenario, precisely because of its high productivity, technology, and capital turnover rates, with the economic structural change that results from rapid economic development also playing an important role. Conversely, energy intensities are highest in the A2r scenario, which illustrates the resource-efficiency implications of limited productivity and the growth in technological innovation. Only through massive (and costly) efforts, as illustrated in the A2r stabilization scenarios, do intensities approach those of the much more efficient B1 scenario, which, because of the high efficiency already achieved in the baseline.

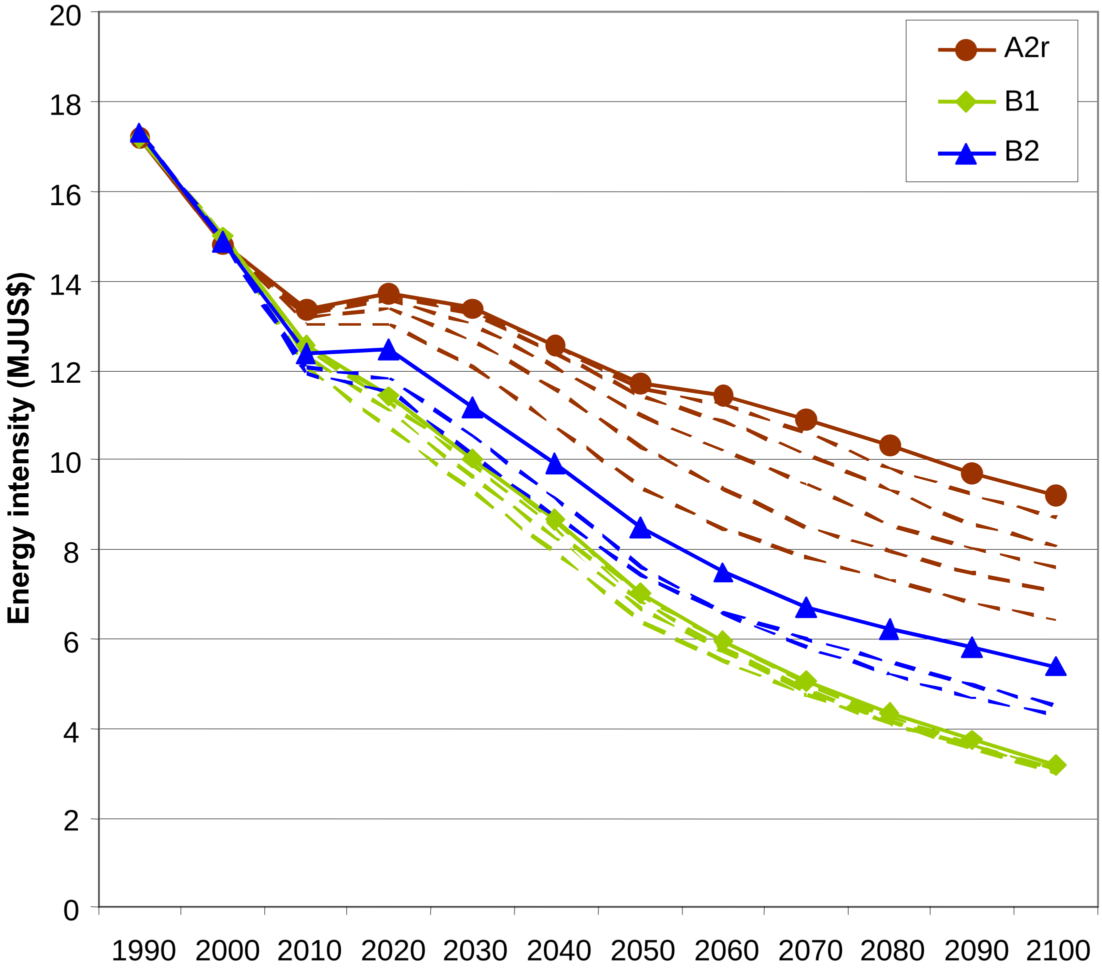

Figure 4. Energy use per unit of GDP (energy intensity) for the three baseline scenarios and their climate stabilization scenarios. See the electronic version of this report for colored figures.

The different demands for forest products in the scenarios determine their respective levels of resource utilization. For forestry, to assess resource availability is a straightforward matter, as land availability is fixed and land-use patterns are endogenous to the scenarios as a function of current uses and projected future demand–supply interactions (Fischer *et al.,* 2006; Rokityanskiy *et al.*, 2006). For energy, the situation is more complex. First, the amount of fossil fuels that might become available in the future is inherently uncertain as a function of the degree of both the explorative efforts that lead to new discoveries and the evolution of technology (exogenous input to our scenarios), as well as prices (endogenous in our scenarios). By and large we follow the quantitative assumptions adopted for the corresponding scenarios in the SRES report (Nakicenovic and Swarts, 2000). For renewable energies, the scenario literature (including our earlier work) has, to date, relied on exogenously determined upper bounds for physical supply potentials derived from the literature (World Energy Assessment, 2000), without explicit treatments of technology or economics (prices). Taking advantage of our integrated modeling framework, we replace this traditional approach with a new one that explicitly considers competing land uses for food, fiber, and forest products and the resulting economics of supply. This methodological refinement has also led to a significant numerical revision of our earlier estimates as a result of the endogenization of the economics of land-based bio-energy, which we consider a major methodological advance in the modeling state of the art (Rokityanskiy *et al.,* 2006).

Fossil fuel resource availability is differentiated in our study by major fuel (coal, oil, and gas) and by resource category (especially conventional versus unconventional resources). See *Figure 5.*

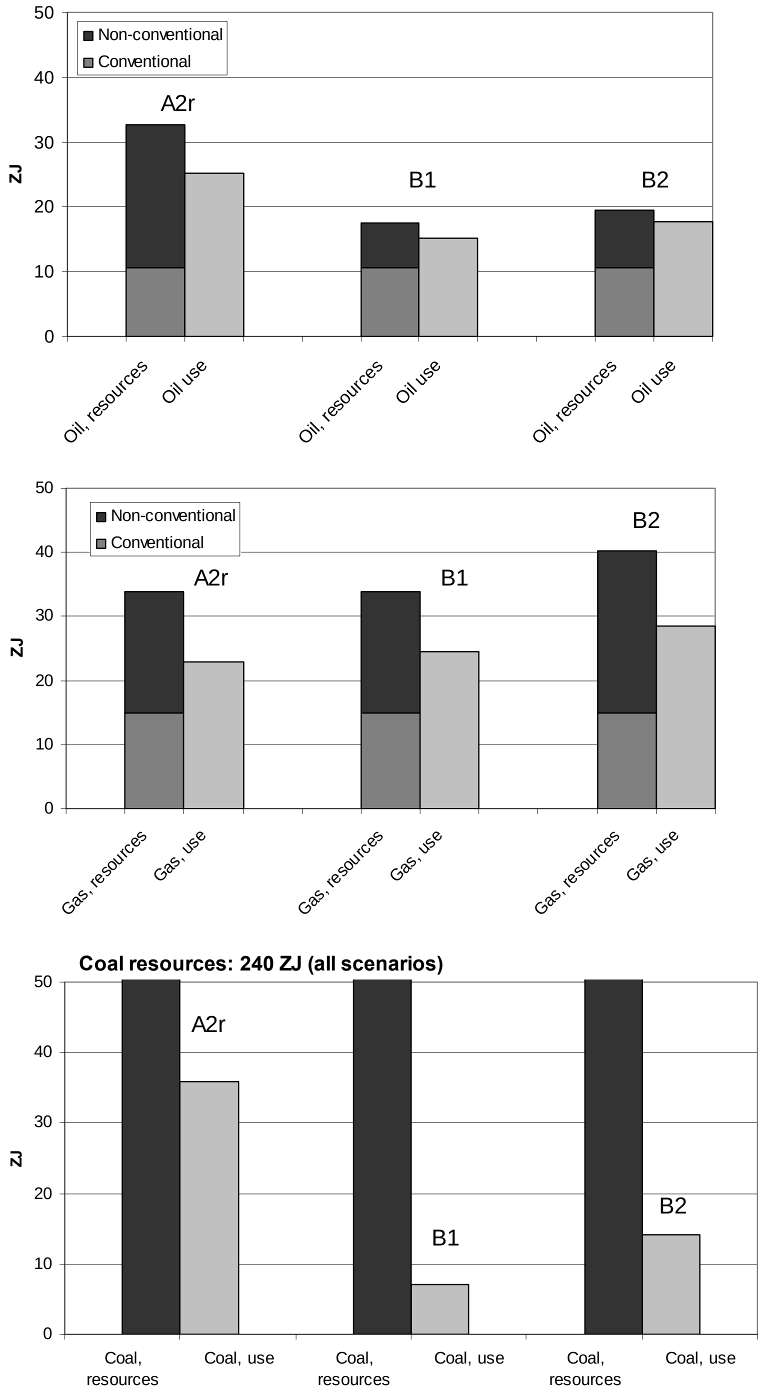

Figure 5. Fossil energy resources: Assumed availability (left bars) and actual use (right bars) for oil (top panel), natural gas (middle panel), and coal (bottom panel) in the scenarios.

Figure 5 summarizes our assumptions at the global level, giving both exogenously defined upper bounds on resource availability and endogenously determined actual use (or "call on resources"). All our scenarios reflect the well-known dichotomy of the inverse relationship between availability and quality of fossil energy resources. Easily accessible and clean resources (e.g., conventional gas) are relatively scarce in comparison with "dirty" (coal) or difficult-to-harvest "dirty" fossil fuels (unconventional oil, such as tar sands or oil shale). Nonetheless, even in considering uncertainty, the scenarios indicate that the frequently voiced fear of "running out" of energy resources needs to be differentiated into a graduation from easy-access "clean," to more-difficult-to-access "dirty" fossil fuels.

Actual resource use in the scenarios, in turn, results from the interplay between exogenously defined upper bounds to resource availability ("potentials"), assumed rates of technological progress, and the relative economics between different fossil fuel resources and their non-fossil substitutes that play out under the different demand scenarios examined, ranging from "high" (A2r) to low (B1). The "call on resources" for coal in our scenarios provides a good illustration. In the A2r scenario, demand is high (high population growth combined with slower productivity growth and, thus, less progress on the efficiency front); international trade in energy, forest products and technology is limited; and overall rates of technological progress are assumed to be more modest.

Conversely, scenario B1, with its lower energy demand (as a twin result of lower population combined with high productivity growth), has an assumed rapid progress in technologies. Scenario B2 is between scenarios A2r and B1. Invariably, therefore, the traditional deterministic perspective on resource availability ("how much to dig out, when") is replaced in the scenarios reported here by a view that considers resource availability not geologically but rather socially and technologically. This is reflected by different scenario tendencies in the evolution of demand, exploration efforts, technological change, and the resulting comparative economic interplay of different technologies.

For the forestry sector supply of renewable resources we have adopted a new methodology to translate theoretical potentials (the renewable equivalent to fossil fuel "resources") into supply potentials consistent with competitive land uses and prices from non-energy sectors (agriculture and forestry). Our new approach improves on a traditional drawback of sectoral energy models, which have, to date, considered the availability and costs of bio-fuels in a competitive context only within the energy sector proper and not in relation to other sectors.

To this end, we perform model iterations between the forest, agriculture, and energy sector models until a consistent picture with respect to land availability and prices is derived. That is, the estimated biomass potentials account for the most salient constraints on land-use availability through food-production and land-price changes (e.g., driven by urbanization and increasing regional affluence). A detailed discussion of biomass potentials and prices at spatially explicit levels is also given on this issue in Rokityanskiy *et al.* (2006). In addition, the implications of selected scenarios for food security, agricultural production, and land-use change, as well as their implications for agriculture-related irrigation are also discussed in Fischer *et al.* (2006) and Tubiello and Fischer (2006). However, the integrated scenarios presented here do not yet explicitly consider the possible water availability constraints or ecological impacts that might result from vastly expanded biomass use and the enhancement of carbon sinks. Related in-depth analyses (for biomass as well as other synfuel options, which would equally require vast amounts of water) remain an important area for future research.

Figure 6 compares our revised estimates of biomass potentials and use to those used in the SRES scenario exercise. Revisions at the global level are minor for the A2r and B2 scenarios, but significant in the case of the B1 scenario. The high economic growth projection of that scenario results in an inflationary trend for land prices, which thus limits the economic availability of land resources for bio-fuels compared to alternative land uses (settlements, agriculture, and forests). This results in a corresponding reduction in the resource potential for biomass in the B1 scenario.

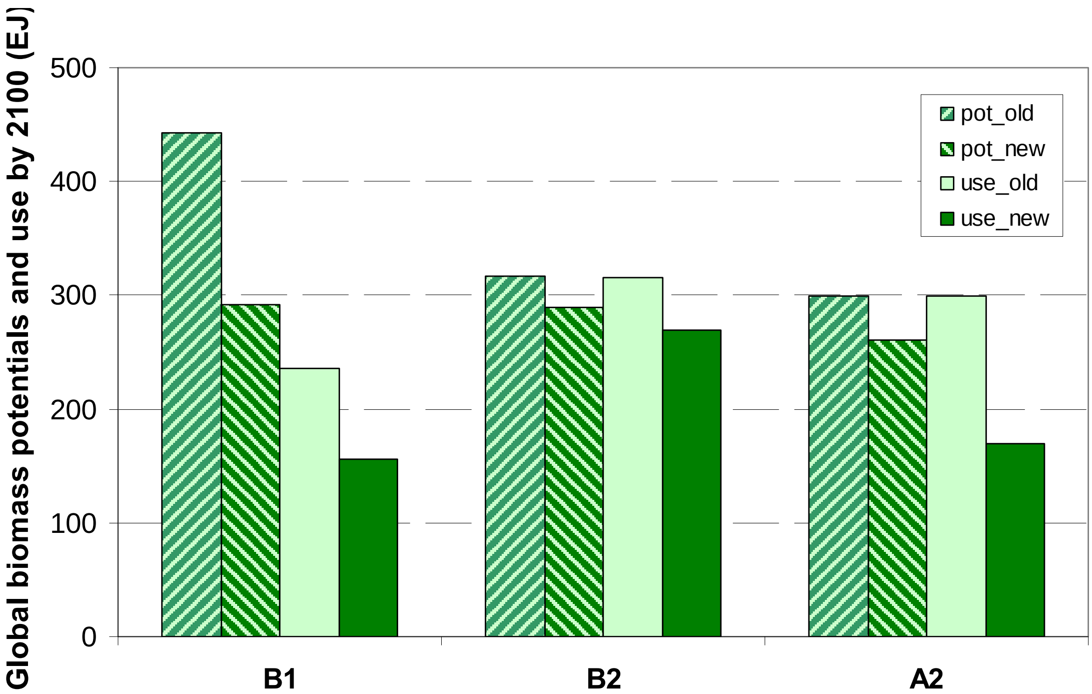

Figure 6. Biomass energy potentials (potential use, left bars) and actual use (right bars) in the scenarios (in EJ): Comparison of previous estimates (left bars) with this study (right bars). See the electronic version of this report for colored figures.

Equally visible in *Figure 6* is that the baseline scenarios use only a fraction of the (revised) production potentials. With increasing climate constraints and emission reduction efforts, however, increasingly larger fractions of the biomass resource potentials are being exploited. Respective levels are again determined within a consistent economic framework, always considering alternative land uses that energy and climate policy models have, to date, been unable to consider. Moreover, as shown in *Figure 6,* the actual biomass use levels are significantly lower in our revised scenarios compared to earlier results. This reflects the impact of a comprehensive and consistent treatment of land availability and production of alternative goods and services in both forestry and agriculture (and hence energy–biomass production opportunity costs).

Figure 6 summarizes our scenarios in terms of the major resource-use category, energy, and agricultural and forestry land use. As indicated above, the energy sector scenarios were calculated for all three baseline scenarios and their stabilization counterparts, whereas for the agriculture sector resource constraints allowed only the analysis of the two "extreme" scenarios, A2r and B1. Global energy use in the scenarios is projected to increase up to fourfold over the next century (A2r). Only in the scenario with highest productivity, efficiency, and technological change (B1) is this growth reduced to an increase by a factor of two over the next century. Given the range of uncertainties explored in our scenarios, further energy-demand growth above the levels projected here appears unlikely, as more vigorous demand growth would be counterbalanced by increasing pressures on resource availability. This would result in rising energy prices that, in turn, would induce further energy conservation measures and bias technological change in the direction of factor substitution.

Contrary to many earlier scenarios published in the literature (for a review see Alcamo *et al.,* 1995 in which forest cover almost invariably declined substantially through continued deforestation), our scenarios indicate a somewhat different pattern. Despite continued short-to-medium term deforestation in the tropics (especially in scenario A2r), global forest cover remains initially stable because of substantial afforestation in industrialized countries as a result of continued agricultural productivity increases (Rokityanskiy *et al.,* 2006). Our alternative scenarios suggest, instead, the possibility of a stabilization of forest cover and preservation of forest resources over the next century, a feature already foreshadowed in some previously published land-use scenarios (Nakicenovic and Swarts, 2000). This holds especially true for the environmental "preservationist" scenario B1, as well as for the stabilization scenarios in which forest cover increases through the enhanced utilization of forests as carbon sinks.

Last but not least, we consider technology as an important driver for our scenarios. Rates of technological change are critical across all sectors. Assumptions about pace and direction of technological change are scenario-dependent, ranging from high (B1) through intermediate (B2), to low (A2r). The scenarios equally assume that technological change, which by its nature is cumulative, builds upon clusters of interrelated technologies that result in path-dependent behavior in the scenarios. Scenario A2r, for instance, continues to rely on derivatives of current technologies. Conversely, in scenario B1, technological change favors the development of alternatives that branch out to ultimately pave the way for a transition.

Technological change assumptions in the scenarios operate both at the level of aggregate trends, such as macro-economic productivity growth or resource efficiency, and at the sectoral level (e.g., crop yields in agriculture). The detailed "bottom-up" energy sector model MESSAGE deploys technology-specific assumptions on availability, performance, and costs of energy conversion technologies whose dynamics unfold over time (for an example, see *Figure 6*). All technology-specific assumptions relate to the aggregate characteristics chosen to describe the three scenarios and thus provide a consistent picture that ranges from rapid change and improvements (B1) to a straightforward conservative technology outlook (A2r) .

II. Globalization Factors and Trends Literature Review

1. Globalization—Introduction and Definitions

Globalization is not new. As many have pointed out, it has been present since the dawn of the modern human era nearly 50,000 years ago in Africa. The difference as regards modern globalization is one of degree. The globalization process, having been severely disrupted by world wars and depression in the early 20th century, again accelerated in the second half of the 20th century, and over the past 20 years it has developed significantly.

Much of the talk about globalization is either of the "for" or "against" variety, with underlying divergences as to whether or not globalization is a zero-sum game. Globalization is often greatly politicized; it is also a core issue of anti-establishment movements that focus on globalization as, for example, "Americanization," the power of global corporations, and the dismal fate of employees vis-à-vis greed for corporate profit or the negative impacts of free financial flows. Many of the standard arguments against globalization have been taken up by Wolf (2004), among others, and refuted. Proponents of globalization, among whom are many prominent economists, argue that the world economy is not a zero-sum game. Globalization provides opportunities that many nations can exploit to improve their prosperity if only they can improve productivity and spur economic growth. However, the process of growth is complex, involving many factors.

There is no single agreed definition of globalization. The term "globalization" has been widely used to describe the increasing internationalization of financial markets and of markets for goods and services. Globalization is often not distinguished from internationalization, and many people appear to use the two terms interchangeably. Economic globalization generally refers to expansion and intensification of international trade and investment; political globalization to the organization of transnational governmental and regulatory institutions and the diffusion of liberal political ideology and institutional forms; and cultural globalization, often but not always, to the spread of Western ideas and cultural practices (Manning, 1999). Wolf (2004) defines globalization as "movement in the direction of greater integration, as both natural and manmade barriers to international economic exchange continue to fall." OECD (2005) defines globalization as follows: "Globalization refers above all to a dynamic and multidimensional process of economic integration whereby national resources become more and more internationally mobile while national economies become increasingly interdependent."

Globalization as used here focuses on the economic dimension and is defined as the *integration of economic activities, primarily via markets*. Economic globalization has, in turn, cultural, social, and political consequences, which are not the focus of this review. Our objective here is to identify the main trends and factors of globalization affecting forestry in the EU. The results of this task should give an overall picture of globalization and its relation to forestry.

This literature review covers globalization in general as well as the four main globalization factors and their related indicators (see Annex 1 for further explanations on the methodological approach as well as literature references). These four factors are:

- Foreign direct investment
- Economic activity, including employment
- Trade
- Technology/know-how

For each of these factors the review also looks into globalization drivers in five dimensions, using the PESTE framework (policy, economy, social, including demography, technological and knowledge, and environmental aspects). For each of the four main globalization factors a review of overall factors and trends is complemented by a review of forest-based industry as well as forestry issues, along the same dimensions and using the respective indicator set. The term "forest sector" is understood to comprise the "forestry" and the "forest-based industries" sectors. Three dimensions of the PESTE framework (economy, technological, and knowledge) are comprehensively covered here, while three other dimensions (policy, social, including demography, and environmental aspects) are covered less comprehensively.

2. Main Globalization Factors and Trends Affecting Forestry in the EU

A total of around 100 studies were briefly reviewed, 45 of which addressed the general aspects and dimensions of globalization, 40 of which were on globalization and related dimensions concerning the forest industry, and 13 of which addressed the dimension of globalization in relation to forestry. This distribution also tends to reflect the general depth of knowledge on globalization trends and effects in these three different (and increasingly narrow) sectors. In fact, most studies on forest-based industry have addressed the forest sector as a whole and included a rather large number of studies focusing on some of the characteristics of changing economic activity (one dimension of globalization) rather than explicitly discussing globalization itself. Only a very few studies on the forest sector refer explicitly to globalization.

Overall, the situation regarding data on historical and future trends is acceptable for globalization in general, but becomes considerably weaker for forest-based industries, where reliable and systematically collected key data are often not available or are not directly comparable. Not surprisingly, data on the comparatively exposed pulp and paper industry are better and more readily available than on more fragmented industries such as furniture. The data situation for forestry is weak.

Of the individual globalization factors, most studies were reviewed in the field of general economic activities, including changes in value added, productivity, and production in general. As the number of studies on this rather general field are beyond the scope of or time available for this study, the review focuses on a number of those that take a longer perspective and an international point of view.

2.1. Globalization and forestry in general

Globalization accelerated particularly after 1989 with the collapse of the Soviet Union and of Socialism worldwide. In a globalizing economy, distances and national boundaries have substantially diminished as most of the obstacles to market access have been removed. In this global market, multi-national enterprises (MNEs) are perceived to be a key vector through which globalization has occurred and continues to evolve. According to estimates by the United Nations Conference on Trade and Development (UNCTAD), transnational companies (TNCs) now comprise some 77,000 parent companies with over 770,000 foreign affiliates. TNCs continue to be dominated by firms from the United States (USA), the EU, and Japan, which were home to 85 of the world's top 100 TNCs in 2004. Thanks to information and communication technologies, among other factors, firms continue to organize themselves into transnational networks to better exploit profitable opportunities and in response to intense international competition. In 2004 only one forest sector company was listed among the world's top 100 non-financial TNCs ranked by foreign assets. This was Stora Enso at number 85, 68.2% of whose investment was transnational (UNCTAD, 2006).

Existing studies on globalization and the forest sector emphasize the fact that the forest industry has undergone profound changes in recent years, in large part driven by new technologies. While raw materials markets and markets for standard commodity products such as pulp and paper have been "global" for some time, it is argued that a new wave of globalization has begun to further reshape the forest products industry, with moving centers of production (e.g., from the North to the South and to China) and of consumption (e.g., Asia), being more visible in the pulp and paper industry than in the structural wood sector. The emergence of large and rapidly growing economies such as the "BRIC" countries (Brazil, Russia, India, China) as competitors in raw materials markets, has heightened the awareness of forest-based industries, among other things, as new investment opportunities, as production centers, and as rapidly growing future consumer markets. This is clearly reflected in the number of studies that refer to globalization. In addition, the continuing enlargement and the increasing economic integration of the EU and the rapid catch-up process of the former "countries in transition" have profoundly reshaped the competitive landscape of virtually all sectors of the European forest-based industries.

Forestry is affected mainly on an indirect basis through the "globalizing" or at least the increasingly internationalization of forest-based industry. To date, "globalization" has not received much attention in forestry, and few studies address forestry and globalization. The studies tend to look at global effects or the effects of globalization on forests in tropical countries, for example, the weak link between trade and deforestation. The effects of an increasingly globalizing forest-based industry or an industry increasingly affected by globalization factors, are also increasingly being felt in forestry at the EU level. These major consumers have more means at their disposal to source raw materials at the global level, better access to such supply sources, and also able to invest more in production facilities abroad. Companies continue to improve labor productivity through mechanization, for instance, substituting technology for labor. Forestry's economic performance is usually seen as weak, and the increasing interest of domestic forest-based industries in investing and operating internationally only adds to the woes. This trend affects forestry profoundly, as it directly affects the shattered economic viability of the European model of sustainable forest management (SFM) and of "multifunctional forestry," including the secured provision of many other services that forests provide (often outside markets and without market-based income streams). This bleak outlook has recently changed, with new opportunities arising for bio-energy production, and some hope of benefits accruing from climate-related policies.

There are hopes that, in the long term, the sector will gain from a bio-based economy. To date, the direct and indirect effects of globalization have not been studied from the perspective of European forestry, beyond the forestry–forest-based industry nexus.

2.2. Investment, globalization, and forestry

The globalization of financial markets has triggered sharp growth in investment portfolios overall and large movements of, in particular, short-term capital, with borrowers and investors interacting through a more and more unified market. Over the period 1990–2000, foreign investment has grown at a significantly more rapid pace than either international trade or world economic production generally. In 1982 the global total of foreign direct investment (FDI) flows was US$57 billion. By the year 2000 that number had grown to US$1.271 billion—nearly 20 times the level of two decades earlier.

Until the early 1990s the main source of external financing for developing countries was official development assistance (ODA). Today, net private capital flows are multiples of ODA. The structure of private flows has also changed notably, shifting from a predominance of bank loans to FDI and portfolio investments. Services have gained the most from the surge of FDI, particularly finance, telecommunications, and real estate. The distribution of FDI among developing countries remains extremely unequal, with over one-third going to just two big countries—Brazil and China.

The globalization of corporations and industries has been led by sharp increases in foreign direct investment and relocation of enterprises heavily driven by joint ventures, cooperation agreements and strategic alliances, and mergers and acquisitions (M&A). M&A in the forest industry is expected to continue in the future, but at a slower pace than observed in the past, given the changes in the world economy and in regulations on competition (IADB, 2004).

In recent years, forest financing has been characterized by an increase in FDI in developing countries to approximately US$8–10 billion a year, and a decline in ODA to about US$1.75 billion a year. Most of the future investments in the forest industry are expected to continue to be concentrated in the pulp and paper segment. FDI in pulp and paper products tends to be around ten times higher than in other woodworking industries. FDI in the pulp and paper segment in the short and medium run will be concentrated in countries where there are low-cost wooden raw materials and a high export-market potential, for instance, Brazil, China, Russia, and some Eastern European countries. In general, pulp mills are expected to be built in South America and Russia while paper and board machines will be located in Asia, especially China (consumption-driven). The perspective is that FDI prevails from the United States (USA) toward Latin America and from Western Europe toward Eastern Europe and Russia (Tomaselli, 2006).

To a lesser extent, but also important, investments will continue to flow to the reconstituted wood panel segment, mostly for medium-density fiberboard (MDF) oriented strand board (OSB) production. Globalization has also taken many other companies in the forest cluster overseas, including wooden furniture producers. Many such companies have internationalized at least as rapidly as companies in the paper field. Similarly, some developing countries, such as Brazil and China, have invested strongly in an export-oriented furniture industry.

Numbers regarding domestic direct private investment in forestry and related forest-based activities are unavailable on an aggregate basis, both globally and in Europe. Estimations indicate that the amount of DI (direct investment) in the forest sector at a global scale exceeds US$60 billion a year, which represents about 1% of total DI in the world. In the forest sector, following the general trend, domestic direct investment is predominant. While investment in new production capacity, overall, is greater in new production and consumption centers abroad, there is also evidence of new investments in new technologies in the traditional forest industry regions, for example, in forest bio-refineries, and also co-production systems in pulp mills producing bio-fuels, electricity, and heat in North America, Finland, Sweden, and Western Europe.

In relation to forestry, direct investment concentrates mostly in developed countries and on forest plantations. This has resulted from the nature of the investment projects and their focus on economic returns. Of the total invested, around 30% is driven toward SFM (forestry) and the remaining 70% toward forest-based industries and trade. In the past few years, forestlands and especially forest plantations have been the main target for FDI. Timberland Investment Management Organizations (TIMOs) have been an outstanding source of DI in forestry. Within the last 15 years, investment in timberland from financial sources in the USA grew from almost nothing to US$11 billion in timberland assets by 2002. There are investments in both plantations and natural forests in the USA, most coming from large pension funds and endowments. In the United States, the industry has been divesting itself of forestland ownership. In the past 25 years, US forest industry lands have been reduced by 50%, with nearly half of that decline taking place in the past decade. Simultaneously, the industry has increased its ownership of offshore forestlands. Similar trends of forest industry divestment have been observed in some countries in Europe (e.g., Sweden). In Europe the most important change in forest investments has been the restructuring of many of Europe's state forest administrations to more efficiently run state forest organizations. This has often gone hand in hand in European state forest administrations, with substantial investment in information technology (IT) and equipment.

With globalization, China has become the world's forest workshop. China has now by far the fastest-growing paper industry in the world as well as double-digit annual growth in paper consumption rates. This expansion has been achieved on the back of large, modern, high-speed equipment, which is very cost-efficient. Low labor costs have not been the driving force of this development. The key factor has been inexpensive capital for investments, which is causing overcapacities and skewing competitiveness. Thus, in the wake of globalization, China has adopted the strategy of becoming a major player in the forest sector in spite of having limited forest resources, limited energy resources, and limited water supply. All this affects the structure of the global forest sector.

Russia has established a somewhat different strategy. There have been limited investments in new capacities (no new greenfield mills) and investments have been made only to trim brownfield capacities. The main feature of the Russian forest sector to date has been the export of wood raw material (nearly one-third of the yearly harvest). Europe/the EU and China have been major importers of this raw material. Russia has now established a different strategy, introducing high and increasing export taxes on roundwood. The objective is to force the industry to make investments in Russia and secure value-added production within the country. If this strategy is implemented at the scale announced, there will be sizeable direct effects in the form of structural changes in the conventional European/EU forest industry, with further substantially increased pressure on existing forest resources, along with over-harvesting in high pressure regions. It will also lead to indirect effects in the form of raw material scarcity for export-oriented production in China and probably increasing levels of illegal logging in Russia.

2.3. Economic activity, globalization, and forestry

In general, in the 1960s, open markets and trade spurred increasing productivity pressure and very rapid factor productivity growth. This was followed by a decade of stagnation coinciding with the energy crisis of the 1970s, recovery to an estimated rate of 0.8% per year in the 1980s and 1990s, and an acceleration in the 2000s (World Bank, 2007). On a global scale and across all economies, labor productivity increased by almost 11% between 1993 and 2003 (ILO, 2005). This was mainly driven by the impressive growth in labor productivity in Asia. The transition economies have experienced remarkable labor productivity growth rates since 1999 and have thereby contributed to the world's recent growth in productivity.

Revolutionary progress in communication and information technologies has enabled a historic (and ongoing) break-up of the production process to such a degree that experts now speak of a new global production process. There is an increasing realization that it is not entire "sectors" of the economy and whole classes of workers that are affected by globalization, but rather individual production tasks.

Unlike in "Mode I" globalization, where the production of whole goods was moved offshore, "Mode II" globalization breaks up individual production processes into tasks and offshores specific tasks rather than whole processes. Global competition occurs on a task-by-task rather than firm-by-firm or sector-by-sector basis. Production specialization is thus becoming even more important, allowing firms to take advantage of differences in factor costs and expertise across countries. International competition plays out at the level of individual tasks—assembly, packaging, data entry, and other services. At the same time partially processed goods can be transported more quickly and at a lower cost than ever before, spurred particularly by container logistics systems.

This globalization of competition heralds the emergence of new strategic considerations for enterprises toward further fragmentation and atomization of production, offshoring, vertical specialization, and a slicing up of the value-added chain. The increasing interdependency and global competition are resulting in changes in business models and production systems: core-competency specialization in differentiated products with an increasingly large technological content, cooperation agreements, and networking/clusters to generate synergy. Innovation competition, as a key source of variations in productivity and economic growth among countries, is increasingly under the microscope and drives the market even more than price competition does. There is no shortage of studies on the future of production and manufacturing that describe complete overhauls of current arrangements.

In the **forest sector** total gross value added (GVA) globally did not change greatly during the 1990s, with an average value of US$342 billion per year (in real terms) (FAO, 2004). Ten years later in 2000, the total GVA of the forest sector amounted to US$354 billion. Of the three subsectors, the pulp and paper industry makes the largest contribution to GVA, accounting for about half of the total gross value added in the forestry sector. The solid wood processing industry is the next largest contributor, with a 30% share of the total, while forestry activities account for the remaining 20%. This distribution of the value added across subsectors remained stable in the 1990s. In the EU the forest-based industries account for about 8% of the total value added in the manufacturing industries. During the last decade, the contribution of the forest sector to global GDP has declined from just under 1.6% in 1990 to just over 1.2% in 2000. This decline occurred because the global economy has expanded (i.e., global GDP has increased by 30% over the last decade) while value added in the forestry sector has not increased at all.

Productivity increases in the wood industries are on average 3% per worker per year (over the last decade). In the pulp and paper industry the productivity increase is on average somewhat higher, at 4% per worker per year (UNECE/ILO, 2003). High rates of increase have been sustained over rather long periods of time in some countries. This is expected to continue. Labor productivity, in particular in the pulp and paper industry, has increased significantly over the last decade. The exception is Eastern Europe, where labor productivity has fallen because of the significant fall in production not being matched by the fall in employment numbers. In comparison with the USA, EU forest-based industries have around a 20% higher labor productivity in the pulp and paper industry, while the EU woodworking industry is on a par with that of the USA.

The literature related to the forest-based industry is rather silent regarding global competition, changing business models, atomization of production, offshoring of services, and innovation competition, indicating that these are not (yet) fully visibly taking place on a larger scale in the sector. Industry relocation, that is, relocation of production of whole sectors or of firms is considerably more visible. As markets become more globalized, companies tend to rely more on plantation forests than on natural ones, particularly in the southern temperate and Asian countries, where labor and materials tend to cost less. For instance, one of the industries singled out for attention by Chinese planners is the higher-value-added wood products industry and the hardwood products segment in particular (furniture, moldings, flooring, kitchen cabinet components, and paper and fiber products). In the EU the most visible trends are new investments and to some extent relocation of production capacities into new EU member states (e.g., furniture clusters from northern Italy to Romania). Energy-intensive industries such as the pulp and paper industries will also continue to face high pressure in the context of climate change.

Innovation competition is increasingly also the focus in the forest sector. The price trend is due to the maturity of the sector, productivity increase, and the increasing globalization and relocation of production. The downward trend of forest product prices and production costs is a central driver in the relocation of forest industry from North to South and from West to East (see above). There is also an increasing awareness of the importance of securing the future, including through technological leadership. The ongoing long-term technology programs in the traditional big forest industry countries, such as Canada, Finland, Sweden, and the USA, are now showing signs of taking more specific steps to invest in pushing more concrete innovation-oriented research. This commitment is different than in the past. Clearly, the urgency to do something, or perish, is the driving force here. This is also signaled through the recent Technology Platform initiatives in the EU and USA and more innovation-oriented research restructuring in Canada.

In **forestry,** studies on economic performance, value-added production, and productivity are rare, compared to studies on other forest management topics. No study was identified that called for a closer look at how globalization impacts on the above issues. There is a range of studies comparing, inter alia, different regions in terms of cost structures. Overall, these studies imply that EU forest owners are facing increasing difficulty in competing because their production costs are higher than those of low-cost competitors outside the EU. A number of policy documents call for increased attention to be given to the decreasing economic viability of SFM, particularly in the context of threats of industry relocation driven by industrial roundwood price competition (global and regional commodity prices) and the non-marketed (in addition to non-marketable services increasingly demanded by society. This, however, is only in part a globalization-related debate; much of it concerns a European model of "multifunctional" forestry where demand for services grows while the main source of revenues to finance the model (industrial wood raw material) is increasingly subject to global price competition. Beyond frequent calls for a fuller valuation of forest goods and services, very few, if any, concrete and substantive actions have been taken to explore and develop alternative business models, such as encouraging diversified sources of income, including income from services. In short, value added in forestry remains confined to the supply of raw material to the industry. Recently, wood for bio-energy has changed the long-term buyer's market for some assortments into a seller's market in many regions, with increasing volumes of cross-border trade.

At the global level, industrial roundwood production fluctuated somewhat between 1980 and 2004, with a net increase of 14% from 1980 to 2004 (FAOSTAT database). The data show that most regions have increased their industrial roundwood production over this time frame. The Food and Agriculture Organization (FAO) estimates that the plantation share of roundwood production will grow from the current one-third to almost one-half of total global production by 2040. Roundwood production from plantation forests is likely to provide 906 million m^3 by 2045 compared with 331 million in 1995. If short-term-rotation forestry for energy purposes becomes widely established, these figures would be considerably higher. Productivity increases in forestry have ranged from zero to 10% per year, with many countries experiencing around 3–4 % per worker, per year.

In terms of prices, for nearly all the main commodity forest products and a range of major European producer countries, *nominal* prices in US$ per unit of forest product increased considerably between 1964 and 2000 (Solberg, 2005). Periods of price increases were interspersed with stable periods (e.g., 1964–1973) and periods of price decline (e.g. 1989–1993). Clear high-price years closely follow consumption and production patterns and economic growth. At least one longitudinal study of prices over the period of a century shows *real* (1999 terms) prices consistently declining from the mid-1950s, along with falling net stumpage, felling, and transport costs. It is the trend of declining *real* prices that is causing some of the global changes in forest industry relocation from North to South and from West to East (see above). The poor state of the forest industry in developed countries in recent times results, to a significant extent, from declining real prices. The price trend is caused by the maturity of the sector, productivity increases, and the increasing globalization and relocation of production.

Except for smaller reductions in 1966, 1968, and 1972, the EU and European Free Trade Area (EFTA) experienced quite a stable increase in their industrial roundwood harvest from 1964 to 1990 and from 1991/1992 to 2000. In Europe forest resources have increased considerably over the last decades. Europe has been characterized by a fairly steady overall increase in forest area over the last 50 years (1950–2000), with an increase in forest area in Western Europe in that time of almost 30%. Growing stock (per hectare) almost doubled during the same period. The growth was significantly lower in Central and Eastern as well as in southern Europe, with about 20% and 16%, respectively. Nonetheless, some assessments of the future availability of roundwood indicate an expected shortfall in Europe of 50 million m^3/year by 2020, and growth thereafter (Nabuurs *et al*. 2005).

2.4. Employment, globalization, and forestry

In 2006 the share of employment of the service sector in total global employment increased from 39.5% to 40% and, for the first time, overtook the share of agriculture, which decreased from 39.7% to 38.7%. Workers in the primary sector will constitute a shrinking share of the world's labor force, declining from about 43% in 2001 to about 30% in 2030. While the share of agricultural workers will fall by about half in developed countries, the stark decline is from an already low base. By 2030 China and India together will account for about 40% of the world's workforce, which will remain predominantly unskilled.

Rapid technological progress, trade in goods, and international sourcing of services are combining to exert new downward pressure on labor markets, particularly for unskilled labor, a problem that will become more acute only in the next 25 years. Global competition is tight in global markets for standard tasks, both in manufacturing and services. As it is increasingly individuals' tasks that are offshored, globalization may help some workers in a firm while harming others. Increasingly, it is not only "blue collar" workers or unskilled labor that are offshored, but a range of tasks across all skill levels. It is estimated that close to 20% of total employment could potentially be affected by ICT-enabled offshoring of services (OECD, 2005). Increased offshoring will therefore not systematically help or hurt skilled workers.

A strong case is being made that it is technology, and not globalization, that is driving wages down. The pressure on wages is becoming relentless, lasting longer than previously when savings were made on unskilled labor through implementation of technical change. Furthermore, leading economists assert that the adverse effect of trade on wages is not substantial. The increasing relative demand for skilled labor is expected to continue to widen the wage gap between skilled and unskilled workers in both developed and developing countries.

In the EU the pace of labor-force and employment growth in the EU25 will be weakly positive over the next 15 years and will turn negative over the period 2018–2050. This is mainly the result of declining trends being projected for the working-age population and a shift in the age structure of the population toward older, less participating groups. In terms of offshoring, flexibility is the key to allowing Europe to seize the opportunities of globalization while minimizing the adjustment costs.

Total employment in the **forest sector** (employment formally covered by statistics) is reported to have increased by about 4% over the last decade, from 12.4 million in 1990 to 12.9 million in 2000. At the global level, employment is, according to estimates by FAO (2005), divided roughly equally among forestry activities, the wood industry, and the pulp and paper industry.[1] In Europe employment has been declining substantially over the last decades. In the 1980s and 1990s this decline mostly affected the countries of northern and Western Europe. The current labor force in the forest-industry cluster in Europe is about 3.9 million full-time equivalents. Pulp and paper is the smallest subsector in employment terms with just 27% of the total. Forestry and the wood industries share the balance nearly equally between them. In the future, assuming that there are continued increases in labor productivity, reductions in employment levels are expected to be largest in Central and Eastern Europe as

[1] Note the seeming inconsistency of employment figures for forestry reported by countries for the Global Forest Resources Assessment 2005, which are given as around 10 million. This is because of the overall weak reporting (not all countries report data) and weak harmonization of data specifications (e.g., reporting of formal and informal [small-scale] employment in the case of forestry by some countries). This difference clearly shows that currently available global data are weak.

well as in the Commonwealth of Independent States (CIS). The total workforce is expected to shrink by 6.9% between 2000 and 2010. No comparable data is readily available for wages and wage change or for skills levels.

Globally, reported employment in **forestry** (excluding the wood-processing industry) declined slightly from 1990 to 2000 by about 1 million (or 10%) to around 10 million, according to new data for forestry compiled in the context of the global Forest Resources Assessment 2005 (FAO, 2006). The global economic development scenario suggests that the rural exodus could be a significant factor in the years ahead, with the share of agricultural workers dropping to less than 35% in 2030. This should raise average wages for rural workers, including workers in forestry. No comparable data is readily available for wages and wage change or for skills levels.

2.5. Trade, globalization, and forestry

The tremendous growth in international trade over the past few decades has been both a primary cause and an effect of globalization. The volume of world (products) trade since 1950 has increased 20-fold from US$320 billion to US$6.8 trillion. Trade is clearly outpacing global output—which increased by some 3.1% per year over the same period—by a factor of two or more. Between 1970 and 2004, the share of exports relative to global output has more than doubled and is now over 25%. Rapidly falling transportation costs—a trend that has been in place since the late 19th century—signified the end of the need to manufacture goods close to the point of consumption. Trade integration will accelerate. "Trade spurs growth spurs trade." The globalization of trade in goods and services is opening up new and increasingly huge markets.

Trade in services has been growing at a pace similar to trade in goods at the global level. Rising from US$358 billion in 1984 to US$2,000 billion in 2004, the share of exports of services in total exports of goods and services has advanced modestly from 16% to 17.5%. While the standard theory of trade has focused on comparative advantage, new trade theory—because of the breaking up of the production process across multiple firms and/or countries—places much more emphasis on the role of specialization and "trading in tasks."

The real value of forest products exports rose by nearly 50% over the last decade to reach a level of $US144 billion in 2000. In constant dollar terms, global exports increased almost 25-fold between 1961 and 2000. International trade in forest products has generally expanded at similar rates in both developed and developing countries. At the regional level, exports of forest products are dominated by the three developed regions. The expectation is that international trade may grow strongly in the coming years for forest product exports from Eastern European countries, Russia, and Brazil. International trade in forest products has increased at a much faster rate than the increase in production. The global value of timber harvested in 2000 was around $US400 billion and around one-quarter of that entered into world trade, representing some 3% of total merchandise trade, according to MEA (2005).

Five countries—the United States, Germany, Japan, the United Kingdom, and Italy—imported more than 50% of world imports in 2000, while Canada, the United States, Sweden, Finland, and Germany accounted for more than half of exports. There has been a major change in the US trade balance ever since, characterized by growing imports compared to exports. During the past decade, China has increased its imports of logs and wood products by more than 50%, and if this rate of increase continues unabated, it will put significant pressure on wood supplies in many regions, particularly Russia and Southeast Asia. China has also dramatically increased exports in several forest products categories, including wooden furniture.

Despite the rapid growth in international trade, the growth in forest products trade has been less than the growth of trade in other merchandise goods. The share of forest products in total merchandise exports declined from 2.9% in 1990 to 2.2% in 2000, according to FAO (2004). This downward trend also appears in all major regions worldwide except Eastern Europe, where recovery in the forestry sector has generally been more rapid and successful than in many other parts of the economy.

2.6. Technology and know-how, globalization and forestry

While the dissemination of information and communication technologies has been one of the most decisive factors in accelerating the process of globalization, the diffusion of technology at the global level may not have advanced at as swift a pace as international trade or direct investment. The globalization of technology stems from the speed with which innovations are propagated: international networks are linking to public and private research centers, and standards are converging.

Revolutions in transport and communications technologies have led to enormous reductions in cost, allowing tasks to be separated in time and space and weakening the link between specialization and geographic concentration. Instructions and information can be effectively conveyed over long distances and intermediate inputs can be transported quickly and much more cheaply than before. For example, the introduction of the container in the 1950s reduced the cost of loading a ship from $US5.83 per ton to 15.8 US cents, and even more savings came from the massive reduction of time spent by ships in port for loading and unloading

Summarizing ICT impacts on the forest sector to date, the following observations can be made. First, ICT implementation in the forest industry and wood production sector has been along "installation period" lines rather than making the kind of ground-breaking advances expected in the "deployment period." Perhaps the important exception is the globalization of the forest industry, which has been greatly enhanced by ICT development, with fundamental changes being made as a result to the industry's operating environment. Second, many ICT impacts on the forest sector are indirect. That is, ICT changes society in general which, in turn, changes the forest sector. There are also indirect ICT impacts within the forest sector itself, with many of the fundamental impacts relating to forest industries and their markets rather than to forests themselves.

The impact of ICT on consumption patterns for forest products has been an issue of great interest for a long time, especially on the future use and consumption of paper products. The possible impacts of ICT have been most clearly identified, and are perhaps most significant, for these products. Although the "paperless office" has been predicted for decades, it has thus far not materialized. Nonetheless, in the countries of the Organisation for Economic Co-operation and Development (OECD), the future trend is likely to favor electronic media at the expense of printed newspapers. Newsprint consumption in a number of OECD countries has already declined and is likely to do so even more in the future. To sum up, the structural changes in the communication paper markets due to ICT will probably be substantial both in terms of volumes and prices. Some experts suggest that developments in ICT have brought us to the beginning of the process of paper substitution.

Speeding up the transition of the sector from being largely resource-driven to being market- and knowledge-driven is integral to its success. Thus, according to some, the sector needs to extend its knowledge base from being mainly technological to also include human sciences. It also requires the current systems of knowledge production and innovation, as well as the amount of private sector funding for R&D, to be revisited. There are increasing signs that R&D is following a globalization pattern in the forest-based industry, with knowledge centers merging to form larger units in order to stay competitive and reach a critical mass in a globalizing world (e.g., Canada), together with increased networking across countries and sectors. For example, the global forest industry has R&D programs in various countries (Agenda 2020, EU Technology Platform). There is also high competition among regions within Europe and globally on R&D-related business investments, through which these regions aim to gain competitiveness or remain competitive and attractive over the medium to long term.

Some major technological innovations have started to become more widespread. For instance, engineered wood products are becoming increasingly common as a result of reductions in the availability of high-quality structural wood, competition from steel products, and cyclical wood prices. The use of engineered wood products in the North American market, for example, has grown at a rate of 20% per year since 1992, reaching more than 29 million m^3 in 1997, and according to projections rose to over 45 million m^3 by 2005. Europe lags considerably behind North America in producing, consuming, and trading engineered wood products. Bio-fuel technologies, particularly so-called second generation cellulose-based production techniques, could dramatically change the world's forest-based industries, for example, changing pulp and paper producers into multiple integrated joint-production units and energy service providers.

Technology and ICT have also reshaped forestry in many regions in Europe, particularly through improved harvesting technologies and logistics. This is expected to continue. Demand for raw material from fast-rotation forestry for bio-fuels using cellulose-based production techniques could dramatically change European forestry in some regions, just as ethanol is currently reshaping corn production in the USA. In the wake of this technological development, if it happens and wherever it happens, the increased demand for wood raw material in the EU and the limited domestic raw material supply, coupled with decreasing raw material supply from Russia (if raw material export policies are enforced as announced), will lead to sharp competition between the conventional forest industry and the energy industry, particularly for those products that are suitable for both production processes. There might be substantially higher prices as a result.

3. Further Major Dimensions Driving Globalization and Forestry

The three dimensions of the PESTE framework that are less comprehensively covered through the globalization factors (i.e., policy, social, including demography, and environment) are briefly discussed now.

3.1. Policy and institutional changes

According to OECD (2005) three major forces have contributed importantly to the recent globalization process:

- The liberalization of capital movements and deregulation, of financial services in particular

- The further opening of markets to trade and investment, spurring the growth of international competition
- The pivotal role played by information and communication technologies (ICT) in the economy.

The first two factors in particular are closely related to individual nation states' efforts to regulate their sovereign affairs in multiple competitive international arenas. However, governments are not the only major players shaping the future of globalization. States are also strongly affected by it in their efforts to coordinate the development and management of policies nationally and internationally. In fact, globalization factors such as technology, financial flows, or trade are seen as the main drivers forcing major changes in the conduct of governments and in the understanding of the traditional nation state. In an increasingly interdependent world, many issues emerge that transcend the boundaries of national sovereignty and require international coordination. These include effective rules and collaboration in phytosanitary regulations to contain potentially severe threats to human life (e.g., avian flu) or environmental impacts (e.g., beetle epidemics, invasive forest species), and the regulation of environmental threats (e.g., climate change), trade in services, and intellectual property rights protection.

The last decades have seen a rise in international governance institutions, for example, UN bodies, international non-governmental organizations (NGOs), and technical standardization bodies (multi-level governance). Another key trend is the emergence of new actors, particularly environmental NGOs that enjoy high levels of societal legitimacy. Private actors have created transnational governance institutions (e.g., forest certification) that underline their role as new players in global environmental politics. This phenomenon of new actors has given rise to conceptions of "multi-actor" governance in governmental policymaking. This represents a power shift that is often perceived as running from state rule through authority over subjects to state rule through moderating and governing citizens. ICT in particular seems to have been highly influential in creating the technical means to reorganize or reengineer national and international governance toward technically enabling more network-based policymaking and a more direct relation to citizens (e.g., through e-government).

It has often been asserted that increased trade integration reduces the frequency and probability of inter-state armed conflict. However, this seems to hold true empirically only if such trade relations are mutually dependent, and it is not necessarily evident if peace causes trade, or vice versa. In relation to international investment flows, the data available indicate that the more FDI host countries receive, the less likely they are to initiate militarized inter-state conflicts. However, a rather large number of policy studies paint scenarios of increasingly large conflicts over increasingly scarce resources, for example, over water or energy, as well as of the risks of breakdown of a fragile globalized network and coordination-based world order.

Many of the emerging trends in global policy and institutional arrangements described above are seen as highly relevant for forests and forest products, including the role of environmental NGOs in advocating biodiversity protection, governmental regulation of tariffs (considered to be largely removed) and non-tariff barriers (including phytosanitary regulations such as those introduced on wooden pallets, and perceived barriers, for example, forest certification requirements). One particularly pertinent case of a policy change with huge effects on the EU forest industry is Russia's recent decision to implement high and increasing export taxes on roundwood. This will lead to substantial pressure on the demand for roundwood, particularly in those countries most dependent on Russia's roundwood (i.e., Finland and Sweden).

Because of the high expectations of society (see below) on environmental quality and in recognizing and acting upon the realities of resource scarcity, policies will continue to push the sector toward sustainable production and better utilization of renewable and non-renewable resources, including recycling and reuse. It is likely that sustainability will be a core EU policy strategy, with policies increasingly addressing sustainable consumption and further developing tools and instruments to that end. The most recent example of a strong EU policy push toward increased sustainability of sources was made in the field of energy (EU 2007; see also EEA 2007).

3.2. Societal and demographic shifts

Societal shifts in Europe are well known and researched. They can be characterized by three trends: aging societies, shrinking societies and workforces, and further urbanization of lifestyles (if not physical relocation). In terms of globalization factors, technology is possibly the most important. Societies are drivers of technological development both through their varying levels of investment in R&D and their capacity for conducting it. Societies are deeply affected by technology, for example, through their role in promoting and supporting aging societies and changing lifestyles or work contexts.

The European demographic profile is changing rapidly. By 2050 the ratio of the working labor force and pensioners will be less than two to one, compared to more than four to one in 2000. The UN predicts that the population of the EU will contract by 7.5 million people over the next 45 years. The shrinking population and aging trends are more pronounced in Eastern and southern European countries, where there will be a significant decline in the population. (In Eastern European countries, the population is forecast to drop by 25% in the next 45 years. The median age of, for instance, Greeks, Italians, and Spaniards is projected to exceed 50 by 2050, with one in three people being over the age of 65).

This puts strains on social security systems, on companies in terms of their workforce, and on a range of other factors. For social security systems to pay for retired people, either taxes will have to go up, or state pensions and health care expenditure will have to be reduced and complemented by private arrangements. Demographic and lifestyle changes (e.g., female occupation rates, later marriages, fewer children) also change forest-related investment and consumption patterns, including in property (construction), products (furniture, paper), and services (recreation and health).

Changing demographics, including urbanization, also lead to shifts in values and the perceived benefits of forests, with immaterial benefits such as "natural landscapes" and biodiversity becoming more important, particularly in affluent societies, than wood production. Urbanization of lifestyles and affluence, currently at different stages across the EU27, changes demand. Societies become increasingly willing to pay, through subsidies (taxes) or markets, for the production of services such as recreation, ecology, water management and protection, landscape, and cultural heritage. This should drive changes in forestry, which, as urbanized lifestyles and affluence grow, is likely to become less and less dominated by commodity production paradigms and more by service/consumption concepts. It also is also likely to result in more areas being put under protection. For instance, the EFISCEN (European Forest Information Scenario Model) project anticipated expansion in the area of (forest) reserves from 4 million hectares in 1990 to 11.9 million in 2050. Note that other, more essential aspects, such as energy scarcity, can have rapid and profound impacts on lifestyle patterns and perceptions.

3.3. Climate change and future energy demand

Climate change and bio-energy are increasingly global issues that are heavily environmentally driven. To sum up, the globalization of environmental issues has had, and will have, large and multidimensional impacts on the forest sector.

Linked to globalization is the development in the consumption of primary energy which, in turn, influences future climate. Increased globalization and economic growth is strongly increasing the demand for primary energy, driven especially by the development of emerging economies like China and India. The latest energy outlook study of the International Energy Agency (IEA) suggests that global energy demand will increase by over 50% during the next 25 years and that the dependence on fossil fuel will be around 80%. Within the same time frame respected scientists suggest that the peak of conventional fossil fuels will be reached. This means a tight demand/supply situation with high energy prices and concerns about future energy security. This development suggests structural changes in existing energy-intensive forest industries at a global level and in the EU.

The increased energy consumption will strongly contribute to increased emissions of greenhouse gases (GHGs) posing a growing risk of triggering serious climate change. There is a need to stabilize the concentration of GHGs in the atmosphere at 500–550 ppm to avoid huge economic losses of global GDP. To reach this goal the global emissions need to be 25% below current levels by 2050. This means, in a business-as-usual scenario, a reduction of emissions by 2050 of 80–85%: dramatic measures will need to be taken to reach this goal.

With this development there will be increased demand for wood raw material in the EU and strong competition between the conventional forest industry and the energy industry with respect to the raw material, with substantially higher prices as a result. This can be illustrated by the recent EU proposal to reduce fossil fuel consumption by 20% by 2020. Such a reduction would not all come from wood fuels. However, if one deducts all other available sources, a harvest of an additional 400–450 million m^3/year would still be needed at the pan-European level (excluding Russia, Belarus, and Moldavia) to reach this goal. This can be compared with a sustainable harvest of 625–630 million m^3/year for the same region. Development in this direction will drive substantial structural changes in the conventional forest industry.

However, while there will clearly be increasing competition among conventional forest products and bio-energy for wood raw material, different industries will be able to venture into joint production; for example, pulp and paper plants and saw mills can produce both conventional forest products and bio-energy (bio-fuels, electricity, heat) simultaneously (forest bio-refineries). One of the ways of achieving this is more efficient utilization of current biomass (i.e., increasing competition with energy efficiency, partly by using more biomass). The increasing biomass may come from forests, agriculture, or waste biomass, or be a mixture of all these. Thus, bio-energy also provides new opportunities to the conventional forest products industry and not just to the energy industry.

3.4. Climate change, environmental change, and disturbances

With climate change the risks for forest production are also increasing. Recent studies illustrate the already high risks of forest and production loss for Eurasia, eastern China, Canada, Central America, and Amazonia under quite moderate climate change. Climate change will influence the future competitive positions of a number of regions in the EU27, including those under water stress and regions affected by frequent forest fires.

Climate and environmental change

Climate change will also increase climate variability and most probably lead to more frequent and severe extreme weather conditions. Under global change, the severity of climate and secondary stressors may increase, with consequences for future forest health and productivity.

The summer of 2003 was characterized by temperatures significantly above average and by extreme drought across large parts of Europe. July temperatures in 2003 were up to 6°C above long-term means, and annual precipitation deficits up to 300mm per year, 50% below average. Intensive monitoring data reveal growth reductions at lower altitudes, while at higher altitudes and in the far north the elevated temperatures accelerated tree growth. Forests in southern Europe seem to be better adapted to drought. The estimated reduction in GPP over Europe was about 30%. Because of drought stress in particular, the future productivity of forests may be lower than expected. However, the majority of ecosystem reactions, including increased defoliation values and tree mortality in some regions, may become visible only in the years to come.

The expected increase in intensity and frequency of extreme events may predispose forest ecosystems to become more unstable and vulnerable to secondary threats. It would then need only slight changes to trigger processes leading to environmental catastrophes. An analysis of tree rings from a boreal site and forest health assessments have revealed drought and insect defoliation to be responsible for reduced growth in predisposed stands, resulting in secondary damage by wood-boring insects and fungal pathogens. Such dieback events are mainly multicausal, with climatic extremes playing the triggering role.

The deposition of pollutants is having a similar predisposing effect on forest ecosystems. However, overall, mean sulfate and nitrate concentrations in open field measurements have been decreasing throughout Europe. The highest concentrations of these pollutants were found in parts of Eastern Europe, northern Germany, The Netherlands, and Belgium. The critical thresholds are still, however, being exceeded on many sites, although atmospheric nitrogen inputs have remained unchanged. Thus, acidification, among other factors, will also remain a driving force disturbing forest conditions in the future. Moreover, in summer 2003, harmful ozone pollution was the worst for almost a decade in large parts of Europe, particularly during the long August heat wave. Estimated ozone concentrations were higher in the south and at higher altitudes.

Despite all threats to forests by environmental change, forest growth has increased across Europe over the last decades. Under certain stand and site conditions, nitrogen deposition can contribute to this growth change; increasing temperature (at high altitudes where low temperatures are usually a limiting factor) and carbon dioxide concentration can also be a stimulus. Whether this increased forest growth will lead to improved forest condition and functioning in the long term will have to be clarified.

Storms

Recent years have also seen the disruptive impact of storms on forests and the forest sector in a number of EU27 countries. While there has been no incidence of larger-scale damage caused by insects and other pests or frost damage, the risk of such damage is clearly increasing. These environmental risks are in addition to the still and persistently high degree of forest damage/defoliation. Storm damage is one of the most important economic factors of forest damage in Europe. Over the past decades, the severity of the damage has increased. The storms in December 1999 caused the highest damage ever reported in Europe (nearly 200 million m^3 of merchantable timber).

Fires

Wildfires in Europe occur annually in all types of forests. Many forest ecosystems are adapted to low frequency fires; in isolated cases some forests even need fire to regenerate naturally. In the boreal zone of the Nordic countries, forests have co-evolved with low-frequency natural (lightning-induced) fires for thousands of years. Here, fire is a natural disturbance event that can initiate new forest regeneration across large areas. Scots pine, one of the main tree species in this region, is fairly well adapted to recurrent low-intensity surface fires. Thus, not all fires burning in the northern forests result in economic or ecological damage.

In the hemi-boreal and temperate forests of central Europe, regeneration does not naturally depend to such a large extent on forest fires. In parts of that region, fire can endanger forest management. In the Mediterranean Basin, fire is the most important natural threat to forests and wooded lands. Southern European countries, including the Balkans, are characterized by a long fire season and highly inflammable forest types.

The fundamental cause of the increasing severity of fire is land-use change and the transfer of population from the countryside to the cities. The abandonment of arable land, as well as a lack of interest in forests as a source of energy. has resulted in the expansion of wooded areas, erosion of the financial value of wooded land, and a loss of inhabitants with a sense of responsibility for the forest. This has resulted in an increase in the amount of available fuel. Regional climate change toward an increase in the frequency of extreme droughts aggravates the situation.

Model results predict an increase in severe fire weather conditions for boreal regions (especially North America and Russia). Researchers assume that forest fire regimes will respond rapidly to current climate warming.

4. Conclusions

Globalization, as it emerges, has resulted in a more fluid economic world of shifting patterns and a more differentiated model of global production. It has helped to provide access to markets and income to a large number of people. It has put different tasks, sectors, and workers under increased pressure. It is also putting a number of issues related to industrial development policy in front of policymakers, including the issue of how to best support innovation and learning, and how to address threats of job loss for particular categories of workers, etc. This is also the case in forestry. Past policies aspired to control change in forestry which was assumed to be stable. The new imperative is to develop policies to manage the capacity of forest to cope with, adapt to, and shape changes rather than ones aiming to preserve the status quo.

All main globalization factors have had, and are likely to have, an increasingly discernible impact on EU forestry. In all globalization factors the forest-based industry is the “entry gate” or carrier of globalization trends to EU forestry. The effects of globalization factors and trends impact on EU forestry through adaptive actions by the forest industry, both actively driven by global opportunity and defensive. Given that the forest industry plays a different role across the EU27, the effects of globalization on forestry vary considerably across EU27 countries.

Of all the different factors, trade in forest products is considered to play the most important overall role across the EU, through the resulting pressures on prices and adaptive actions to increased competitiveness (e.g., through investment, technological adaptation, and productivity improvement). In those regions particularly exposed to globalization (i.e., regions with export-oriented forest industries), competitive pressure and globalization opportunities have spurred cross-border investments both in Europe and globally, as well as increasing innovation competition for developing advanced technologies and products.

Globalization factors and trends have been shaped by states’ policies and institutions, and vice versa. This has led to the emergence of a dense network of international governance arrangements that can be characterized as “multi-actor” and “multi-level.” The effectiveness and legitimacy of such arrangements in containing the possible negative effects of globalization and promoting its benefits will largely determine future globalization trends. These, in turn, will be shaped by society’s actual and perceived levels of well being, as determined by many factors, including energy supply, the environment, and the stability of the social health and security system. See Annex 3 for detailed results tables.

III. Baseline State of Forestry and Recent Patterns in the Development of Forestry in the EU

1. Introduction and Objective

The objective of this task is to specify the current (baseline) state of forestry and patterns in the development of forestry in the EU. This task builds on the main results of the previous, which identify major globalization factors and trends and where and how they impact on forestry. It should establish the baseline status of forestry on which globalization impacts and the baseline scenario of development. This will be done by reviewing recent developments both in forestry and forest-based industry in relation to their competitiveness and economic functioning. This includes main market trends, supply and demand for timber and wood products, and international trade in forest products.

2. Methodology

The "Baseline state of Forestry" and "Recent Patterns of Development" (baseline trends) will be analyzed based on the "Forestry-" as well as the "Forest-based Industry State and Development Indicators" (see Annex 2). Existing databases and other information sources used for the relevant analyses include:

- EUROSTAT NewCronos, including industry and investment data;
- EUROSTAT COMEXT trade data;
- UNECE Statistical Database;
- FAO forest data, including forest owner structure etc.;
- Data of Joint Questionnaire on forest products and trade;
- EFSOS and related studies, FAO productivity study, WTO sustainability impact study, EU industry Roadmap studies; and
- Data and studies on cost and revenue structures.

For the recent patterns of development the examination period is, as suggested, at least ten years. Both areas of analysis, "Baseline State of Forestry" and "Recent Patterns of Development," are structured according to the indicator structure. They contain a quantitative section based on secondary data analysis (and expert estimates where necessary), as well as a qualitative section containing a common set of issues and questions that derive from the literature analysis as "soft" factors and issues. Detailed tables and figures are presented in Annex 4.

3. Baseline state of EU Forestry and Development Patterns

3.1. Forest Ownership and Management

3.1.1. Status of forest ownership and management

According to the latest available international data on forest ownership (FAO, 2006) in the EU27, around 60% of forests (excluding other wooded land) are in private ownership, while around 40% are publicly owned. The share of private ownership is very diverse among the EU27 countries. The highest share of privately owned forests occurs in Portugal (92.7%), followed by Austria (80.4%), Sweden (80.3%), and France (74%). If other wooded land is added, Spain comes in fourth, with a total of 78% of forests and other wooded land owned privately. State ownership includes ownership by national or regional (e.g., provincial, bodies, or state-owned commercial enterprises, as in Ireland). In several countries ownership by other public institutions, namely, cities, municipalities, communes and so on, is of considerable importance. Ownership by public institutions other than the state is most widespread in Central Europe.

According to latest data available on numbers of forest holdings, there are a total of 8.7 million forest holdings in the EU27 (excluding Romania), practically all of which are private. There are 70,000 public forest holdings in the EU27 (excluding Romania). The large majority of forest owners are non-industrial private forest owners. Only in a few countries does private industry hold a more substantial share of forest land, most importantly in Scandinavian countries. For instance, in Finland industry owns 9% of productive forest land (METLA, 2006a). Ownership sizes vary considerably between private and public forest owners. The average size of public holdings in the EU27 is about 975 ha while the average size of private holdings is 12.7 ha.[2] Moreover, the median size of private forest holdings in many countries is around 5 ha or less. For instance, the average size of private properties in the Czech Republic and Slovenia is 3 ha. Compared with former forest resource assessments, the number of holdings has decreased. It seems probable that, next to closure of unprofitable holdings and their purchase by other holdings, some countries may have excluded holdings of less than a certain minimum size from the present assessment. This could make a difference of several million in the total number of holdings in Europe. In the near future, an increase in the number of private holdings is expected in several Eastern European countries because of the continuing restitution or privatization process.

Note that a specific forest ownership enquiry was recently undertaken by UNECE/FAO in collaboration with CEPF, to be published in 2007. New data will also become available through the MCPFE 2007 state of European forests report, due to be released in November 2007.

3.1.2. Forest ownership and management change trends

The following highlights three trends in EU27 ownership and management changes that are rather typical of general developments. The examples used are:

- Privatization in countries in transition, focus on Romania;
- State forest organization change in Sweden; and
- Demographic and lifestyle changes of forest owners in Finland.

A number of further changes are also becoming visible or are ongoing, including:

- The establishment of plantations in southern Europe (Portugal, Spain, France, Italy), the further development of plantation-based forestry in Ireland and parts of Scotland, as well as the push to establish short-rotation forestry for bio-energy production.
- The ongoing change of forest management paradigms from production-oriented toward service- and consumption-oriented forestry in and around densely populated areas characterized by urbanized and affluent societies, particularly in Northwest Europe.

[2] Note that the data on ownership are for "forests and other wooded land" not for forests alone (as in the rest of the report).

- Ongoing marginal land abandonment by farmers and forest owners, particularly in Mediterranean countries, with natural expansion of subsequently unmanaged (private) forests on abandoned farmland.

3.1.2.1. Ongoing privatization in countries in transition

In the countries of Central and Eastern Europe (CEE) formerly under centrally planned economies, forest resources and forest industries were owned or controlled and managed by the state for more than four decades. With the political change, countries also began examining privatization possibilities in the forest sector. The question of restitution of forest resources to former owners and using forest property to compensate them for the losses they suffered through expropriation in the late 1940s was and remains a hot political issue. The share of private forests in Poland and Slovenia is not the result of privatization, as these private forests already existed in the Socialist period. Most CEE countries have set a policy imposing an upper limit to the privatization of forest resources. Substantial forest resources, it is felt, have to remain state property to secure the provision of social and environmental services of forest resources on a sustainable basis. Often, the better quality forests or forests with high environmental values are retained by the state.

For instance, in Romania in 1946, 30% of the forest resources were privately owned and 46% of all forests belonged to the communities. In 1985 private forest was at 0%, increasing to 5% in 1995. Between 1991 and 1999, property was restituted according to the Forest Act of 1991, whereby a uniform area of 1 ha of forest was returned to former private forest owners. In a second stage, starting in 2000, the maximum amount of forest restituted per owner was 10 ha. By 2003, a total of 7.8% was private forests, with an average size of 0.68 ha (Bouriaud *et al.*, 2005). A new forest restitution law in 2006 has removed forest area restrictions. This stepwise process has resulted in highly fragmented private forest ownership.

In many of the European "countries in transition" from centrally planned to market economies the privatization or restitution process is still evolving and not concluded. While in some countries, such as Poland and the former countries of Yugoslavia, some private ownership did exist in recent times, in others it did not (Albania, Bulgaria, Romania). In Hungary, Latvia, and Slovakia private ownership has already grown to and now accounts for around 40% or more of forest area.

In the new EU member states the former overall dominance of the state administration in forest management has somewhat changed with the emergence of new types of forest owners. Because of restitution processes and privatization, the number of private forest holdings has increased considerably. However, in most of the countries, the average holding size is very small, usually less than 5 ha. Moreover, many of the new forest owners are in a difficult situation, with often little or no formal training in forest management, poorly developed markets and infrastructure, and sometimes little long-term interest in forest management. The high share of non-operational private forests without any management activities and lack of capacity in private forestry is a pervasive issue.

3.1.2.2. Strategic changes in state-owned forest management

Many, if not most state forest organizations have generally gone through something of a substantive change over the last decade, both in old and, in particular, new EU member states. (see above). The pattern of change of the example chosen here, AssiDomän AB in Sweden, illustrates a larger change that has taken and continues to take place in Central Europe (e.g., Austria, Bavaria), the Baltics, and northwestern Europe.

AssiDomän AB, the largest forest owner in Europe with 2.4 million ha of productive land in Sweden, has undergone changes that reflect a trend in state forest ownership change among production-oriented countries:

1850	State land ownership was at minimum level;
1859	Foundation of Domänverket (State Forest Service);
1875–1955	Purchase of 640,000 ha;
1975	Domänverket's land holdings of 6.2 million ha, of which 4.10 million ha are productive forest land (20% of productive forests in Sweden);
1992	Domänverket transformed into Domän AB, still 100% state-owned;
1992–1994	Domän AB Land holdings: 3.4 million ha; ownership: 100% state-owned company;
1994–1999	AssiDomän AB Land holdings: 3.3 million ha; Ownership: 51% state-owned company;
1999	AssiDomän AB Land holdings: 2.4 million ha; Ownership: 35% state-owned company;
	Sveaskog AB Land holdings: 0.9 million ha; Ownership: 100% state-owned company.

One of the most important drivers in terms of moving from being a national enterprise to becoming a limited company has been international trends (market economy taking over, globalization of economics, increasing competition) along with changes in government.

The creation of Sveaskog in 1999 was mainly driven by the state's wish to divest itself of forestry areas outside core areas and of areas of less commercial value, and thereby reduce state ownership of the company. This was intended to allow higher efficiency and competitive power and thereby increase profitability. In 2002–2006, Sveaskog, commissioned by the government to sell forest land to private forest owners, continued selling forest land to small private owners, bought forest land, and strongly increased activities related to eco-tourism, hunting, forest protection, and R&D. Note also that Swedish forest companies are not allowed to invest in forest land (unless they sell an equal amount of land).

3.1.2.3. Demographic and lifestyle shifts—Toward urban forest owners

A couple of decades ago, the typical Finnish forest owner was a male farmer living in the country with little formal education. In 2003 only 19% of forest owners were farmers, compared to 23% of forest owners who were paid employees. The factor with the greatest impact on the structure of the forest owner group is the aging of the population, which means that the largest group of forest owners are pensioners (43% of forest owners in 2003). The number of forest owners living in towns, big and small, is growing and stood at 40% in 2003. Nevertheless, 60% of forest owners still live in sparsely populated areas, and only 20% live in cities with more than 20,000 inhabitants. Half of the forest owners still live on their holdings (METLA, 2006a). The share of farmers (as main occupation) among forest owners in West Germany ranges between 14% and 48% (Mantau *et al.*, 2005).

This situation is quite common in other parts of Europe. For instance, in Central Europe, based on representative survey data (Rametsteiner *et al.*, 2006), the following situation is characteristic: responsible positions as forest owners or managers are highly male-dominated, with an estimated 90% or more of forest owners or managers being male. Only in the category of below 10 ha are women somewhat more visible. Almost two-thirds of owners are more than 40 years old.

3.1.3. Growing stock and balance of increment and fellings

The share of forest and other wooded land of the total land area in EU27 countries ranges from around 68% in Finland and Sweden to 1% in Malta. A study by UNECE, compiling data over the last half century (UNECE/FAO, 2003) shows that forest cover has expanded steadily over the last half century. Growing stock and net annual increment have been characterized by a higher degree of volatility, which indicates that problems remain in the consistency of such inventory data over time. Gross forest area keeps expanding, because of land-use changes. In the past few years, forest area has increased in the United Kingdom and Denmark particularly. According to UNECE/FAO (2003), changes in forest area are mainly caused by afforestation of former agricultural lands, with the aim of increasing long-term timber supply, increasing the level of non-wood goods and services, and providing alternatives to the agricultural use of land. In general, afforestation activities have slowed down since 1980 UNECE/FAO (2003).

A result of the increasing forest area is an increasing total growing stock. The average annual increase in the growing stock in Europe as a whole amounts to nearly 620 million m^3/year. The total growing stock in the EU27 comprises some 20 billion m^3, according to latest available data from FAO (2006), most of which is located in Sweden, France, Finland, Italy, Romania, and Austria (data for Germany was not reported for FAO 2006). Growing stock per hectare ranges between 300 m^3/ha in Austria and less than 50 m^3/ha in Spain, Greece, and Cyprus. The EFISCEN project predicts that even if fellings remain at the current level, Europe’s average growing stock will rise from 137 m^3/ha in 1990 to 226 m^3/ha in 2050.

According to latest available data, the total increment in the EU27 is 756 million m^3, compared to total (reported) fellings of 430 million m^3. The increment per hectare decreases toward northern and southern Europe because of more unfavorable climatic conditions. Compared with former assessments of the UNECE/FAO, the absolute increment as well as the increment per hectare is steadily increasing because of improved growth conditions. The country with the largest quantity of annual fellings is Sweden (73 million m^3), followed by Finland (68 million m^3), and France (65 million m^3). The low levels of utilization of the increment in some countries might be a consequence of low or lack of profitability, management objectives like biodiversity conservation or recreation areas, or ownership structures (i.e., in general, small private holdings are not intensively managed and data quality on fellings is often considerably weaker than on increment). Moreover, the data on annual increment refer to the total forest and other wooded land area, whereas data on fellings relate only to the forest area available for wood supply, which in some countries may be considerably smaller. Moreover, not all increment is accessible for harvesting, for biological, technical, or economic reasons. A simple comparison between annual increment and fellings may cause misleading assessments of resource availability.

3.2. Investment

3.2.1. Domestic investment and gross fixed capital formation

Investment is usually divided into domestic and foreign, public and private. In general, and on a global scale, private funding with over 90%, dominates forest finance and domestic investment constitutes over 90% of private sector flows. These figures are rough estimations whose magnitude is also considered to apply to the EU27. While some countries collect and publish detailed data, overall very little is known about the volumes invested in forestry, both private and public. A research project on public funding, covering 19 countries in Europe for the period 1990–1999, found the following (EFI, 2005): The amount of public funding to forest areas varied greatly from an average of €0.81 per ha in Estonia to €1,874.39 per ha in the Netherlands and €1,560.13 per ha in Switzerland.

During the 1990s, four categories of activities received more than one-half of all public financing in 11 countries[3] and the Catalonia region of Spain (EFI, 2005):

- Forest protection (16.7%);
- Planning and forest inventory (16.3%);
- Infrastructure (14.1%); and
- Afforestation and reforestation (12.6%).

These funds, according to EFI (2005), were largely domestic funds in a number of countries, supported by EU funding. The forestry measures of the EU rural development programs allocated some €4.8 billion for forestry measures from the EAGGF under the Rural Development Regulation (CR No. 2157/1999) between 2000 and 2006, accounting for approximately 10% of the total rural development budget (EU, 2003).

In terms of capital stock, the statistical aggregate of Gross Fixed Capital Formation (GFCF) is a measure of the net new investment by enterprises in the domestic economy in fixed capital assets during an accounting period. It is usually defined as the total value of additions to fixed assets by resident producer enterprises less disposals of fixed assets during the quarter or year, plus additions to the value of non-produced assets (such as discoveries of mineral deposits, or land improvements). While it is not possible to measure the value of the total fixed capital stock very accurately, it is possible to obtain a fairly reliable measure of the trend in new fixed investment.

Given the structure of forest ownership sizes in Europe, it is easy to see that the vast majority of forest owners will fall outside any statistical data collection efforts, and only larger private forest owners, industrial companies, and state forest organizations will reach a company size that would allow more substantive fixed capital formation through acquisition of forest land, infrastructure, and harvesting equipment investments. No data are usually publicly available for shareholding companies to determine their GFCF. However, as an indication, the investments in 2005 in fixed assets and shares of Sveaskog, Sweden's largest forest owner with 15% of the country's productive forest land, amounted to MSEK 152 (103 in 2004). These mainly relate to forest machines and roads. Sales of fixed assets, primarily forest properties, amounted to MSEK 797 (628 in 2004) (Sveaskog, 2006). This, in effect, is a net reduction in fixed capital. Metsahallitus, a state enterprise that administers more than 12 million ha of state-owned land and water areas in Finland (of which managed forests are 3.5 million ha), invested around €21.4 million in its forestry operation in 2005 (calculated, interestingly, on the basis of the market price of the trees retained). The average return on investments in the period 2000–2004 for the whole company is 9%. No data are currently publicly available on GFCF in forestry per country.

3.2.1.1. Case: Domestic investment in Finland and Sweden

The following case describes trends in investment in forestry and the forest industry in Finland, a leading forest industry country in the EU27. *Figure 7* shows not only the

[3] (Czech Republic, Estonia, Slovenia, Poland, France, Belgium, Germany, Switzerland, Netherlands, Finland, Norway).

substantive investment undertaken annually since the early 1980s in the forest industry, but also the high level of fluctuation over the years, with a recent cooling-off period which, together with increasing overseas investment, led to a lively debate concerning the future of forest industry in Finland.

In comparison, according to METLA (2006b), total investment in timber production in Finnish non-industrial private forestry in 2004 was almost €170 million and €175 million in 2006, with a share of financing by private forest owners of almost €120 million (METLA 2006b). Overall, however, investment in timber production has fallen considerably since the early years of the decade in Finland (METLA 2006b).

In the case of Sweden, the investments in the pulp and paper industry during the last 15 years has been of the magnitude of €1 billion per year. The investments in the other forest industries have been substantially lower or about €0.45 billion per year (see *Figure 20*).

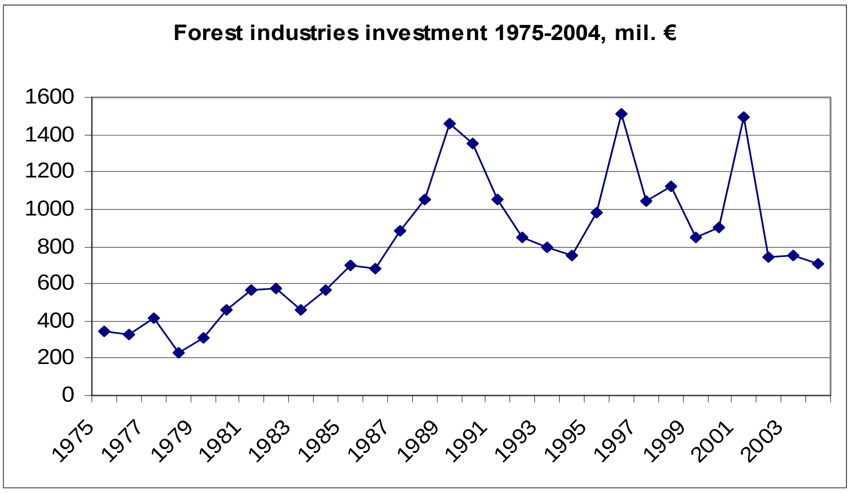

Figure 7. Investment of forest industries in Finland 1975–2004 (woodworking as well as pulp and paper industries), in million €. Source: METLA (2006a). See the electronic version of this report for colored figures.

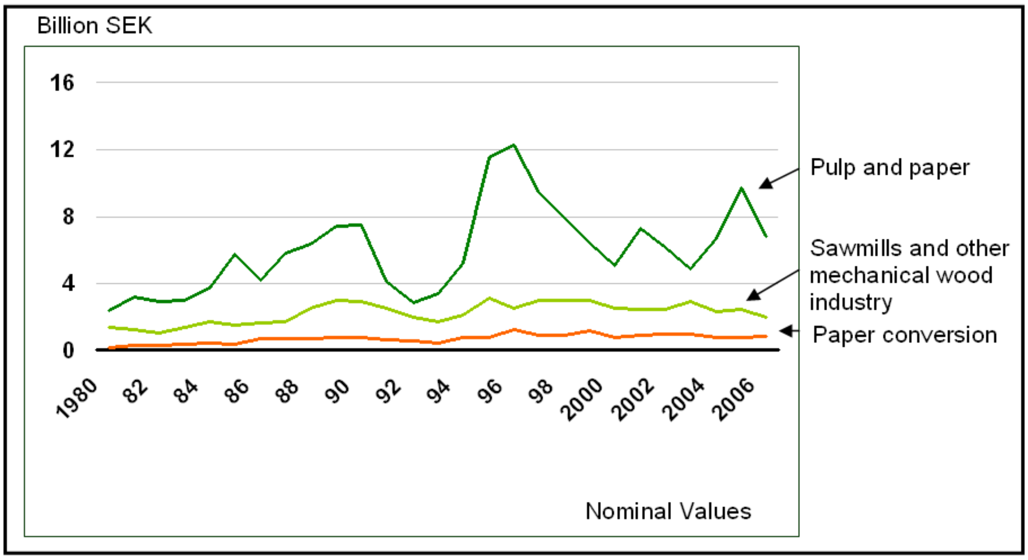

Figure 8. Investments in the Swedish Forest Industry 1980–2006. See the electronic version of this report for colored figures.

3.2.1.2. Case: UK forestry net expenditure

Net expenditure on public forests by the UK Forestry Commission in 2005–2006 totaled £66 million. £56 million was used to fund forest management and development, £32 million for recreation, conservation and heritage, and £39 million for harvesting and haulage. This should be compared with a total income of £62 million generated from timber sales in 2005–2006 (Forestry Commission, 2006), see *Table 5.*

Table 5. Net expenditure in public forests by the Forestry Commission. Source: Forestry Commission (2006).

	million £
2001–2002	49.2
2002–2003	74.2
2003–2004	66.4
2004–2005	62.1
2005–2006	65.6

3.2.2. Foreign direct investment

EUROSTAT collects data on FDI investment flows into different sectoral activities in the EU27 and outside. However, data on FDI in the category "Wood, publishing and printing" as well as on investment in forestry are only available for some of the EU27 countries, and only for some years. FDI in forestry (outside the EU27) is mainly undertaken by large Scandinavian companies in growing consumer markets (such as China) or strategic raw material producing countries (such as Brazil, and to a limited extent, Russia).

Cross-national "FDI" within the EU27 is considerable, however, and focuses on forest industry development, including the pulp, paper, sawmilling, and furniture industries. Considerable investments have been undertaken in the industrial development of the Baltic (see Ollonqvist *et al*., 2006) and some Southeast European countries, where both raw material abundance and comparatively cheap labor costs, among other factors (such as these countries also being emerging consumer markets), has led to industry relocation (e.g., furniture clusters from Northern Italy to the Balkan countries, particularly western Romania, see Cesaro *et al.*, [2006]) and investment in new and additional production capacities (e.g., pulp and paper production in Eastern European countries). Foreign capital has also been invested in many other countries, including Ireland and Scotland, where new raw material has become available following larger-scale afforestation. In Ireland in particular, inward FDI has been strongly promoted through low corporate tax. Large investments have also been made recently in panel production and sawmilling in Austria, Switzerland, and Poland, among others. Regional aid and investment support (e.g., for greenfield sawmills), have contributed to raw material scarcity and price hikes, particularly in recent years.

3.2.2.1. Case: StoraEnso investing in forest land in China and Brazil and disinvesting in non-core business forest land elsewhere

In 1998 two of the largest forest industry companies in the EU merged: STORA and Enso became StoraEnso. Less than two years later in September 2000, trading in the company's shares started on the New York Stock Exchange.

In 2002 StoraEnso restructured its ownership of forest lands in Finland, selling 59% of its shares in its Tornator forest company to a new company established by Finnish institutional investors and leaving itself with a 41% share. At the same time, StoraEnso North America sold some 300,000 acres (125,000 ha) of forest land to Plum Creek Timber Company, Inc.

In 2004 StoraEnso finalized the restructuring of its forest land ownership in Sweden. The group's Swedish forests were transferred to Bergvik Skog AB with the majority of its shares being sold to institutional investors and StoraEnso retaining a 43.3% stake. StoraEnso also finalized the divestment of its 146,000 ha of forest land in Ontario, Canada, as well as of its plantation interests in Indonesia. The area planted for commercial use in Indonesia was approximately 35,000 ha and the concession area 299,700 ha.

In November 2005 StoraEnso signed an agreement with Gaofeng Forest Pulp and Paper Company that will enable StoraEnso to increase its land concession rights and wholly owned plantations in southern China to approximately 60,000 ha. In the same year, it also announced that it had started purchasing land in southern Brazil and Uruguay for fast-growing plantations. As in Brazil ten years ago, StoraEnso has started buying land and planting forest in China.

In September 2006 StoraEnso signed a contract with Beihai city in Guangxi province, China. In the period 2006–2008, Beihai city will provide StoraEnso with a total of 30,813 ha of plantation and land by purchasing existing plantations and establishing new plantations on forest land. The aim is to create a sustainably managed fiber base of 160,000 ha of plantation land by 2010 to support the establishment of an integrated pulp and paper million in Guangxi in the long term (StoraEnso, 2007). This investment of US$150 million in eucalyptus plantations in Southwest China should safeguard future roundwood procurement (METLA, 2006b). The company also bought approximately 50,000 ha of land, of which approximately 30,000 ha are productive plantations in Brazil (StoraEnso, 2007).

3.2.2.2. Case: Government-assisted investment in forest raw material supply—UPM-Kymmene and Botnia in Russia and Uruguay

The Northwest Russia Forest Investment Project was launched in 2001 by the World Bank International Finance Corporation (IFC) with funding from the government of Finland to develop forest industries in Northwest Russia and to particularly address ongoing timber supplies of the required quality and quantity for sawmills and pulp mills operated by UPM-Kymmene, the second largest forest company in Europe, and Botnia, Europe's second largest pulp producer, of which UPM Kymmene owns 47%. To date, the project has facilitated about US$236 million of investments in Russia, far exceeding the initial target of US$50 million (IFC, 2005). More recently, UPM bought a Russian timber harvesting company that has around 184,000 ha of forest leased from the Russian state. Botnia, through Forestal Oriental S.A., bought a total of 156,000 ha of land in Uruguay to supply parts of the raw material of a new (and controversial) pulp mill in Uruguay, also assisted by IFC and the Multilateral Investment Guarantee Agency (MIGA) which are each investing US$170 million and acting as guarantors for up to US$ 350 million for Botnia's pulp mill project in Fray Bentos, Uruguay (Botnia, 2006).

UPM still has the largest amount of its own forests and forests under management/lease in its home country, Finland. It owns 920,000 ha of forestry land (managed through a separate company, Silvesta, which will specialize in forestry work) and has approximately 9,000 separate forestry service agreements with private forest owners in Finland, adding some 280,000 ha. It manages 953,000 ha of forests in Canada, as well as forests in the UK (154,000 ha) and the US (UPM, 2006).

3.3. Economic Activity

3.3.1. Gross value added

Gross value added at basic prices corresponds to the value of output (at basic prices) less the value of intermediate consumption. The contribution of forestry and manufacturing of wood and paper products (i.e., the forest sector, to gross domestic product (GDP) or gross value added [GVA] indicates its macroeconomic importance). It can also give an indication of the role of the forest sector in rural development. Data on the contribution of various sectors to the gross domestic product have been collected for decades for nearly all European countries. The European Statistical Office (Eurostat) collects data on GVA by branch of activity. In its Economic Account for Forestry, it reports GVA (value at basic prices) in forestry for the EU15 in the year 2000 to be €11.7 billion. Internationally harmonized data for forestry activities are available only for a range of European countries up to 2000. Data available for Sweden 1990–1999, the UK 2000–2004, and Finland 1990–2000 show similar slightly upward trends. In comparison, trends in countries such as France, Italy, and Greece are flat over the period 1990–2000.

For all other countries, the share of forestry activities is usually reported as a combined figure for ISIC/NACE category 02: Section A: “Agriculture, hunting and forestry.” The true share of forestry may vary considerably because of the relative importance of forestry and agriculture in respective countries. The share of total gross value added of the agriculture, hunting, and forestry sector combined (ISIC/NACE 02) at basic prices for the year 2000 is higher than 10% in Bulgaria and Romania. In both countries agriculture plays a major role.

In Europe as a whole the contribution of the forest sector to GDP has declined from 1.4% in 1990 to 1.1% in 2000. In most Western European countries there was a marked decline over the period 1990–2000. The countries with the largest contribution are Finland (7.9 to 7.5% of GDP), Sweden (4.9 to 3.4% of GDP), followed by Portugal (3.1 to 2.1% of GDP) and Austria (2.4 to 2.2% of GDP).

3.3.2. Production (industrial roundwood, wood fuel, non-wood goods, services)

Forests provide a wide range of goods and services. Commercially, however, by far the most important product from forest in the majority of EU member states is wood, mainly roundwood, and to a minor but growing extent, wood fuel. Forests provide a variety of products other than wood. Non-wood forest products are, for example, Christmas trees, game, mushrooms, cork, berries, nuts, and others, such as medicinal plants. Non-wood goods and services are niche markets in terms of income for the EU27 region overall. However, non-wood goods often have high economic importance for forestry in particular countries, for example, cork in Portugal.

3.3.2.1. Industrial roundwood

Data on current levels and historical trends in industrial roundwood[4] removals of the EU27 countries show Sweden to be the leading country in terms of industrial roundwood removal at around 68 million m^3 in 2003, followed by Finland, Germany, France, and Poland. Data also show the steady increase in roundwood harvests in Sweden since the early 1980s and a similar increase in Finland. In comparison, roundwood removal in Germany and France was comparatively stable, with a marked peak in 2000, caused by storm damage. There has been a constant increase in roundwood production in Poland since the early 1990s. In comparison,

[4] Roundwood comprises all quantities of wood removed from the forest and other wooded land and is reported in cubic meters under bark (i.e., excluding bark).

most other EU27 countries produce considerably less, and have also seen less dramatic increases in production, with the exception of Estonia and Latvia, which showed the most dramatic increase in the decade 1993–2003 with an increase of almost 420% for the former and close to 270% for Latvia. The estimated value of industrial roundwood removal in 2005 is available for 18 of the 27 EU countries and amounts to a total of US$11.1 billion or around €8.4 billion at current exchange rates.

In recent years in particularly, there has been increased demand for roundwood and forest products in a number of areas, with shortages indicated for some areas such as southern Sweden, and sometimes tight supply in other regions such as Ireland and Scotland. Russia's recent decision to implement high and increasing export taxes on roundwood will lead to substantial pressure on demand for roundwood, particularly in those countries most dependent on Russia's roundwood (i.e., Finland and Sweden). If implemented as planned, it will force companies to shut down production units.

3.3.2.2. Wood fuel and solid biomass for energy

Wood fuel is wood in the rough for use as fuel. Wood fuel removal, according to official data, has declined steeply in some countries since the early 1960s, particularly in France, Finland, and Spain, followed by Romania. Note that the figures for France (the largest producer for the 1960s and 1970s) are possibly a good overall indication of the weakness of data reported on wood fuel in many countries. In other countries the reported amount of removal for wood fuel started to increase in the late 1970s and early 1980s. The largest producers in 2003 according to UNECE/FAO data are Sweden, Italy, and Germany, followed by Finland. The production of the EU27 shows a steep decline from 1964 from 62 million m^3 to almost half this amount in 1978 and a continuous upward trend in wood fuel removal up to 48 million m^3 in 2003. Note that self-consumption is usually not included. Note also that international harmonization of reporting on wood fuel has taken shape only quite slowly over the last decades.

Wood for energy is provided directly from forests, as well as indirectly, mostly in the form of residues from the wood processing industries (black liquor) and through burning recovered wood products, such as pallets, construction wood, and furniture for energy. Wood energy supply and use is much larger than wood supply directly from forests, as covered by the wood fuel data above. In fact, wood energy from wood processing residues (black liquor in pulp and paper production) is a major component of wood energy supply in many countries. Becker (2006), extrapolating from 12 countries studied in Europe as a whole (excluding Russia), gives a very rough estimate of the *direct* supply of wood energy at about 250 million m^3/year, which is a considerably higher figure than that for wood fuel reported to the UNECE/FAO (48 million m^3 in 2003).

The EU25 primary energy production of solid biomass (principally wood and wood waste, but also straw, crop harvest residues, vegetal and animal waste) reached a total of 58,800 million tons of oil equivalents (MTOE) in 2005, an increase of around 5.7% over 2004. European electricity production of solid biomass origin also shows marked growth, with a 16.2% increase between 2004 and 2005 (+6.1 TWh or a total of 44.1 TWh), according to EurObserver (2007) data.

3.3.2.3. Non-wood forest products

Non-wood forest products consist of goods of biological origin other than wood, derived from forests, other wooded land, and trees outside forests. Data are available for 14 of the EU27 from FAO (2006), the most recent data collection (apart from the recently concluded, but not yet released data for the upcoming MCPFE 2007 report). At best, some countries collect data on the most important products or have data on commercial production or exports. Personal use often accounts for the largest share of use, but goes unreported.

The total value of non-wood forest products removal in these 14 countries according to FAO (2006) is US$1.48 billion. Data reported range from more than 400% of value accrued through non-wood forest products in Denmark (Christmas trees) to close to 0%. According to MCPFE data, the most important non-wood forest product in the EU27 is game, followed by Christmas trees, mushrooms, and cork.

Non-wood forest products are not seen as economically important in many countries, and because of the difficulties and costs of collecting accurate data, many countries do not collect and report data on them. At the same time, the values of non-wood forest products show that they can be an important source of income, especially in rural areas. There is evidence that in a range of EU countries, including the Mediterranean countries, NWFPs have a leading economic importance (Pettenella *et al*., 2006). The case of Italy is remarkable in this regard: according to official data, the collection of wild mushrooms, truffles, chestnuts, and berries in many regions is much more important—in economic terms—than wood. In Finland, the total calculated value from NWFPs was €108 million in 2005, of which €71 million came from game. The total NWFP value was only 6.4% of the total timber value (including wood chips, commercial, and household use) (METLA, 2006a).

3.3.2.4. Services

Marketed services have seemingly gained in political importance in recent years. They include, for instance, hunting licenses, fishing licenses, private contracts for conservation, managed outdoor recreation areas or trails for mountain biking, horse riding, skiing, and other recreational activities. However, data on marketed services is very poor indeed. In Central Europe, according to Rametsteiner *et al*. (2006) services contribute very little to the turnover of forest holdings. The most important further income source from services are services for other forest holdings. This, among other things, is an important additional source of income for very small forest holdings. According to the same authors, game contributes a very small share of income, even for larger forest holdings, on average across Central Europe. Renting includes hunting leases but usually result in low additional income on average. According to MCPFE, for instance, forest owners in Denmark earned €22 and Hungary €18 million in 1996. In France, the Office National des Forêts, managing 4.6 million ha of forest and woodlands (27% of French forest land), had gross hunting revenues totaling €41 million (76% through auctions) in 2004 (ONF, 2005).

Forests play a highly important role as providers of other services to society, like recreation, attractive landscapes, CO_2 sequestration, erosion prevention, hydrological regulation, biodiversity preservation, etc., which are not marketed and often are unaccounted for. While the research undertaken in Europe on such “forest externalities” is considerable, they are generally not coordinated, focusing on one or a few local externalities—of very uneven quality and rarely with a regional or European vision. In an effort to calculate the total economic value (TEV) of Mediterranean forestry, Merlo and Croitru (2005), found that the TEV is around 133 €/ha/year, of which the value of wood is only around 47 €/ha/year, or around 35% of the TEV. It is also notable that services for nature conservation have practically no source of income at the moment. Payment for environmental services is not yet a strong and visible issue in Europe, and even less a source of income. However, some countries have introduced payments to compensate the forest sector for the provision of drinkable water. Voluntary initiatives related to the “Kyoto forests” as compensatory investments for CO_2 emissions are also starting.

3.3.3. Productivity

The available data show huge differences in labor productivity in the EU27, a consequence of different production conditions, both biophysical and technological, as well as management approaches. According to data from FAO, Sweden is by a large margin the leader in terms of labor productivity in forestry, followed by Finland and Austria. All three countries have a substantial export-oriented forest industry. The data also show the high potential for increased productivity in many Eastern and Southeast European countries, particularly Bulgaria and Slovakia. Note that internationally available data on employment in forestry are often rather weak and tend to be less harmonized than, for example, data on roundwood production.

According to FAO (2004), labor productivity (in m^3 total roundwood per employee) in forestry (ISIC/NACE 02) has remained quite stable over the period 1990–2000 in Western Europe, with a slight downward trend over the decade (around 3,750 m^3/employee in 1990 compared to around 3,600 m^3/employee in 2000). In comparison, Eastern Europe has seen falling labor productivity, from low levels at around 550 m^3/employee in 1990, due to declining production, without a corresponding decline in employment numbers. Since the mid-1990s, productivity in Eastern Europe has started to grow consistently and, in 2000, reached a level that was equal to 80% of the 1990 level. Nordic countries showed the most noticeable growth in labor productivity, with a 100% increase over the period 1990–2000. Note that, as in many other areas, official internationally comparable data are weak and usually fail to capture self-consumption or small forest holdings (self-employment).

3.3.4. Employment

Employment provided by forestry is an important contribution to the socio-economic benefits generated by forests, especially for sustainable rural development. According to data from FAO (2006), employment in forestry in the EU27 fell by more than 20% between 1990 and 2000, from 661 to 548 thousand person-years. In Germany, more people work in forestry (calculated in full-time equivalents) than in any other of the EU27 member states, followed by Eastern European countries. The data also shows the dramatic decrease in forest work in Poland and Romania in the period 1990–2000.

The European average of employment as a proportion of the total labor force remained stable over the years 1998 to 2000, with an EU27 average of 1.4% of the labor force being employed in forestry (ISIC/NACE Division 02). In Estonia and Latvia, forestry's proportion of the total labor force is more than double the European average, and grew steadily between 1995 and 2000 Finland followed (see Annex 4).

3.3.5. Costs and price developments

Data on roundwood log price developments in nominal prices collected by UNECE/FAO over the period 1990–2006 for spruce demonstrate the relatively high roundwood log prices for spruce/fir in Austria, compared to Finland and Lithuania. However, according to national price data for Lithuania, Estonia, and Latvia, raw material prices are already close to Finnish prices. Data on standing sales and sawlog price indices, in real terms over a 25-year period in the UK, demonstrate the downward price pressure. The standing sales price index measures the average price received per cubic meter of standing sales timber from Commission sales. The softwood sawlog price index measures the average price received per cubic meter of sawlogs from Forestry Commission sales.

3.3.6. Profitability and return on investment

EUROSTAT, in its Economic Accounts for Forestry, reports entrepreneurial income[5] (at basic prices) for the EU15 to be €6.1 billion in 1995. The EU15 figure for 2000 is the only year for which entrepreneurial income is reported (EUROSTAT, 2005). For a number of countries, national data are available on the profitability of investments. Usually, data availability across countries reflects the relative importance of the forestry and forest-based industry sector in the national economies. The following section provides data from countries in three regions: Nordic (Finland), Northwest Europe (UK), and Central Europe (Austria)

3.3.6.1. Case: Profitability of forestry in Finland

In Finland profitability, calculated as the investment return on forest ownership, decreased considerably during the period 1995–2001 and has been on an upward trend since. On average for the period 1993–2003, profitability was 4–5% (METLA, 2004). Per-hectare net earnings in non-industrial private forestry were around 90 €/ha in 2006. In real terms, this figure is some €25–30 below the net earnings in the peak years of 1997–2000 (METLA, 2006b). *Table* shows net earnings of non-industrial private forest owners to be around 90 €/ha per year, according to METLA (2006b).

Table 6. Finland: Non-industrial private forestry balance sheet calculation for 2005 and forecast for 2006–2007, €/ha. Source: METLA (2006b).

	2005	2006	2007
Gross stumpage earnings	106.0	103.4	110.9
Gross costs	20.9	21.7	22.0
Subsidies	4.3	4.3	3.9
Net earnings (before tax)	89.4	86.0	92.8

3.3.6.2. Case: Profitability of forestry in the UK

Returns to the UK forest owner are made up of sales of timber (standing or felled), sales of other goods and services, increases in the value of the woodland (from annual increment or market factors), and the net income from subsidies (e.g., planting grants), less taxes. Estimates of the overall return from commercial sitka spruce plantations are produced annually in the Investment Property Databank (IPD). In the UK, the total return from forestry in the three-year period 2002 to 2005 is estimated to have been 8.2% per annum. This represents a recovery from the negative returns of recent years, and is similar to the level in the mid-1990s (Forestry Commission, 2006).

Note that tightening raw material supply, where it occurs, will put considerable upward pressure on prices, which in turn should increase the profitability of forestry. If Russia's roundwood export tariff policy is implemented as planned, this will force forest industry companies to shut down production units.

3.3.6.3. Case: Profitability of forestry in Austria

In Austria, one of the best-documented countries in the EU27, data based on the EUROSTAT Economic Account for Forestry statistics manual show that production in forestry, GVA, as

[5] The entrepreneurial income account makes it possible to measure income, which is similar to the concept of current profit before distribution and taxes on income, as customarily used in business accounting.

well as entrepreneurial income in forestry, declined between 1990 and 1993 and increased gradually and quite steadily until 2003, when it reached €545 million at current prices (Sekot, 2005). Of the total value of production in 2004, 65% was contributed by industrial roundwood, 15% by fuelwood, and some 16% by services Sekot, 2005). In a longer-term comparison of income in forest holdings >500 ha in Austria, Sekot (2002) finds that real income decreased by around one-third between 1977 and 2001, while GVA was cut by about half over the same period. Real profitability over this period fluctuates considerably, and was around 75 €/ha, on average, for the five year period 1997–2001. Over a longer period the data show a downward trend (Sekot, 2005).

3.4. Trade

The EU27 is a major global player in wood raw material trade. Intra-EU wood raw material flows are a major factor in overall international trade, again enhanced by the accession of the new member states in 2007. This spatial expansion of the raw material base is facilitating the transition to a wider and more effective wood raw material market both within the EU and with external traders. The extra-EU wood raw material flows are predominantly inwards (mainly from east to west).

3.4.1. Import

Roundwood import by countries of the now EU27 has seen a continuous and rather steep increase in the period 1964–2003. Roundwood import increased strongly over the period 1990–2003, from around 32 million m^3 to 56 million m^3 in 2003, with particularly steep increases in countries with major export-oriented forest industries, such as Finland (importing around 13 million m^3 in 2003), Sweden (close to 10 million m^3) and Austria (8 million m^3) Note that Russia's plan to impose duties on roundwood exports will affect the trade balance in all of Europe, but particularly in Finland and then in Sweden.

Wood fuel imports, where data quality is less consistent and lower, grew by some 7.6% annually between 1993 and 2003 in the EU27, with particularly strong growth since 1999, reaching some 2.5 million m^3 in 2003, according to data from the UNECE/FAO. The largest importers reported are Sweden and Italy, both having reported particularly steep increases in wood fuel imports to around 650,000 m^3 in 2003, followed, at some distance, by Austria and Denmark.

3.4.2. Export

Roundwood exports from the EU27 grew by some 50% in the period 1993–2003, with about 5.7% annual growth on average, reaching 32 million m^3 in 2003, according to the UNECE/FAO. While exports from Germany and France in particular (the two largest roundwood exporters in volume terms until recently) have decreased considerably, export from the Baltics has grown considerably, with Latvia now being the leading exporter of the EU27 member states with some 4.4 million m^3 of roundwood export in 2003, followed by Estonia and the Czech Republic. It is expected that this export growth in the Baltics and other new EU member states will recede after some time as these countries move into value-added processing.

Wood fuel export has grown even stronger than wood fuel import, according to UNECE/FAO data, with annual growth of close to 10% between 1993 and 2003 in the EU27, reaching around 3.1 million m^3 in 2003. However, fluctuations between years have been steep. The data, like those in wood fuel imports, are of often varying quality. In 2003, Latvia was the leading wood fuel exporter with some 540,000 m^3, followed by Hungary and France. The available data also show an increase of export activity in many countries, particularly since the early 1990s.

3.4.3. Trade balance

Available data for the period 1999–2005 show that Finland has considerably expanded its imports of roundwood over this period and its leading position as roundwood importer in the EU27. Partly because of the geographic location, Russian roundwood has become extremely important to the Finnish forest industry. The import volume of Russian roundwood has more than doubled from the early 1990s to recent years, consisting of 13.4 million m^3 in 2003 and accounting for about 20% of the total industrial use of raw wood in Finland. The share of Russian roundwood has been over 80% of total roundwood imports to Finland. While birch pulpwood is still the most important import assortment (over 45%), the share of softwood logs has increased, especially since the mid-1990s. In 2003 the share of logs was about 37% of the total roundwood import from Russia. The spruce sawlogs in particular have increased their share from 2% in 1995 to 19% in 2003 (METLA, 2005).

Over the same period, Austria has equally increased its amount of roundwood imports while Sweden has seen its roundwood import reduced by more than a third during the same period, partly because of domestic roundwood supply from storm damage. The largest exporters, Latvia and Estonia, have gradually reduced their roundwood exports over recent years, as has France after a surge of exports in the wake of the 1999 storm damage. Portugal has changed from being a net importer to a net exporter, while Bulgaria and Romania did not open up their borders to large raw material exports prior to EU accession. Eastern Europe is divided into export-oriented countries, like the Czech Republic, Slovakia, and Bulgaria, on the one hand, and importers, such as Poland and Romania, on the other, that have developed from being an exporting to an importing country. Among all the EU27 countries, Latvia has the highest export rates followed by Germany, the Czech Republic, France, and Slovakia.

Data on net trade in wood fuel tends to show a quite different picture from the net trade balance in roundwood. According to the data, Italy has even increased its wood fuel import from the high levels in 2003. A number of countries have slightly increased their import share too, such as Austria, Denmark, and Finland. Of the major exporters, Latvia has reduced exports compared to imports, while others, such as the Czech Republic and the UK, have increased wood fuel exports.

Overall, the 12 new EU member states appear on the exporting side of the spectrum led by Latvia, the Czech Republic, Estonia, and Bulgaria. Of the old EU15 member state countries, only France and the United Kingdom are exporters. The other Western countries are import-dominated.

3.5. Technology and Know-How

3.5.1. Technology use in forestry, including ICT

Data related to technology use in forestry, including information and communication technology (ICT) and technical equipment, particularly harvesting equipment, are not collected on an international basis. However, national data and anecdotal evidence suggest major differences among countries, ranging from very highly mechanized and ICT-intensive forestry, particularly in Sweden and Finland, to broad use of basic and outdated technical equipment in countries such as Bulgaria and Romania.

A crude proxy for comparing different levels of mechanization (along with intensity of management driven by, inter alia, biophysical conditions of forests) is to compare the number of employees per hectare of forests. This comparison, which complements data on labor productivity as well as non-existent data, is an output indicator, showing staffing levels in some countries such as Bulgaria or Slovakia to be a multiple of those in Sweden or Finland. It is evident that the number of employees per hectare gives an incomplete picture, as production conditions and management objectives are not the same in the countries compared.

ICT applications focusing on forest management and inventory technologies, wood supply logistics, and process automation have in many cases appeared as the key elements for competitiveness in the global context. Gene technology is expected by some to soon produce breakthroughs in tree breeding. Working toward environmentally and ecologically sustainable silviculture is also paving the way for biological pesticides and insecticides in forestry.

3.5.2. Human capital

Forest research in Europe has only a few large-scale research facilities, but its overall total capacity is substantial: some 46 national research institutes are engaged in forest research, characterized by a large diversity of sizes and focus (Houllier *et al*., 2005). A survey of NFRIs in 26 European countries revealed that these cover around half of the research capacities of these countries, with a capacity of around 3,200 person-years of academic degrees in 2003 (Houllier *et al*., 2005). The same authors estimate that around 3,000 forest researchers work in the 46 NFRIs in total.

The degree of education of forest owners/managers is increasing in general over forest holding sizes. A survey of forest owners in around seven Central European countries (Rametsteiner *et al.*, 2006) shows the number of people with an academic degree has increased almost linearly over size classes. From about 500 ha onwards, the majority of forest owners or managers in this survey possess an academic degree. Owners and managers with a primary school education make up the majority owning less than 10 ha; however, their share decreases exponentially over increasing property sizes. People educated in technical schools (forestry or other) are the most frequently represented in forest holdings between 10 and 100 ha.

3.5.3. Research and innovation

In terms of forestry research capacity, the number of institutions and individuals researching the different aspects of forestry knowledge is very large. A survey of 18 European countries (15 EU countries, Iceland, Norway, and Switzerland) undertaken in the context of COST in 1998, found that more than 10,000 researchers from nearly 1,000 research units publish on forestry and forest-related topics. However, many institutions have just a few individuals researching forestry matters and as a minor part of their activity. In total, in those 250 research units that responded to the questionnaire, more than 3,000 researchers and 2,000 technicians are involved in forestry research. The highest number of research personnel was identified in the UK, Germany, Finland, France, Italy, and Sweden. The total number of research personnel was higher in 1998 than in 1994 (4,500 and 5,500, respectively). Significantly higher numbers of research personnel were found in countries like the UK, Germany, Italy, Switzerland, and Belgium. The share of research in economic and social aspects of forestry was about 10%, both in 1994 and 1998. Most of the research units that responded to the questionnaire (more than 80%) are state institutions. Nearly two-thirds of their research funding comes from national public sources and one-third from international funds. Since 1994 no significant changes have occurred in the total amount of research funds from all sources (national, international, and private) (Bystriakova and Schuck, 1999).

Houllier *et al*. (2005) estimate that about €300 million per year is spent in national forest research institutes alone and about the same in universities and other research bodies. They find that by far the largest amount of funding to NFRIs is national, while EU funding plays a comparatively minor role. An evaluation of the EU contribution to the whole forestry wood chain in the period 1998–2004 estimates its contribution through several program, particularly the EU Fifth Framework Program for Research (1998–2002) and the EU Energy, Environment and Sustainable Development (EESD) program, at around €142 million (EU, 2003).

Innovation data specifically on forestry are not collected internationally or nationally. A number of surveys have recently been undertaken on innovation activity. In a survey of forest owners in Central Europe, Rametsteiner *et al*. (2006) found that, on average, 9% of the forest owners/managers in Central European (CE) countries have introduced one or more products or process innovations (selling a new product or service or introducing a new technological or organizational innovation) in the period 1998–2001. Of the forest holdings, >500 ha, which is about 56% or more than half of all forest holdings, have introduced some innovations during this period, mostly process innovations, all of which were incremental and not new to forestry. The innovation activity in Central European countries in the last three years clearly correlates to the size of the forest holding. In many countries, the rate of innovation across company size follows an exponential-type curve where innovation frequency increases considerably in the size categories 50–500 ha and grows more slowly from 500 ha onwards. In all countries, the percentage of innovative forest holdings larger than 500 ha is at least four times that of forest holdings with properties smaller than 500 ha.

4. Concluding Remarks

The baseline state of forestry in the EU27 studied here is intended to complement more widespread and relatively well known information on (increasing) forest area, resources, and growing stock as well as the (positive) balance between increment and fellings in European countries. However, the shortfall in relation to internationally comparable data is high, while there is a rather large amount of information available at national level. The short period available for this task did not allow all data sources to be identified. Here we have focused on a few cases to highlight the overall picture. This, however, does not replace the need to conduct a more comprehensive review of the situation.

IV. Commonalities and Differences in the State and Development of Forestry in European Regions

1. Introduction and Objective

The objective of this task is to identify commonalities and differences in the state and development of forestry as found in the previous task for the selected regions/forestry types of the EU that show specific patterns in development of forestry.

2. Methodology

The methodology for this task is secondary data and literature analysis: its core substance is based on the information provided under the previous chapter. The results of the data and literature analysis on the "Baseline State of Forestry" and "Recent Patterns of Development" in the EU, as well as additional documentation on the regional or national level, are analyzed on the basis of the typology of regions as specified in the "Regional Typology." The ensuing regional tables, data and literature review results were analyzed to identify "Commonalities and Differences in the State and Development of Forestry" in different regions, which are reported in this document.

Following the request by the EC, a regional / forestry typology was elaborated that did not follow country borders. This limits data availability in this task. The resulting generic regional types of forestry situations in the EU are as shown in *Table 7*. While it is rather evident that no typology can be generated where each country or region within a country falls neatly in one and only one type, the seven regional types should nonetheless be able to characterize at least general patterns and allow different regions to be characterized as a mixed type of some of the regions. The numbering of the regional types follows a roughly descending order of general integration, from a forestry production point of view, into the economic forces (factors) shaping globalization.

The main chapter of the report describes the relative characteristics in terms of commonalities and differences of these regions in relation to globalization factors and other drivers/dimensions of globalization, as specified above.

The approach to structuring the report according to the globalization factors and related indicators, showed (not surprisingly) considerable data gaps in some of the key aspects of globalization factors (lack of consistent international data in, for example, domestic and foreign direct investment data). It was therefore decided to use the more general and "generic" analytical framework of PESTE, as used and described in the first chapter.

This broader analytical concept allows the description in a more qualitative form and is less based on hard, quantitative, and comparable data of commonalities and differences among regional types dimensions (or forces) possibly or actually driving globalization as a whole or one of its main factors. The PESTE framework comprises the following elements:

1. Policy (understood to include institutional arrangements);
2. Economic (covered under economic globalization factors);
3. Social (including socio-demographic); and
4. Technology (covered under economic globalization factors).

This list starts with the economic dimension and the technological dimension, respectively, as these two dimensions are more integral components of the factors that comprise "economic globalization."

Table 7: Regional Types of Forestry in the EU27

Type 1: Globalized regions/Nordic–Baltic	Globalized pulp–paper industry oriented raw material production oriented regions in Nordic countries, and related supply regions in the Baltic states
Type 2: Wood production oriented regions/central Europe	Raw material production oriented regions in central Europe supplying sawmilling/pulp–paper industry, and related supply regions
Type 3: Plantation-oriented/(mainly) "Atlantic Rim" Western Europe	Regions based on plantations, mainly supplying to pulp/paper forest industry, mainly in "Atlantic Rim" Western Europe
Type 4: Broader, multifunctional forestry-oriented regions/Western Europe	Broader, multifunctional forestry oriented regions with industries mainly catering to domestic consumption in Western Europe
Type 5: Urban society service influenced regions/northwestern Europe	Regions with forestry dominated by/oriented toward serving urbanized societies and comparatively little raw-material-production-oriented forestry in northwestern Europe
Type 6: "Countries in transition" regions/Eastern Europe	Regions dominated by restitution issues, "countries in transition," little, broken, private forestry tradition, weak infrastructure and uncompetitive domestic forest industries in Eastern Europe
Type 7: Low forest management intensity regions/ southern Europe	Regions dominated by low forest management intensity (if any), comparatively high importance of non-wood forest products, forest fires in southern Europe

Note: This document does not attempt to describe all aspects of characteristics of these dimensions but focuses on the characteristic commonalities and differences among regional types within them.

3. Commonalities and Differences in the State and Development of Forestry in European Regions

3.1. Economic dimensions – Micro: Ownership, management, production, and income

3.1.1. Forest ownership

Most regions in Europe now have larger shares of private than public ownership. The largest number of countries with a dominant share of public forest ownership can be found in the "countries in transition" dominated by Eastern Europe. In a number of these countries, particularly in Southeast Europe (Romania and Bulgaria), a large share of forests is public estate. Note that a recent legislative change in Romania in 2006 has opened the way for large-scale restitution/privatization, which to date has been limited to very small forest areas per parcel restituted. In the majority of these countries formal restitution is not yet finalized. Overall, there is a trend toward more private-ownership-dominated structures in the EU27 countries because of the privatization process in Eastern Europe.

With the restitution of private property in Eastern Europe, the similarities in terms of ownership size also increase across the EU27. The dominant pattern of distribution of average size of ownership is one of high fragmented ownership, with around 12 ha average forest holding size and a median of some 2–5 ha per forest holding. The average forest holding size of public forests is considerably higher in some of the Eastern European countries (Lithuania, Poland, Bulgaria, Estonia) than in the other regions. The average size of private forest holdings is considerably higher in Nordic countries compared to other regions in Europe, allowing considerably higher economies of scale and productivity. It is remarkable that in most of the regional types the number of private forest holdings is decreasing because of the closure of unprofitable holdings and their purchase by other holdings (probably also because of changed assessment size criteria). This trend might result in a difference of several million from previous assessments of private holdings. However, countries belonging to the "transition type" show a clear upward trend regarding the number of private forest holdings because of the ongoing restitution process.

3.1.2. Forest management

In those countries where forest management remains dominated by public forests, for example, in Poland (or Ireland), state forest organizations tasked with forest management have adopted a broadly market- and profit-oriented business model. The overall trend in terms of forest management is toward a similar business model: competitive market orientation. One of the most important drivers of the move from being a national enterprise to a limited company have been international trends (market economy taking over, globalization of economics, increasing competition) along with changes in government policies. The objective of increasing profitability was furthered by divesting areas outside core areas and that were of less commercial value, by reducing state ownership of the public companies, and by fostering higher efficiency and competitiveness.

The fragmented small forest holding size structure described above characterizes the situation of a large number of forest holdings in practically all regions, in that the forest owners depend on other sectors than forestry for their main income. Forest income is thus a marginal source of income for the vast majority of forest owners, and the share of forest income as well as working time spent in forestry is decreasing. A significant number of studies also show that an increasing share of these small-scale forest owners are increasingly "at one removed" from working with the land, characterized by fewer owners being employed in the primary sector (including agriculture) and larger physical distances between "urbanized" forest owners and their forests (see e.g., Niskanen *et al*., 2006; Mizaras, 2005).

In raw material production-oriented regional types, associations of forest owners are increasingly common in terms of providing better organized management of small forest holdings in many countries; such associations are a recent phenomenon in "countries in transition/Eastern Europe," in "low forest management intensity/southern Europe," and in the new plantation-forest-dominated region, compared to other regions. In the Nordic regional type, characterized by a more globalized forest industry, a dominant model of industry-organized supply, strong forest-owner associations, and harvesting management is well established, which enables more efficient servicing of the raw material needs of the industry, compared to other regions. The same globalization factors have generally led to outsourcing of forest management and raw material supply, for example, the selling off of large forest areas by state organizations and the establishment of private industrial forest companies.

3.1.3 Forest production, increment and felling, products and services

In all European regions forest area has expanded steadily over the last half century. Gross forest area keeps expanding, particularly in low forest management intensity-dominated/southern Europe and in the plantation-oriented "Atlantic Rim" regions, particularly because of EU support for afforestation. Forest area increases are also being more and more observed in Eastern European countries following the decrease in agricultural land and large productivity gains in agriculture.

In terms of roundwood production and the balance between increment and fellings, the countries of the globalized forest regions as well as those in the wood production-oriented regions show the highest increment rates as well as the highest felling rates. Nordic countries from the globalized forest regions and particularly their supply regions (Baltic countries) together with some countries from the wood production-oriented regions (Germany, France, and Poland) show the highest shares in industrial roundwood removals. In comparison, most other EU27 countries produce considerably less and have seen less dramatic increases in production over time.

In some years, and under raw material supply pressure, fellings at times seem to be higher than increment in raw material supply regions (e.g., Baltic states, CIT /Eastern European states close to central European production centers), a situation that is likely to become more frequent, as is the probability of illegal logging under raw material supply stress. Strains in raw material supply will be particularly felt in the globalized region in Nordic and Baltic states in the course of Russia's implementation of its recent decision to impose export taxes on roundwood. The supply situation is also strained at times in the production-oriented Central European and plantation-oriented "Atlantic Rim" regions. The felling rate is considerably lower in non-production-oriented regions as well as CIT type Eastern European regions that are infrastructure and technology laggards and now experiencing a rapid catch-up race. The felling rate is almost zero for the low forest management intensity regions in southern Europe.

The result of increasing forest area and of the low levels of harvesting compared to increment is an increasing total growing stock. The total growing stock is largest in the Nordic region (and some countries of the type 2 and 3 regions) and lowest in CIT/Eastern European regions and the low forest management intensity regions in southern Europe. Growing stock per ha is more than 2.5 times higher in the central European region (around 250–300 m^3/ha) than in southern European regions (around 50 m^3/ha). The increase in maturing and over-mature stands in some regions, particularly in the production-oriented Central European region, is due either to a lack of the right technology for efficient use of large diameter raw material or to the effect of a non-production-oriented management concept. Growing stock per hectare is also higher in many Eastern European countries compared to Nordic states because of low levels of utilization. The low levels of utilization in the different regional types are driven by different factors, including: 1) low or lack of profitability of forest management (low intensity forest management regions/southern Europe and Alpine regions in central Europe, among others); 2) non-productive management objectives like biodiversity conservation or recreation areas in non-raw material production-oriented regions; and 3) fragmented ownership structures in all regions. Small private holdings are usually not as intensively managed as larger, more commercially oriented holdings. The demand for raw material will undoubtedly decrease the gap between increment and fellings in most of those regions where such gaps exist.

Wood is traditionally a source of energy in all regions; however, in several regions, wood energy production has seen a steep upward trend, along with strongly increased international commodity-type trade. This is particularly the case for the more raw material production-oriented regions: the globalized Nordic–Baltic region is considerably advanced in terms of share of wood energy production, particularly because of energy production from "black liquor" by pulp/paper companies. Some countries in the Central European region, and larger countries oriented toward domestic production, such as France, are producing notable shares of energy from wood, often in smaller-scale energy-production units. Plantation-oriented "Atlantic Rim" regions also produce wood for energy purposes. The general energy situation, discussed in more detail below, will see increased demand for raw material of specifications that partly compete with other industrial uses. Wood energy production in short-rotation forestry systems could involve huge areas of forests in all regional types (as part of joint production systems) and particularly in regions that until now have been low-intensity forest management regions, as well as in Eastern European regions where there has been conversion of agricultural lands.

Different regional types differentiate quite clearly in terms of the role they give to harvesting and income from non-wood goods. As with wood for energy purposes, non-wood goods play a quite important role in terms of self-consumption in all regions. However, it is mainly in the "countries in transition" Eastern European and low intensity management southern European type of forestry that non-wood goods are considered as having comparatively high importance in wood production terms. While non-wood goods in terms of volume are also an important category in the Nordic region, they are a relatively minor source overall if compared to wood. Game is a non-wood good that is particularly important in some central European, Eastern European, and Nordic countries, and a recognizable source of income in many other regions.

Forests play a highly important role as providers of services, both non-marketed and marketed to society. These include education and recreation, as well as health-related services, attractive landscapes, carbon dioxide sequestration, erosion prevention, hydrological regulation, biodiversity preservation, etc. Many, if not all, of these are not marketed and often are unaccounted for in all regional types. Non-marketed services are an important contribution to forests and forestry to society across all regions, but are emphatically so in the low-intensity forest management regions of southern Europe. For instance, 80% of the worldwide production of cork originates in this region.

Market-based services as a source of income, including payment for environmental services provided by forests, are on average very weakly developed across all regions in the EU27. However, developments such as climate change response policies, among others, increasingly act as driver for change. The search for viable business models is more advanced in urban society and service-dominated regional types and tends to become less of a focus in raw material production-oriented regional types, where the focus is on income from wood.

3.2. Economic dimensions—Macro: Value added, productivity, employment, price, and profitability

3.2.1. Value added and productivity

Gross value-added data for forestry is available at EUROSTAT for nine of the EU27 countries for the years 1995 and 2000 (value at basic price, nominal). The data show no common pattern or clear regional differences for the regional types (no data are available for new member states or acceding states). Two of the countries, Portugal and Finland, reported strong growth in value added, while the majority of countries reported a slight decline (less than 10% decline, three countries) or considerable decline in value added (between 11% and 25%). Data for the period 1990–2000 indicate a similar result of no consistent variation among regions, but slightly upward trends for Sweden, the UK, and Finland. In several of the countries, such as Portugal and the UK, some regions invested in further developing plantation-based forestry. This might indicate that regions with more production- and globalization-oriented forestry show a positive gross value added that is also visible in total country statistics. However, there are a number of uncertainties related to the available data.

In terms of contribution of the forest sector to GDP, most Western European countries have experienced a marked decline relative to other sectors over the period 1990–2000. Again, within Western Europe the degree of decline varies among countries, but not among regional types. For instance, Sweden and Portugal experienced steep declines of one percentage point or more. In Eastern Europe as a whole, the forest sector contribution to GDP has declined from 1.5% in 1990 to 1.4% in 2000. However, after the steep recession in the early 1990s, the forest sector has become one of the leading sectors in some of these countries. For instance, the contribution of the forest sector to GDP in Estonia and Latvia grew from 2.1% each in 1992 to an impressive 5% and 4.9% , respectively, in 2000 (FAO, 2004).

Labor productivity in forestry has remained quite stable over the period 1990–2000 in Western Europe, while Eastern Europe has seen falling labor productivity because of declining production without a corresponding decline in employment numbers. But productivity in Eastern Europe has started to grow consistently again. Only the Nordic countries showed a higher growth in labor productivity. From the globalized forest regions, Sweden and Finland, followed by Austria, are examples of countries with wood production-oriented regimes that also show the highest labor productivity in the EU27. According to EUROSTAT and the Labour Force Survey, the labor productivity is ten times higher in leading Nordic countries, such as Finland than in Eastern European and Mediterranean countries. The existing data show that countries with a substantial export-oriented forest industry in Western European countries also have higher productivity. The Baltic countries, Central Eastern, and Eastern European countries especially show high potential in terms of biophysical and technological parameters to enable them to close the huge gap between them and the countries with the highest productivity.

3.2.2. Employment

Employment provided by forestry is considerably more important in the Eastern European region, where the primary sector as a whole still plays a more important role as employer than in Western Europe. Employees in forestry per hectare of forests is up to 20 times higher in some Eastern European countries than in the leading countries in the Nordic region. This huge difference, however, is rapidly shrinking, as forestry in Eastern European countries adapts to more competitive, market-oriented models of forest management, and with the ongoing restitution process. FAO (2006) data show the dramatic decrease in forest work in Poland and Romania in the period 1990–2000. Overall, the increasing use of advanced technology in forest management, including harvesting and transport, exerts downward pressure on employment in virtually all regions, especially those that follow a competitive production-oriented type of forestry. Only a few countries have reported increasing numbers of employment between 2000 and 2005, for example, France and Latvia (FAO 2006). In Estonia and Latvia the proportion of forestry in the total labor force was over twice the European average, and grew steadily between 1995 and 2000. Estonia and Latvia are followed by Finland, another big forestry employer (see Annex 4).

3.2.3. Price and profitability

Insufficient comparable data are publicly available to allow comparison of prices for identical wood assortments from the different regions or their development over time. Overall, prices for standard assortments (conifer sawlogs) tend to be somewhat higher in Central Europe (Germany, Austria), followed by Nordic countries. Prices for sawlogs in the Baltic region have risen considerably over the last decade and are today only somewhat lower than Nordic prices. This is, inter alia, because of the increasingly high demand for raw material imports to Finland and Sweden, as well as increasing integration of the Nordic–Baltic region. Such upward price movements are temporarily dampened by storm events, such as those that occurred recently in southern Sweden. The prices of soft sawlog delivered to sawmill in southeastern Europe are around some 50% the price of those in the Nordic countries.

Nominal log price developments prices collected by UNECE/FAO over the period 1990–2006 for a number of assortments in a range of countries demonstrates the relatively high roundwood log prices for spruce/fir in Central Europe, compared to the Nordic–Baltic region, as well as the downward trend in nominal prices in Central Europe compared to slightly upward nominal price development in Nordic countries. Overall developments in both sawnwood and sawlog prices display convergence in the period 1995–2003 in some major Nordic, Baltic, Central, and Eastern countries, which indicates that deepening integration in European markets is also detectable in the forest sector (Haenninen *et al.*, 2007). Data on standing sales and sawlog price indices in real terms over a 25-year period in the UK demonstrates the downward price development in real terms in the UK for standing timber and sawlogs. In most regions this downward trend in prices has flattened out or reversed over recent years.

In common with other areas, profitability data in forestry are weak. EUROSTAT, in its Economic Accounts for Forestry, reports entrepreneurial income[6] (at basic prices), which can be used as one proxy to assess profitability in forestry. The available data show that profitability differs considerably among countries. They also indicate that public forestry in Central and Western European countries, as well as those where forestry is dominated by urban societies, shows negative entrepreneurial income (i.e., more funds are invested in than income received from forests). Entrepreneurial income is comparatively highest in regional types oriented toward competitive production-oriented forestry, such as in the Nordic, central European and plantation-oriented regional forestry types. Entrepreneurial income is slightly positive in Central and Eastern European countries for which data are available (e.g., Lithuania, Slovakia). According to EUROSTAT data, entrepreneurial income per hectare of forest is highest in Portugal. More in-depth examples for three countries are shown in the previous chapter on the baseline state, which reports data from Nordic (Finland), Northwest Europe (UK), and Central Europe (Austria).

3.3. Investment

Domestic private investment in forestry and maintaining or increasing the capital stock invested in forestry is a function of the profitability of forest management, which is, in turn, correlated with the production orientation of the different regional types. Based on limited data available across all regions on Gross Fixed Capital Formation (GFCF)[7] from EUROSTAT, domestic investment in productive capital formation is higher in the globalized Nordic–Baltic region and other production-oriented regional types than in other regional types. This pattern is interrupted after major storm or other events damaging larger areas of forests, which then require increased investments, such as the storms in France and Germany at the turn of the millennium. However, if measured per hectare of forests, GFCF is higher or equally high in countries characterized by urbanized societies, compared to production-oriented regions, according to EUROSTAT data. Domestic investment is comparatively poor in "countries in transition" (with some exceptions for those CITs that supply to regional production centers in the Nordic or central European regions), as well as in countries with low forest management intensity in southern Europe. In fact, abandonment (i.e., negative capital formation) of forest land is an ongoing trend in southern European countries. This situation has been somewhat ameliorated by EU policies supporting investment in afforestation and forest fire prevention. However, if domestic investment in nonproductive (e.g., protective services for forests), is taken into account, the differences among these regions would be less marked. Generally, countries showing higher shares in privately owned forests and regions with production-oriented management tend toward more and more stable investment.

Domestic public funding for forestry, according to the limited data available, is considerably higher than EU funding across all regional types. The average amount of domestic funding varies greatly between an average of €0.81 per ha (in Estonia) to €1,874.39 per ha (in the Netherlands) in the 11 countries analyzed by EFI (2005). EU public funding for forestry, as EU contributions to domestic public funds for the period 2000 to 2006, is in the magnitude of €2.3 billion for afforestation measures and €2.4 billion for other forestry measures (ECA

[6] The entrepreneurial income account makes it possible to measure income, which is similar to the concept of current profit before distribution and taxes on income, as is customarily used in business accounting.

[7] GFCF is *not* a measure of *total* investment because all kinds of *financial* assets are excluded, but it is the closest measure of domestic investment in forestry

2004). This is a considerable increase from the period 1992–1999, when afforestation of agricultural land under the previous Regulation (EEC) cost the EU budget €1,519 billion.

Foreign direct investment in forestry is almost exclusively undertaken by companies located in the globalized Nordic region and is driven by both opportunities and the need to secure raw material supply for new production and consumer markets outside Europe, particularly in South America and Asia.

3.4. Trade

The regional differences with respect to trade in wood raw material was discussed in detail in the last chapter (see also Annex 4) and will not be repeated here. In addition to what has been stated in Deliverable 2.1 on trade, we would add the following:

Roundwood imports:
The top ten importing countries (2003) in Europe are led by two countries from the globalized Nordic countries region: Finland (importing some 13 million m^3) and Sweden (9.7 million m^3), closely followed by Austria with some 8 million m^3 of roundwood imported in 2003 (UNECE timber database 2004). All three countries have doubled or even tripled their imports of roundwood since 1990. Italy and Spain as Mediterranean countries imported 5 million m^3 and 3.3 million m^3, respectively, which rates them number 4 and 5. In contrast to the high rate of increase of the Nordic countries, the countries of the low intensity forest management region show stagnating or even negative rates, as in the case of Italy, where import of roundwood decreased from 6 million m^3 in 1990 to 5 million m^3 in 2003. The subsequent five ranks are taken by countries of Central/Northwest European countries, such as Belgium, Germany, France, Luxembourg, and Portugal, whose imports of roundwood each exceed 1 million m^3 annually.

Wood Fuel Imports Including Charcoal:
When looking at the country ranking for wood fuel import into EU countries, UNECE data (timber database data up to 2004) reveal that the strongest importing countries are quite widely distributed over the European region. According to these data, Sweden leads the ranking, accounting for 676,000 m^3 in 2003. This Nordic country is followed very closely by the Mediterranean country Italy, which imports 636,000 m^3 of wood fuel and charcoal. The third and fourth country in this ranking, namely, Austria and Denmark, respectively account for only around one-half of the imports of the leading countries. Finland and Greece both import slightly more than 100,000 m^3 annually. Beginning with Germany, the annual import of all other countries is below 100,000 m^3 at a quite sharply decreasing rate. It is notable that by 1990 hardly any importation of wood fuel and charcoal was reported by European countries. Consequently, the increase rates of the countries mentioned above are high—Sweden, for instance, reportedly started with imports of 500 m^3 in 1990. An exception is Italy, which was the only country already reporting imports of some 400,000 m^3 in 1990, hence showing one of the flattest increase rates since. Almost all countries showed a reduction in the imported amounts during the second half of the 1990s and the start of the 2000s. It should be noted that, particularly as regards wood fuel, the data quality and consistency have only recently increased with the growing importance of wood fuel as a source of energy and increasing international trade.

Roundwood Export:
According to UNECE data (timber database up to 2004), in 2003 the largest exporters of roundwood in Europe were, on the one hand, located in some of the northeastern European countries in transition such as Latvia (4.5 million m^3), Estonia (3.3 million m^3), the Czech Republic (3.1 million m^3), and Hungary (1.7 million m^3), and, on the other hand, in the broader, multifunctional forestry-oriented countries of Western Europe, namely France (4.3 million m^3) and Germany (4.1 million m^3). It is remarkable that among these leading export countries (in absolute volume terms), those from Eastern European regions and countries in transition showed relatively sharply increased rates, whereas the top two countries of Western Europe, France and Germany, show similarly sharp decreasing rates. Germany, especially, by 2003 was exporting only half the amount of roundwood that it exported in 1991.

Wood Fuel Export including Charcoal:
In common with the situation in the roundwood export market, countries in transition dominate the country ranking for fuel wood and charcoal export: Latvia (539,000 m^3), Hungary (387,000 m^3), Estonia (336,000 m^3), Czech Republic (219,000 m^3), Slovakia (155,000 m^3), and Romania (89,000 m^3). A few Western European countries such as France (379,000 m^3), UK (345,000 m^3), and Central European Austria (137,000 m^3) have comparable exports. In the case of wood fuel exports, all top-ranked countries show large rates of increase, with remarkable fluctuations over the past decade (timber database up to 2004).

Net Trade Roundwood:
Data from FAOSTAT (2007) clearly show that the countries of the globalized region as well as the production-oriented Central European countries are importing more roundwood than exporting. After subtracting the export from the import, Finland still shows a net trade balance of 15 million m^3 in 2005, as do Austria (8 million m^3) and Sweden (5 million m^3). Countries from the low forest management intensity region along the Mediterranean Sea, Italy and Spain, also show a negative export balance with an import surplus of 5.6 million m^3 and 3.2 million m^3, respectively. Whereas the balance slightly improved toward fewer imports or remained stable in the Mediterranean countries and largely improved over the last years in Sweden, Finland, and Austria, the net trade balance is shifting largely toward increasing imports.

Net Trade of Wood Fuel and Charcoal:
When the statistics of wood fuel and charcoal net trade are compared, the top ten countries are distributed over Europe without any regional pattern. Italy, after exports are subtracted from imports, shows a net balance of 860,000 m^3 in 2005 at a sharply increasing rate. This Mediterranean country is followed by Denmark, Austria, Germany, and Finland with a maximum net trade of 260,000 m^3. Only Germany shows a high increase rate similar to that of Italy. Correspondingly, the roundwood net trade of the Eastern and northeastern European countries show the largest export surplus as a region, from the point of view of volume, being led by Latvia (342,000m^3), followed by the Czech Republic, Bulgaria, and Estonia. However, France in 2005 is ahead of all other countries (volume export surplus of 407,500 m^3), and France and the UK (191,000 m^3) are the only Western European countries showing a wood fuel export surplus from the point of view of volume (FAOSTAT, 2007).

3.5 Technology: ICT, infrastructure, knowledge production, and human capital

3.5.1 Technology use in forestry, including ICT

The KOF Index of Globalization (http://globalization.kof.ethz.ch/) is an index measuring three main dimensions of globalization: economic, social, and political. One sub-index, referring to data on information flows, can be regarded as mimicking the implementation of new technologies in general, including forestry technologies. However, the dataset is not complete, as the typology used in this report and data are available only until 2004. The trends are illustrated in *Table 8.*

Table 8. Information flows based on KOF Index of Globalization

Region	**1994**	**2004**
T1 globalized	66.5	95.2
T2 wood production-oriented	67.8	93.4
T3 plantation-oriented, Western Europe	67.2	92.6
T4 multifunctional-oriented, Western Europe	67.9	90.3
T5 urban society service	69.8	94.0
T6 countries in transition	56.4	86.7
T7 low forest management intensity	46.3	74.0

The Index of Information Flows shows a rapid development over time in all regions. It can be concluded that the most rapid development has taken place in the T1 globalized region. Two regions are strongly identified to be lagging behind. The T7 low forest management intensity region is over 20 units behind the most developed region, T1. The T6 countries in transition region is nearly 10 units behind the most developed region, T1, in this respect. It means that these two lagging regions have the most to gain from implementing new technologies and improving information flows. This is also true for forestry-related information technology, assuming that general information flow data is a valid approximation of the situation in forestry.

From the EUROSTAT economic accounts for forestry as an indicator of gross fixed capital formation investment into intangible fixed assets, including computer software, it can be seen that the Nordic countries such as Finland clearly lead the statistics (according to the scarce data availability of EUROSTAT EAF). Finland's investments in this sector have been constantly increasing since the 1990s, reaching €7 million in 2000. In Germany—an example of the wood production-oriented region of Central European countries—the investments in intangible fixed assets, including computer software, are the second highest in Europe, amounting to some €4.2 million in 2000. A comparison with the previous years shows that the rate of increase in this area is stagnating somewhat or even slightly negative. In common with Germany, there is a slight decrease in IT investments in Austria to some €1.3 million in 2000. However, only in Switzerland have these IT investments clearly decreased over the years from €2.6 million in 1990 to €1.5 million in 2000.

The highest rates of increase are shown in the region of the countries in transition and Eastern Europe. Slovakia, for instance, doubled its investments in computer software from €0.6 to €1.3 million between 2000 and 2005. Other countries such as Lithuania have just started making notable investments amounting to €0.05 million in 2005.

The lowest or no investment (or lack of data) is shown in the low forest management intensity regions of the Mediterranean countries, such as Italy.

However, it should be pointed out that the statistics available are far from complete. It seems quite possible that the numbers reported are underestimates by an order of magnitude of around 5 to 10.

3.5.2 Human capital

The European total investment of some 3,200 person-years in academic degrees from national forest research institutes is relatively unevenly distributed over all regions (Houllier *et al.*, 2005). However, there is a clear pattern in the fact that some of the countries of the globalized Nordic region and the wood production-oriented central European region host about two-thirds of the total person-years in forest science. This distribution is led by France with more than 600 person-years in national and other forest research institutes. Close behind are Sweden and Finland at some 400–600 person-years. The UK as the only Northwestern European country among the leading regions also hosts more than 500 person-years. Central and Central Eastern European countries, such as Switzerland, Germany, the Czech Republic and Slovakia, and Poland host between 200 and 400 person-years.

Two countries of the low forest management intensity countries of the Mediterranean region, Spain and Italy, are also outstanding with respect to person-years in forestry sciences, hosting some 350 and 220 person-years, respectively.

Fewer forest research staff are found in the other Mediterranean and Southeast European countries such as Croatia, the former Yugoslavia (Serbia, Montenegro), Greece, and Portugal, where fewer than 100 person-years of forestry research are carried out annually. Some countries in Eastern Europe report considerable manpower in research full-time equivalents, including Romania (600 staff in public forest research institutes).

How many person-years are performed at national forest research institutes and how many are performed at other forest research institutes? A comparison among European countries shows that in of the majority of Nordic and Central European countries, most person-years are performed in the national institutes. However, in countries such as UK, Germany, France, Spain, Portugal, and Yugoslavia the share of person-years in forestry research carried out at other forest research institutes is at least as high as those performed at national institutes. In France and Spain, person-years performed at other forest research institutes are in the majority.

3.5.3 Innovation and research

According to (Houllier *et al.*, 2005) there is a wide range of national institutions dealing with forest-related research issues in Europe. Some 50 national institutions are engaged in forest research as their main activity. The field of research of these institutions is about two-thirds applied research and one-quarter basic research. Forest research in national or federal institutions is also mainly (74%) funded by the respective governments—only 4% of research funding in these institutions comes from the EU. Even though the share of EU-funded research is small, it is an important source of funding for many institutions, and approximately 70 of the national institutions in Europe stated that they would be interested in applying for funding under the FP6 and FP7 instruments (Houllier *et al.*, 2005).

Many forest research institutes in Europe are narrowly specialized, resulting in a lack of interdisciplinarity and integration. Lacking harmonization also hinders the sharing and exchange of data to address regional or global problems, which results in work duplication. However, the close contact of institutes with practical forest issues ensures the relevance of the topics they address. Knowledge transfer is one of the key issues of applied forest research of the forest research institutions surveyed in Europe (Houllier *et al*., 2005).

The top ten national forest research institutes' total funding amounts to some €230 million annually. This distribution most benefits institutes from northern and Central European countries (METLA [€48 million], WSL [€42 million], SLU [€35 million]). An exception are the institutes INRA of France and Forest Research of the UK which are ranked 4 and 5, respectively, followed again by institutions in central and northern European countries such as Germany, Sweden, Norway, and Austria. All institutes mentioned show a minimum of 10% EU funding. Nearly half of the surveyed national forest research institutes are involved in more than five EU projects.

3.6 Social and political dimensions

There are hardly any data available for analysis of the social and political dimensions of globalization with respect to the sub-regions studied for Europe.

In the earlier text we used the KOF Index of Globalization, which measures three main dimensions of globalization: economic, social, and political. With respect to the social and political dimensions of globalization we have used this index to set forestry in different regions in the wider social and political context. Again, the index is not available for all of the countries studied in Europe and is available only up to 2004. However, the information is summarized in *Table 9.* *Table* 9 illustrates the development of the overall globalization index, which is composed of economic, social, and political indices for globalization, also presented in *Table 9.* The social globalization, in turn, takes into account a number of sub-indices dealing with personal contacts, information flows, and cultural proximity. The political globalization takes into account the number of embassies, membership of international organizations, and participation in UN Security Council missions.

From *Table 9* and from a general development point of view of globalization, it can be concluded that there was a substantial overall growth in globalization between 1994 and 2004. This has been especially rapid in regions T6 (countries in transition) and T7 (low forest management intensity). However, these two regions are lagging behind in overall globalization development in comparison with the rest of the regions in 2004, which are all on about the same level. Economic globalization has also been especially rapid over time in regions T6 and T7. The highest general economic globalization level in 2004 is in regions T5 (urban society service) and T3 (plantation-oriented)—only the UK and Ireland are included in this group. This seems to be a logical development. These two leading regions are followed by regions T1, T2, T7, and T4.

With respect to social globalization it can be concluded that there has been rapid development in all regions, but most obviously in region T6. In 2004 these two regions were lagging behind the remaining regions with respect to social globalization. The lagging regions are T6 (countries in transition) and T7 (low forest management intensity).

With respect to political globalization there has also been a very rapid development in region T6, which started at a low level. Regions T4 and T1 had the highest rate of political globalization in 2004. It can be concluded that to reach a high overall general globalization index, it is important to have strong simultaneous development of economic, social, and political globalization.

Table 9. Indices for overall globalization: economic, social, and political. Based on KOF Index of Globalization.

Region	Overall Globalization		Economic		Social		Political	
	1994	*2004*	*1994*	*2004*	*1994*	*2004*	*1994*	*2004*
T1 globalized region	78.9	87.4	84.1	86.6	68.8	86.2	86.7	90.2
T2 wood production-oriented	76.6	87.2	74.2	85.0	79.1	89.0	76.4	87.5
T3 plantation-oriented: Western Europe	78.5	86.2	86.2	90.5	72.0	82.8	77.4	85.3
T4 multifunctional-oriented: Western Europe	77.6	85.1	71.1	78.3	73.4	83.9	93.2	96.4
T5 urban society service	82.4	84.9	89.3	92.0	77.6	87.2	79.7	80.1
T6 countries in transition	46.5	68.1	52.9	75.1	43.5	66.5	42.1	60.8
T7 low forest management industry	66.5	80.3	69.3	80.6	60.5	74.7	82.4	88.1

4. Concluding Remarks

The report shows a large number of differences in, and commonalities of, forestry-related issues in the EU27; however, considerable data gaps exist. The following concluding remarks can be made:

- Most regions in Europe now have larger shares of private than public ownership.
- Economic activities in forestry in the form of investments and gross value added are dominated by the Nordic–Baltic regions.
- The removal of industrial roundwood is dominated by the Nordic–Baltic region followed by the northwestern and Central Eastern regions.
- Wood fuel production has increased over time because of increased energy prices.
- The productivity of the Nordic–Baltic region is far higher than in other regions.
- The Nordic–Baltic region is the major net importer of industrial roundwood, followed by the Mediterranean and Central European region.

V. Identify How the Main Trends and Factors of Globalization Relevant to Forestry Are Affecting Different Regions of the EU

V (i): Regional Effects of Globalization Factors and Trends on Forestry

1. Introduction

The overall objective of this task is to assess the effects of globalization on the various EU regions identified in earlier tasks. A second objective is to assess the strengths and weaknesses in the globalization process of the EU regions identified. The knowledge gained from previous tasks have served as an input platform for the work carried out by the model analyses described in this chapter.

To assess the effects of globalization on the EU regions, it is of utmost importance to carry out the analysis at a global level with EU regions linked to the rest of the world. The driving forces of globalization mainly occur outside the EU and with no link between the EU and other regions of the world, the possibilities of identifying the globalization effects on the different EU regions are limited.

To make this linkage a battery of different models and huge databases has to be used. Moreover, as the globalization process is a very complex one, including many different factors and dimensions, the analytical work has to be carried out in scenario form. In the Detailed Analysis Framework Specification chapter, we have presented in detail the complete scenario input data for the overall framework of the scenario analysis. This framework deals with demographic, economic, and technological factors, as well as resource efficiency, energy, and land use. The description of this data will not be repeated here but has been used, together with the knowledge gained from Tasks 1 and 2 and other specifically collected material, as input data and for the formulation of the specific forest sector scenarios. For analysis of the forest sector scenarios a specific package of interlinked models has been developed and this package is described in the following sections.

2. Methodology and Modeling Approach

We followed three methodologically distinct yet complementary approaches in order to assess the impacts of globalization on five European Macro Regions in a global forest sector context. Due to data limitations there was no possibility to follow the earlier discussed typology (Task 2) for EU with seven regions in the analytical work. Thus, we were forced to work with five macro regions of Europe. Each of these approaches aims at different features of forest sector behavior and determinants of sector development (*Figure 9*):

1. A static multi-commodity trade model (Forest Demand Supply Model, 4DSM) was established to assess baseline scenarios and policy impact scenarios on supply, demand, trade, and marginal prices in and among 14 global regions.

2. BEWHERE is a geographically explicit mill location model that aims to assess optimal saw and pulp mill size (economies of scale in production) and their optimal location within European and non-European countries.

3. A dynamic Bilateral Forest Sector Trade Model (BFSM) was constructed to describe a rich set of factors affecting market behavior along the entire supply chain for sawnwood, pulp and paper, and bio-energy markets. The model was calibrated for the geographical extent of Europe and the rest of the world.

Recent trends in the forest sector were used to project the situation in 2030 with the help of the above-mentioned models. This time horizon was chosen due to different reasons: a) it is not longer the analysis is based on forest sector studies of demand and supply that typically project the forest sector situation until 2030 - projections in this analysis beyond 2030 would lack solid data basis from other studies; b) it is not shorter because underlying trends like forest growth and population dynamics are long-term developments that need to be taken into account in decisions today – 2030 is thus a medium target that is reflecting long-term trends on the one hand and is highly relevant for today's decisions on the other. Prices as presented in the study serve as an indicator or index for globalization impacts on the sector. Trends toward the situation in 2030 were not explicitly modelled because of the complexity of the underlying systems. The systems are hard to capture using models of the high level of aggregation designed and used to analyze the specific question of globalization. They delineate the underlying forces that are already affecting the forest sector and characterize their direction at a global level. In principle it would be possible to run the model in yearly time steps. However, the trend would turn out to be quasi-linear and would not add any further qualitative and quantitative insights. Constructing a model with greater sophistication of populations of forest sector agents with heterogeneous expectations would entail a tremendous effort and the models would thereby lose their transparency. A more detailed description of the models used in this study is given in Annex 5.

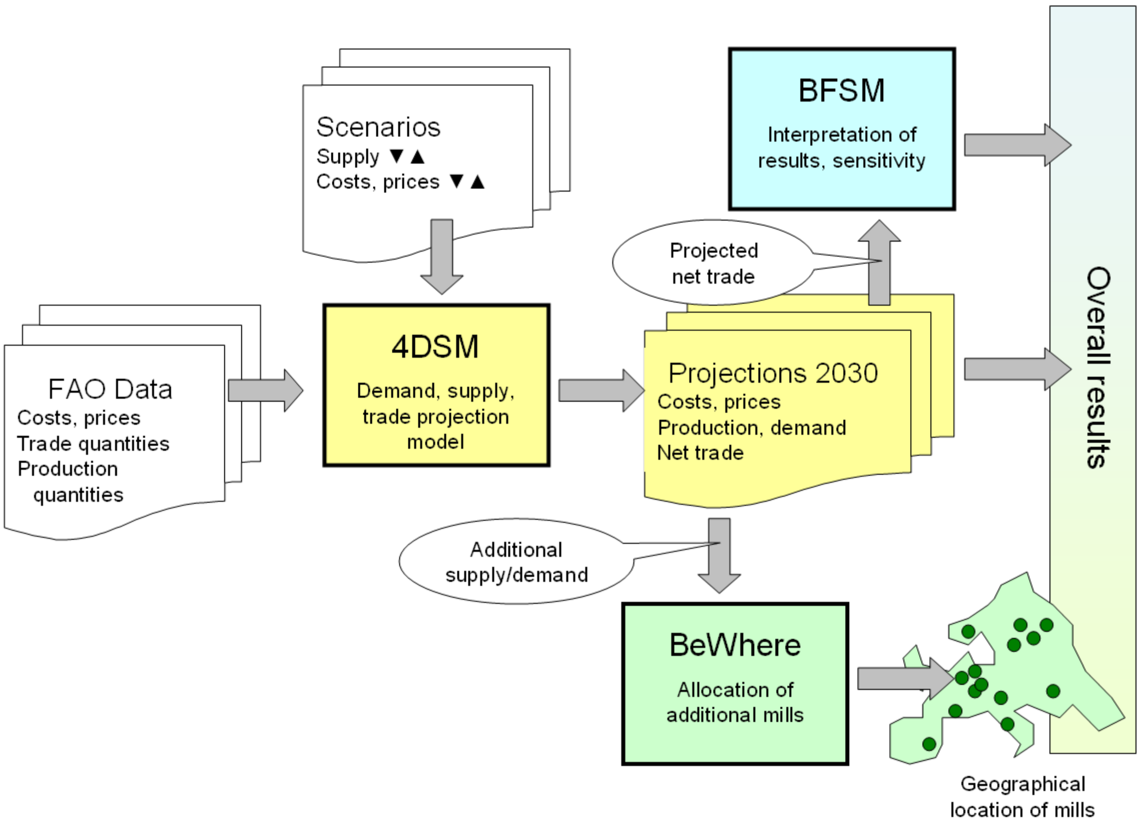

Figure 9: Flowchart of data flow between models. See the electronic version of this report for colored figures.

2.1. Data sources and definitions

To obtain the data required by the models and to sketch the scenarios, a number of sources were included, ranging from public databases, informal telephone expert interviews, literature review, and smaller in-house analyses. The databases and sources included in the modeling were:

- FAOSTAT database ForesSTAT on forestry sector production;
- FAOSTAT database TradeSTAT on forest product trade;
- RISI database for locations of individual pulp and paper mills, with additional economic and technical information (http://www.risiinfo.com/);
- Model runs on forest biomass development using the GLOBFORMOD model;
- Secondary literature and other sources, mainly on economic information regarding the European and global forest sector; and
- Telephone/e-mail expert estimations and own analyses.

The analysis focuses on three levels of production (see *Table 10*) with respect to industrial roundwood as the raw material source for forest products. The aggregate industrial roundwood is split into two categories of wood, sawlogs (including the Food and Agriculture Organization (FAO) definition of SAWLOGS+VENEER LOGS) and pulp logs (which is PULPWOOD+PARTICLES). As forestry end-products in this study we consider sawnwood and pulp and paper. Sawnwood is formed by the two FAO categories SAWNWOOD and WOOD-BASED PANELS. As pulp and paper products, the analysis considers the PAPER AND PAPERBOARD plus PULP category of the FAO.

For simplicity's sake, the analysis is limited to this structure. We introduced internal factors for the conversion of logs to end products. We did this: 1) to allow an ideally fully balanced forestry product market; 2) to account for possible inconsistencies in the FAO database; 3) to account for trade of logs and products not captured by the dataset used; and 4) to compensate for flows of material between categories (such as particles and wood remains from sawnwood to pulp and paper or pulp to wood-based panels).

Table 10: Hierarchy of the production chain assumed in the analysis according to FAO nomenclature. Names in brackets are names used in this study and respective units. Sawnwood and wood-based panels in this study were aggregated to sawnwood.

Level 1 (wood)	Level 2 (logs)	Level 3 (products)
INDUSTRIAL ROUNDWOOD	SAWLOGS+VENEER LOGS (saw logs in [cubic meters])	SAWNWOOD (sawnwood in [cubic meters])
		WOOD-BASED PANELS (sawnwood in [cubic meters])
	PULPWOOD+PARTICLES (pulp logs in [cubic meters])	PAPER AND PAPERBOARD (pulp and paper in [t])
		PULP or WOODPULP (pulp and paper in [t])

2.2. Scenario description

To model the effects of globalization factors it was necessary to establish a baseline scenario (based on knowledge gained from previous tasks and the overall scenario framework) for future demand of the included products. Once the baseline scenario was established, the affected variables could be highlighted using different scenario descriptions.

The baseline scenario is also based on a metastudy of reports and studies from organizations such as FAO, UNECE, ITTO and consultant companies operating in the forest-based sector industry on a global scale, and processed internally at IIASA. The input data is for 2005, and an annual average change figure is set for each region analyzed.

One aspect of the current situation in global forestry in terms of global trade of industrial roundwood is summarized in *Figure 10*. There are large fluxes of timber between China and Russia, whose net trade balances of saw logs and pulpwood are displaced toward import in the case of China and toward export in the case of Russia. The regions of Europe have a more balanced trade, the region of Nordic–Baltic being an exception.

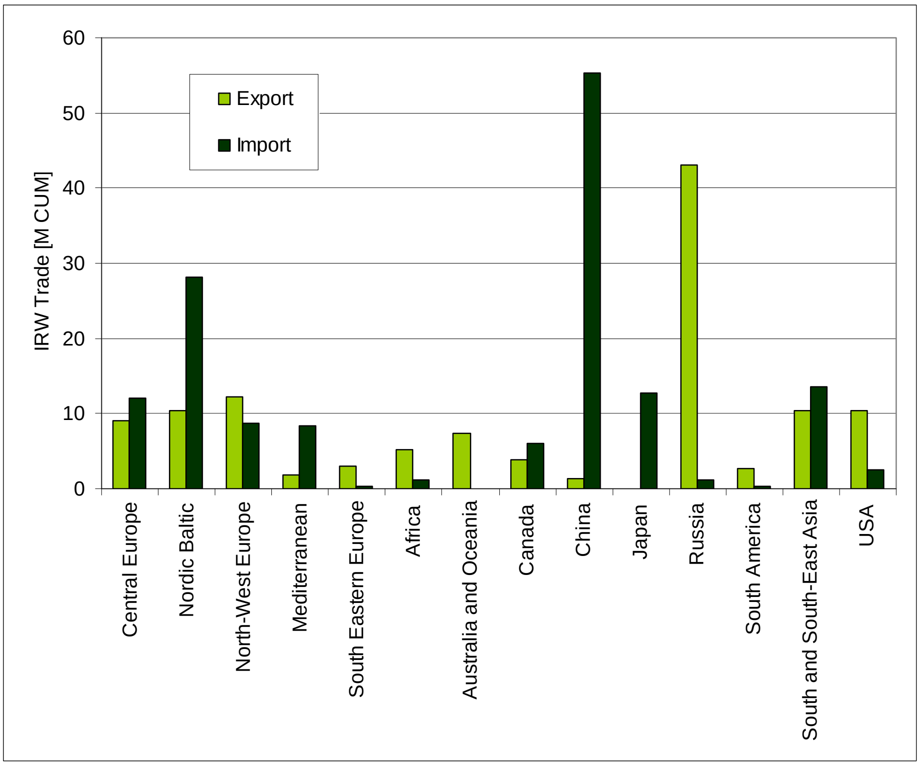

Figure 10: Overview of import and export quantities of industrial roundwood of different world regions in cubic meters. Data based on FAO data from ForestSTAT 2005.

Examples of assumptions in the Baseline scenario:
Sawnwood demand in Europe (except Southeast Europe), North America, Japan, and Oceania is assumed to be declining to only modest growth, with figures ranging between -2% and 1.5% per annum. For the other regions a strong growth is estimated, ranging from 1.8% as the low scenario for South America and up to 7% as a high-case scenario for Russia.

A similar development is expected for paper and paperboard demand in the baseline scenario. In this case, slightly more optimistic development is foreseen, with growth figures for Western Europe of some 1.5%, North America 0.5%, and Oceania above 2%. The demand for paper and paperboard in regions like China, Russia, and Southeast Asia as well as Eastern European countries is expected to see growth figures of 3% or more.

As mentioned earlier, the forest products industry is complex, with a large number of interactions among products, processes, and organizations affecting its development. We have therefore established the scenarios that are most likely to develop and whose results would indicate the future effect of the highlighted individual variables (*Table 11).*

Table 11: Overview of scenarios considered in the analysis and affected variables**.**

Scenario name	Scenario description	Variable affected in 2030
Baseline	Baseline scenario of development of global forestry sector	None
Environmental constraints	Wood supply change due to environmental constraints	Supply quantity
Competition with energy	Wood supply change due to competition with energy market	Supply quantity
Wood mobilization	Wood supply change due to mobilization (plantations, accessibility, etc.)	Supply quantity
Value-added demand	Demand price change due to value added	Demand prices
Technological change	Wood cost change due to technological change	Supply cost

"Environmental constraints" scenario: A lower supply of wood for industrial purposes due to environmental constraints such as protection of tropical rainforests, necessary erosion protection, and biodiversity issues of flora and fauna. Regions more affected are Africa, South America, Southeast Asia, and the United States.. Less affected is, for example, Nordic–Baltic with a high share of protected forests.

"Competition with energy" scenario: Bio-energy is currently seen as a possible way of decreasing usage of non-renewable fossil fuel consumption. The supply from forests to the energy market is expected to increase, affecting the traditional forest-based industries. In general, for the regions a reduction in supply is foreseen compared with the baseline scenario, but the scenario proposes differences among regions based on the size of industry, type of industry, harvesting and distribution regimes, and traditional usage of wood for energy.

"Wood mobilization" scenario: Mobilization of wood supply owing to, for example, plantations and developments in infrastructure, is modeled in the third scenario. New land-use regimes, improved silviculture, species usage, and construction of road networks are expected to increase wood supply. New plantations in South America and Oceania are expected to enhance supply from these regions the most, whereas land availability and productivity changes in Eastern European countries will spur development.

"Value-added demand" scenario: This scenario represents a development in the forest-based industry in the supply of more value-added products, which will positively affect the demand price. In general, the development in the forest-based industry is to move toward a higher degree of value-added products, cutting out intermediaries. From a primary product perspective this will have an effect on demand price, and, in general, the development is similar in all regions, although lower for Russia and higher for China.

"Technological change" scenario: Technological improvements in wood supply, for example, land-usage monitoring, harvesting methods and regimes, as well as logistical developments, are examples driving supply costs downwards. In general, regions with less developed forest practice regimes, for example, Africa, Southeast Europe, and also Oceania and South America are facing a greater change, with increased plantations affecting harvesting costs positively.

Figure 11, the sawnwood market, and *Figure 12*, the paper and paperboard market, show the shift parameters of the constant elasticity of substitution (CES) supply and demand functions as set out in the scenario description in *Table 11.* The shift parameters were quantified in in-house scenario group meetings and subsequently implemented in the global 4DSM forest sector trade model.

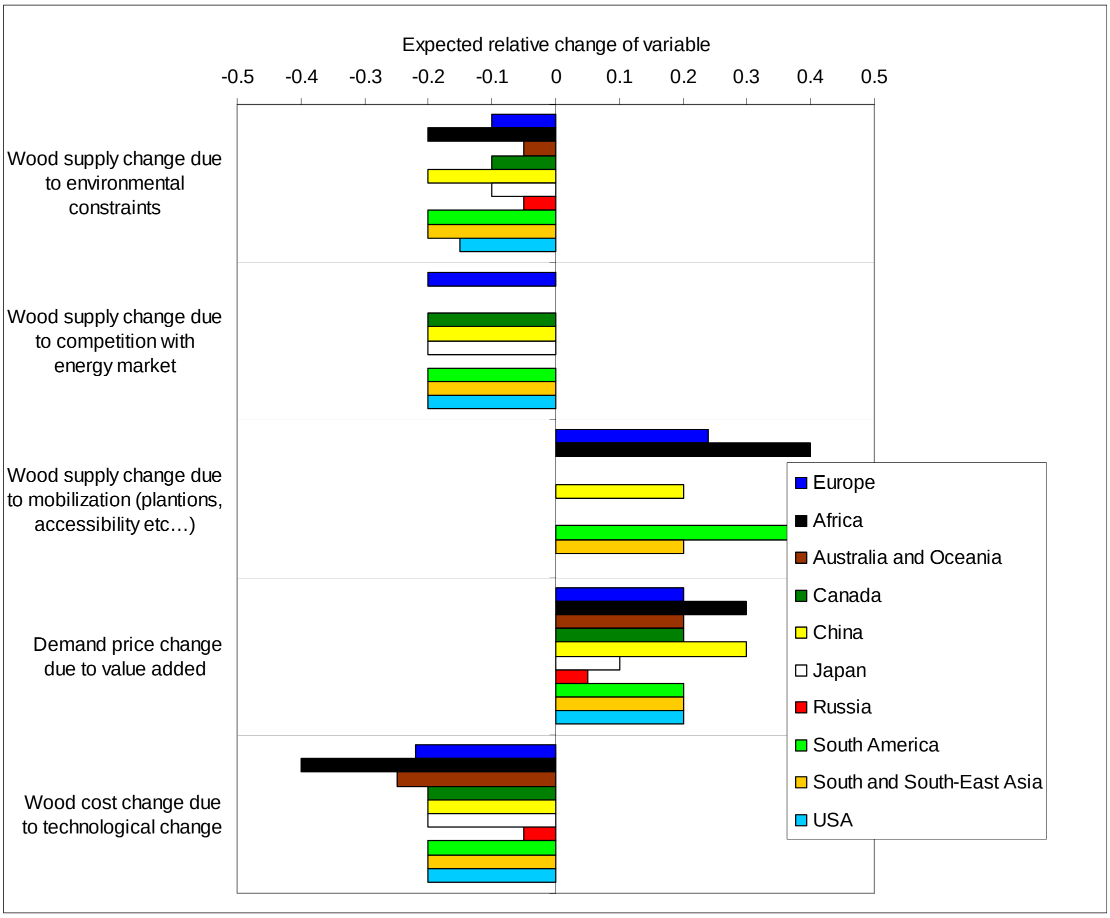

Figure 11: Scenarios of expected relative change in key parameters of the CES supply/demand function affecting the behavior of the sawnwood market in 2030.

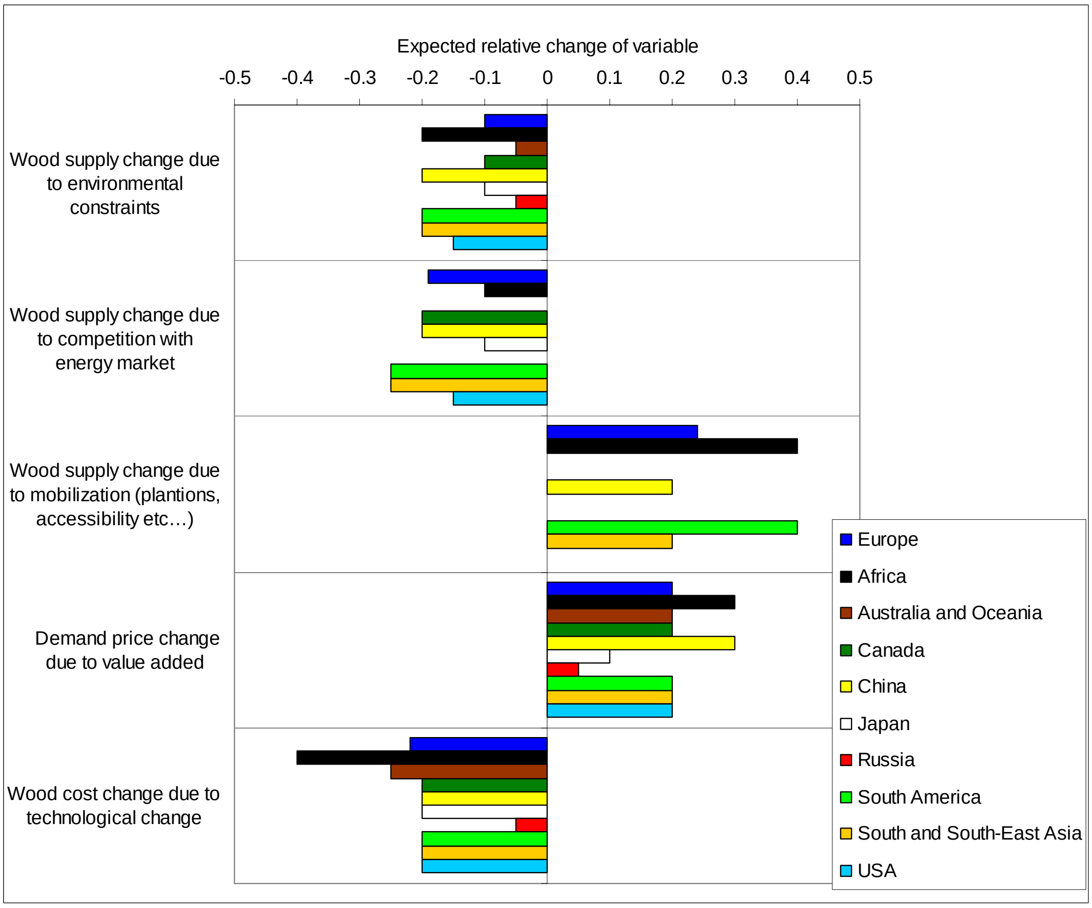

Figure 12: Scenarios of expected relative change in key parameters of CES supply/demand function affecting the behavior of the paper and paperboard market in 2030.

3. Results

3.1. Results of the 4DSM Model scenarios for global regions

3.1.1. Sawlog and sawnwood market

In absolute figures, South America leads the regional ranking for sawlog production at some 400 million m^3 in the baseline run of 2030. Russia is ranked second at 300 million m^3, and at the same time Russia is the relative winner because of an increase in production rate of more than 300% compared to the baseline run of 2005. Third place is taken by the USA, with some 280 million m^3 in 2030 (180 million m^3 in 2005). Africa shows a rate of increase of 180% from 30 million m^3 in 2005 to some 100 million m^3 in 2030. Canada and China are the only regions showing a reduction in sawlog production by 15% and some 2%, respectively, in 2030, compared to 2005.

From the European regions, the winners in absolute figures are the Northern and Western European regions. The Nordic–Baltic region reaches some 90 million m^3 in 2030, followed by the northwestern European region at some 60 million m^3 and Central Europe at some 45 million m^3 by 2030. On the other hand, the southeastern European and the Mediterranean regions are the relative winners, showing rates of increase of 100% and 50%, respectively.

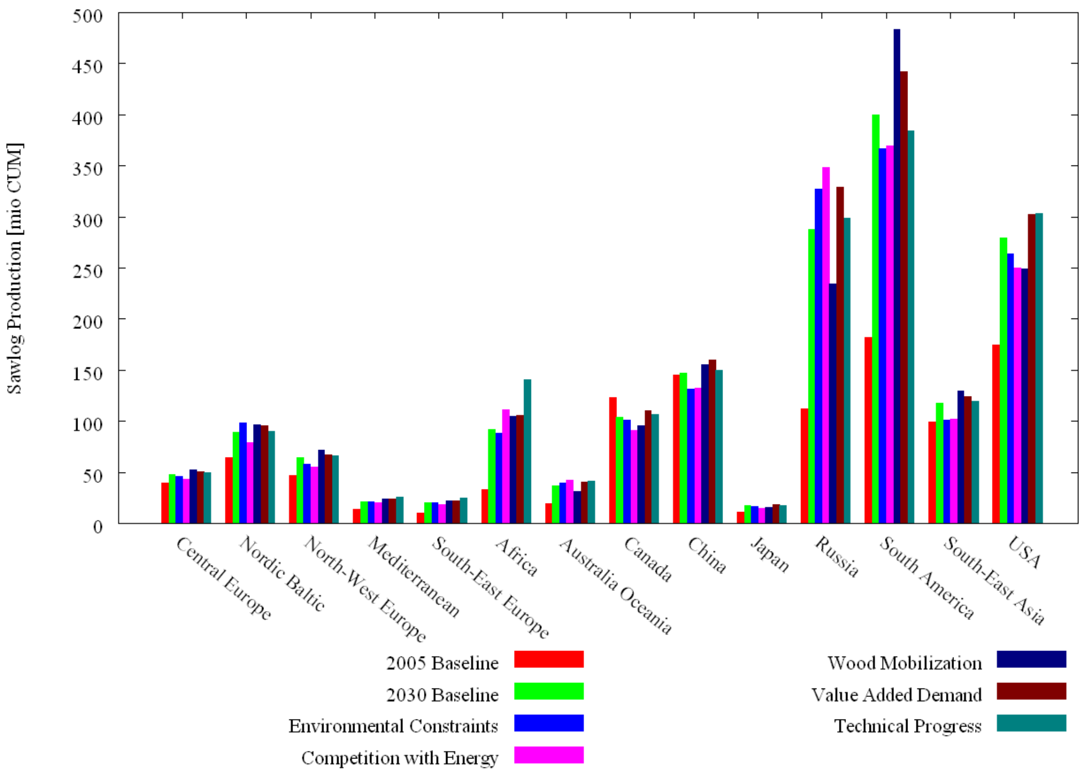

Figure 13: Expected supply/production quantity of sawlogs in world regions in 2030 in million cubic meters for different scenarios.

In the scenario analysis, *Figure 13* indicates that, in absolute terms, the wood mobilization scenario has a high impact on sawlog production. In South America especially, improved accessibility leads to increased production of almost 100 million m^3 compared to the baseline in 2030. Moreover, because of a change in value-added demand, sawlog production increases significantly in South America. In Russia, competition with energy turns out to have the most impact, driving the increment of sawlog production by some 50 million m^3. The application of environmental policy leads to increased production in Russia because of a leakage effect. Overall, wood mobilization, value-added demand, and technical progress are stronger driving forces in most of the world regions than environmental policy and competition with energy. On the other hand, environmental constraints and increased wood mobilization result in a production decrease of some 20–25% in Canada and up to 8% in China, compared to the baseline in 2005.

A similar overall analysis is true when looking only at the European regions. An exception is the Nordic–Baltic region where, in common with Russia, the application and improvement of environmental policies lead to an increase in sawlog production. In all other regions, wood mobilization and technical progress have the greatest effect, especially in the Southeast European region and in the Mediterranean area.

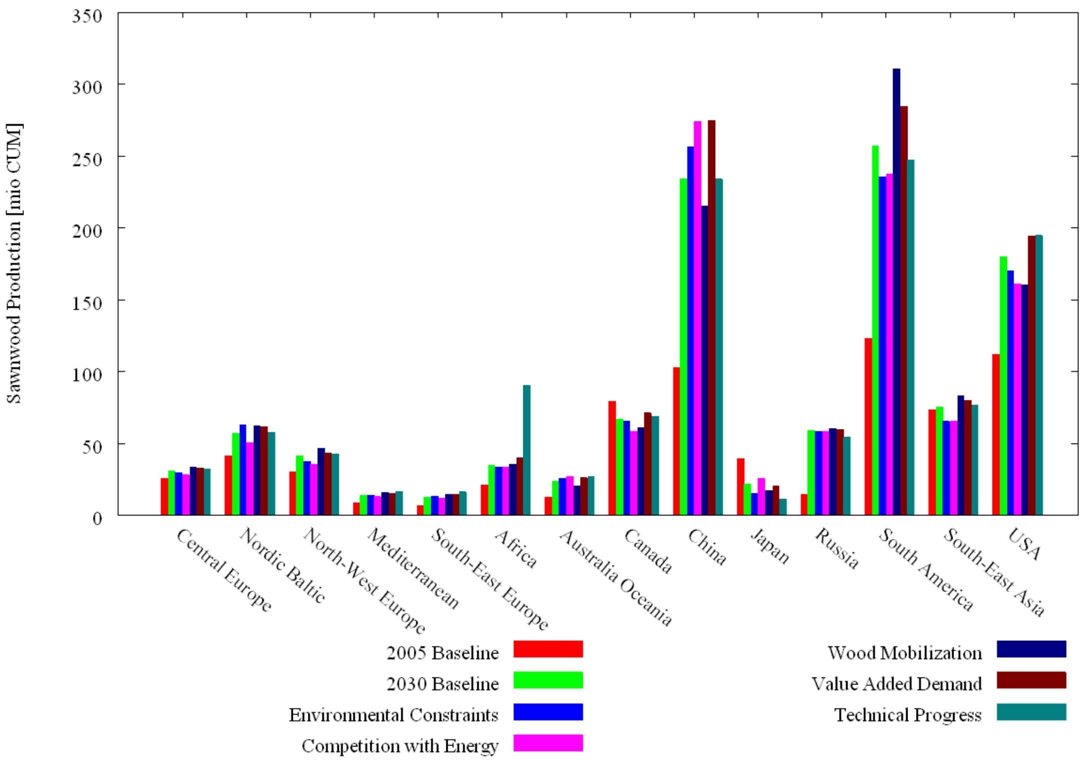

Figure 14: Expected supply/production quantity of sawnwood in world regions in 2030 in cubic meters for different scenarios.

When comparing the baseline scenarios 2005 to 2030, *Figure 14* indicates that South America is 250 million m^3 slightly ahead of China (230 million m^3), followed by the USA with a sawnwood production level of 170 million m^3. However, the relative winner is Russia with a rate of increase of more than 300%, followed by China (+120%) and South America (+100%). Only Japan (-60%), Canada (-15%), and Southeast Asia (-5%) show negative increase rates.

In Europe, the traditional production regions of Nordic–Baltic (55 million m^3), Northwest Europe (40 million m^3) and Central Europe (30 million m^3) are ahead of the Mediterranean and Southeast Europe regions, which show a sawnwood production of some 20 million m^3. In relative terms, the situation appears to be upside-down. Southeast Europe and the Mediterranean show the highest rates of increase of 100% and 50%, respectively. Only the Nordic–Baltic region can show a similarly high rate of 50% increment in sawnwood production by 2030.

The main driver for increased sawnwood production by 2030 in South America appears to be improved wood mobilization, which produces an additional 50 million m^3 compared to the baseline run in 2030. Half that effect can be achieved by increased value-added demand. In China, increased competition with energy and higher value-added demand can lead to an additional 40 million m^3 of sawnwood production. In the USA, value-added demand and technical progress can drive the production to a further 20 million m^3.

Over all global regions, wood mobilization, value-added demand and technical progress are causing stronger effects than improvements in environmental policy and the competition with energy.

In the European area, environmental policy shows, especially in relative shares, slightly more effect in the Central and northwestern regions than in the Southeast or Mediterranean regions. However, here too wood mobilization and value-added demand can be seen as the main drivers for increased production in absolute terms.

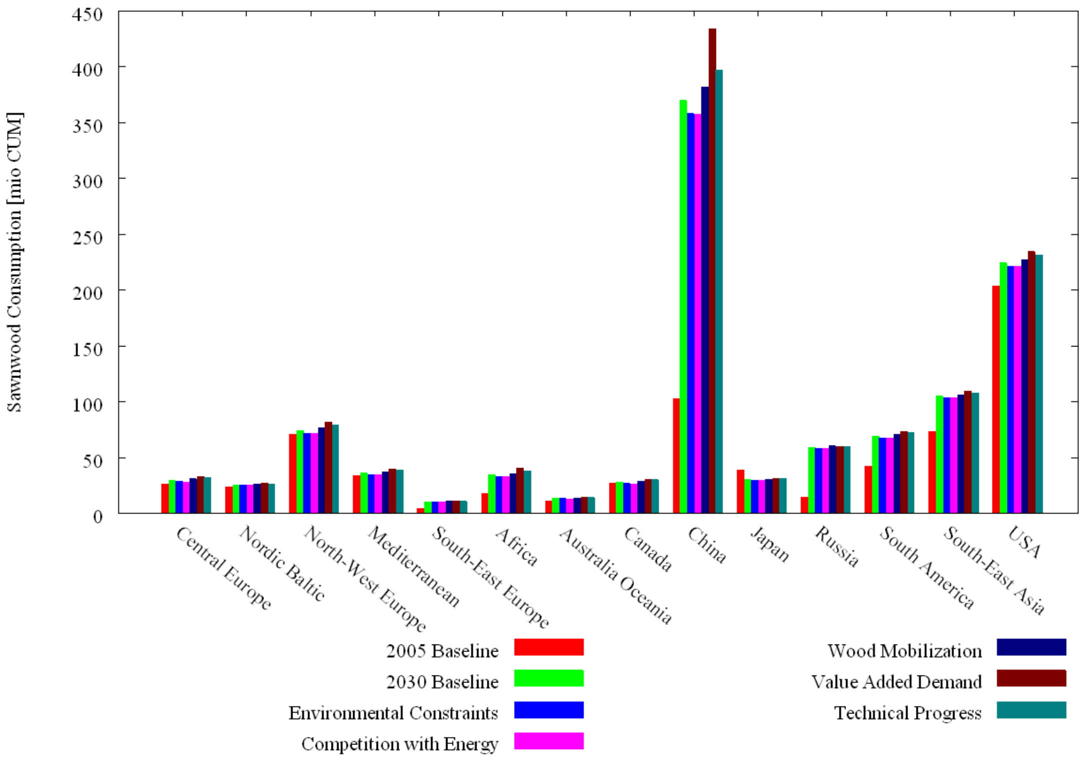

Figure 15: Consumption of sawnwood in million cubic meters by global regions and according to different scenarios. See the electronic version of this report for colored figures.

Figure 15 indicates that consumption of sawnwood is projected to increase by a factor of three in China and in the southeastern European region. By the year 2030 China will have overtaken the currently leading region in consumption terms, the USA, by 30–50% to reach a sawnwood consumption level of some 350–400 million cubic meters. Other global regions, such as Africa and South America, are projected to double their consumption by 2030. Consumption in Southeast Asia will increase by about one-third by then.

Except for Southeast Europe, where the rate of increase is indicated to be some 150%, the European regions show rates of increase for sawnwood consumption of only 5–10%.

US growth is projected to be modest at some 10% and Japan is projected to cut its consumption substantially. Overall, the scenario effects on consumption are small, with the exception of China, which will experience high growth in consumption, and Russia, a growth country with a relatively strong and approximately threefold increment.

3.1.2. Sawlogs and Sawnwood: Effects on prices and costs

In the following we use the words “price” and “price index” to describe model results. These prices emerge as endogenous variables in the model. However, the prices resulting from the model solution as model internal market clearing prices should not be interpreting as a price forecast.

Figure 16 indicates that, in absolute terms, sawlog prices increase the most by 2030 in China, Japan, and Southeast Asia, reaching some US$80 per m^3 in all three regions, compared to about US$58 per m^3 in 2005 (baseline difference). Similarly, high prices will be reached only in South America, which will show around US$78 per m^3 by 2030. In relative shares, Africa and Russia demonstrate the highest price increase rates (70%), followed by Canada and the USA (50%). Nevertheless, those countries with the highest relative price increment still show the lowest absolute prices by 2030.

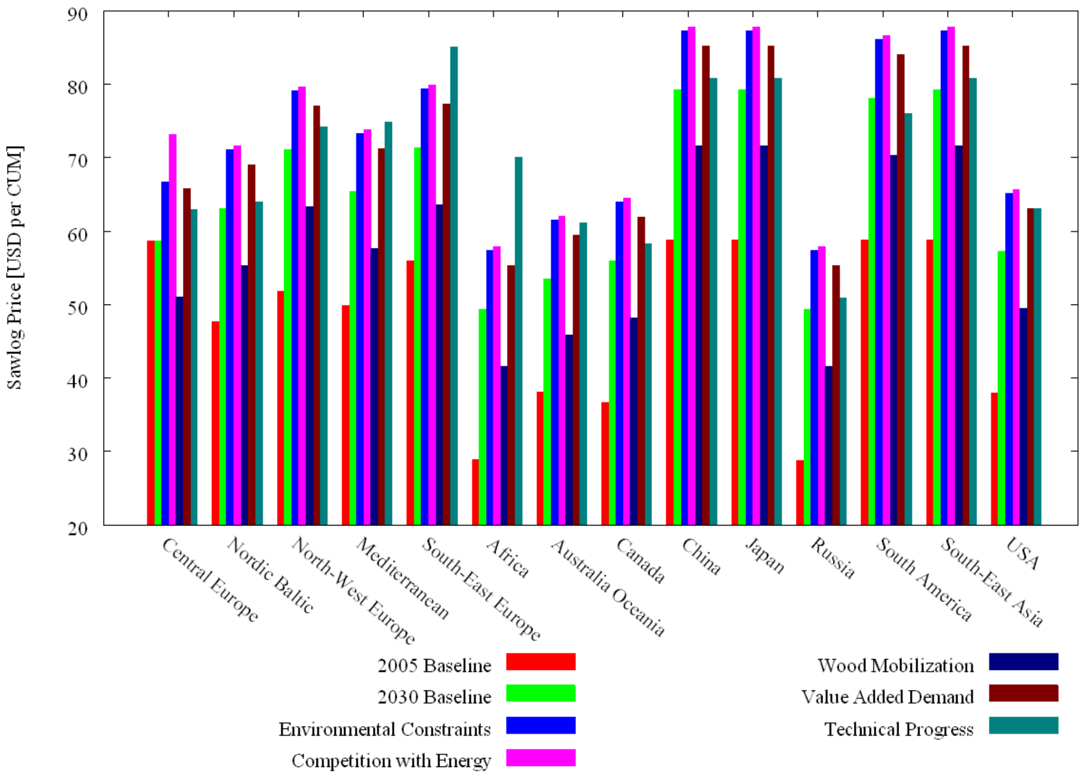

Figure 16: Projected prices for sawlogs in US dollars by global and European regions and for different scenarios.

Europe overall reveals a relatively high price level for sawlogs by 2030, led by Northwest and Southeast Europe with some US$70 per m^3. These regions are followed by the Mediterranean and the Nordic–Baltic region, where the sawlog prices will increase to around US$65 per m^3 by 2030. In relative figures, the highest price increment is shown by the regions of Northwest Europe and the Nordic–Baltic (about 30–35%). The lowest absolute price, as well as the lowest rate of increase for sawlog prices by 2030 is demonstrated by the Central European region.

By analyzing the scenario effects, *Figure 16* points out that, in absolute terms, the strongest drivers for sawlog prices at a global level are increased competition with energy and additional environmental constraints. Almost all over the world, these two factors are responsible for a price lift of US$8–15 per m^3 sawlog compared to the baseline scenario for 2030. Value-added demand and technical progress are identified as further important drivers for sawlog prices by 2030. The latter is especially true for Africa and Southeast Europe where a price increment of US$10–20 per m^3 can be achieved. In relative shares, technical progress in Africa also accounts for a price increment of 140% compared to the 2005 baseline. Improved environmental policies and more competition with energy lead to a price increment of around 100% in Africa and Russia and 70% in Canada and the USA.

In Europe, the strongest effects are generally caused by strengthened environmental policies and the increasing competition with energy, which can lead to additional price increments of 10–20% in some regions (i.e., Central Europe) compared to the baseline runs for 2030. However, technical progress in the countries of the Southeast European region could also lead to a price increment of 20% or some US$14 per m^3 of sawlogs compared to the baseline of 2030. Improved wood mobilization could lead to lower price increase rates for sawlogs in 2030 and would even cause a 17% price decrease relative to 2005 in Central Europe.

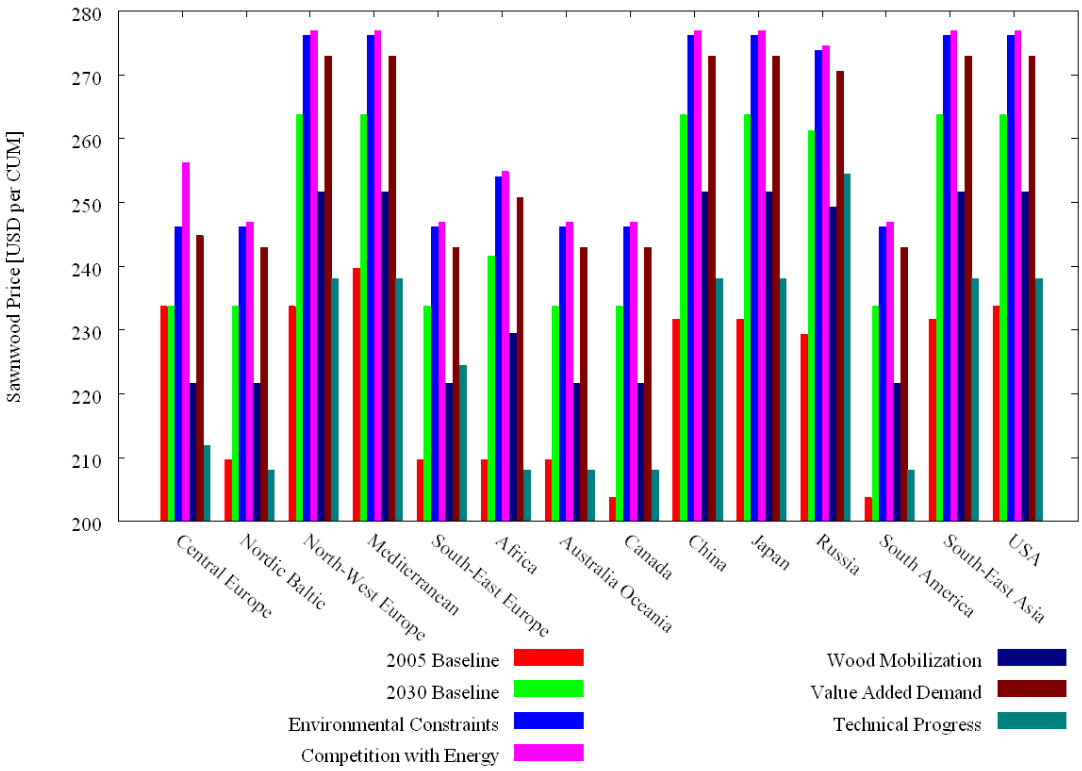

Figure 17: Price for sawnwood in US dollars by global and European regions and for different scenarios.

The model predictions for sawnwood indicate the highest prices for Europe, Asia, Russia, and the USA, reaching slightly more than US$260 per m^3 in 2030 (*Figure 17*). Sawnwood prices of about US$230 per m^3 are calculated for all other global regions, with Africa exceptionally showing slightly more than US$240 per m^3. In relative terms, Africa, Canada, and South America are facing the highest price increase rates of some 15% compared to the 2005 baseline. The average absolute increment over the survey period is about US$30 per m^3 globally.

European regions, especially the Mediterranean and Southeast Europe, present rather low price increments, together with Australia/Oceania (plus 10%). However, no price change is indicated for sawnwood in 2005–2030 for the Central European countries. All other European regions indicate price differences of some US$20–25 per m^3 between the baseline runs in 2005 and 2030.

Comparing the different scenarios as drivers for a sawnwood price change over the survey period, environmental constraints, competition with energy, and technical progress are identified as the leading factors. These three factors are responsible for price differences of about US$10 per m^3 compared to the baseline run for 2030. In Central Europe especially, the increased competition with energy leads to a price increment of more than US$20 per m^3 from the baseline in 2030. In common with the effect of improved wood mobilization and technological progress on sawlog prices, these scenarios also keep prices lower for sawnwood. In Central Europe, the two factors lowering the general price increment would even reduce the price between 5 and 10% from the 2005 baseline level. Small price reductions of about 1% can further be shown for the Nordic–Baltic, and the Mediterranean region. These are due to technological progress.

3.1.3. Pulpwood, paper, and paperboard market

Figure 18 indicates that in European regions, pulpwood production increases by some 50% and will thus maintain its global competitiveness. The strongest relative growth is expected in Southeast Europe according to the model parameterization, more than doubling the current output. Moreover, in Central Europe an increase of some 80% is projected to occur, mainly through thinning operations. In these two relatively high-growth regions the increase is more or less independent of the scenario adjustments. In the other regions, however, we find that competition with the bio-energy market in particular for ligno-cellulosic materials will lead to a reduced supply of pulpwood. With respect to other global regions we find the African continent to be the most successful relative winner with a tripling of pulpwood output to some 70 million cubic meters by 2030. Russia is also projected to increase its pulpwood output by some 250%, and South America will see an increase of 200% by 2030. Canada, on the other hand, will lose its competitiveness mainly because of severe supply constraints. Particularly interesting is the finding that in a scenario of globally differentiated increased wood mobilization, Canada will lose out even more.

Substantial trade occurs in 2030, with overall trade volumes in pulpwood just about doubling. The main importing country of pulpwood will be China. China is projected to be a net importer of some 150 million cubic meters of pulpwood, followed by Southeast Asia and Japan. The main exporting region of pulpwood is Russia with almost the same export quantity as China’s import quantity (which does not mean that all exports from Russia are imports to China). The next largest exporter of pulp logs is Africa with some 50 million cubic meters and the USA could become a next pulp log exporter, depending on the success of supply by the other regions.

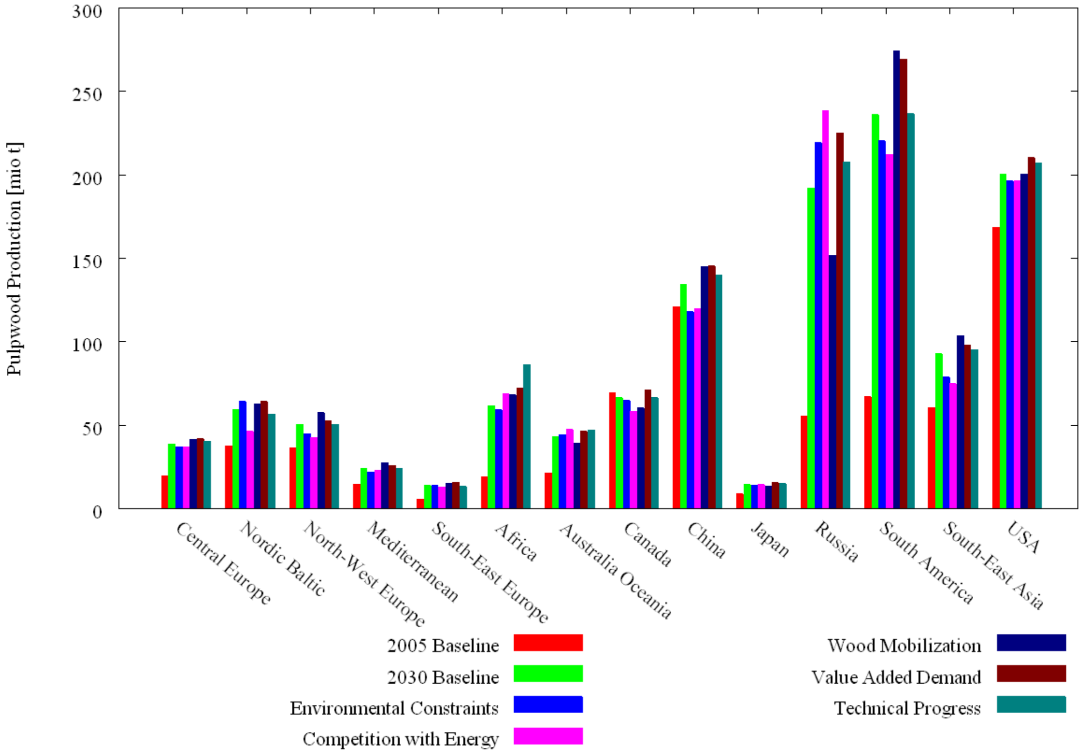

Figure 18: Expected supply/production of pulpwood in million tons by region and impact scenario.

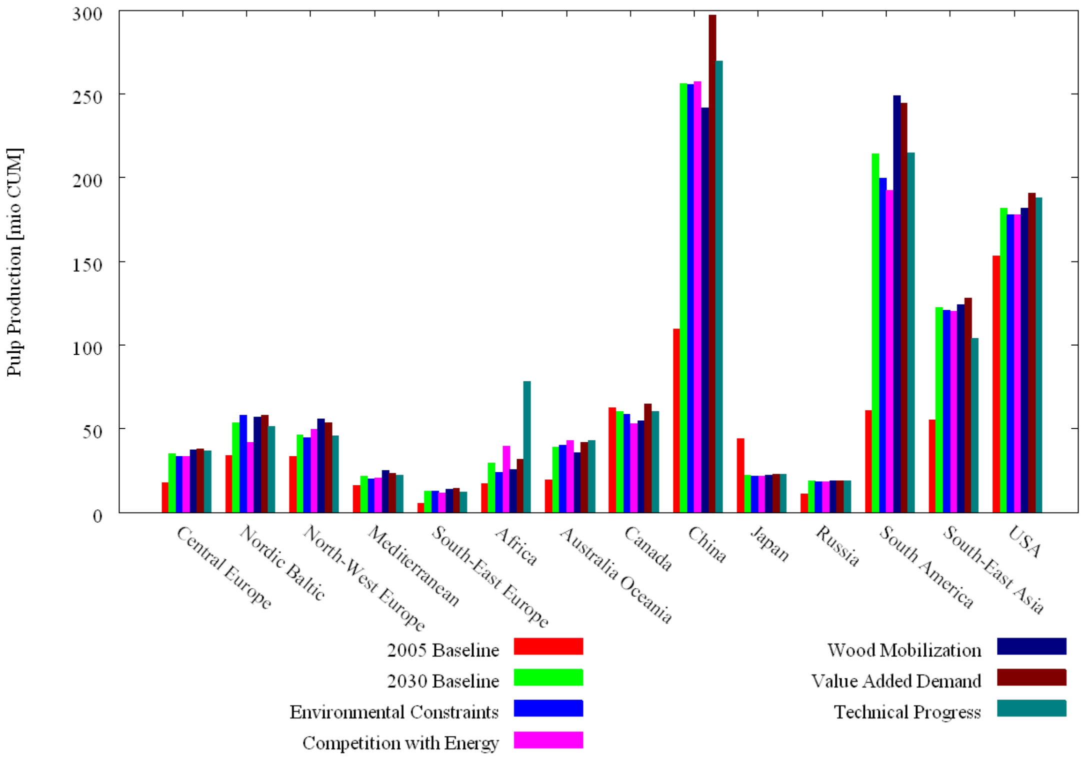

Figure 19: Expected paper and paperboard production in million tons by region and impact scenario

Paper and paperboard production exhibit the strongest growth in South America by more than tripling in output (*Figure 19*). A doubling in total paper and paperboard output is projected to occur in both China and Southeast Europe. Central Europe, because of the strong assumption of a large fiber supply in terms of pulp logs, also exhibits strong growth in this sector. An interesting case turns out to be Africa, which on average is projected to grow by some 75%. However, under the scenario of stronger-than-baseline technological progress, production of paper and paperboard would increase by 350%. This suggests a strong sensitivity of this region to this particular parameter of technological progress. Russia turns out to be an interesting case. Despite its strong international position on the pulpwood market in terms of paper and paperboard products, Russia is projected to increase its production by some 50% to satisfy internal demand. However, Russia does not appear as a major net exporter of paper and paperboard products according to the model output. This model result is in stark contrast to Russia's forest sector and associated trade policy.

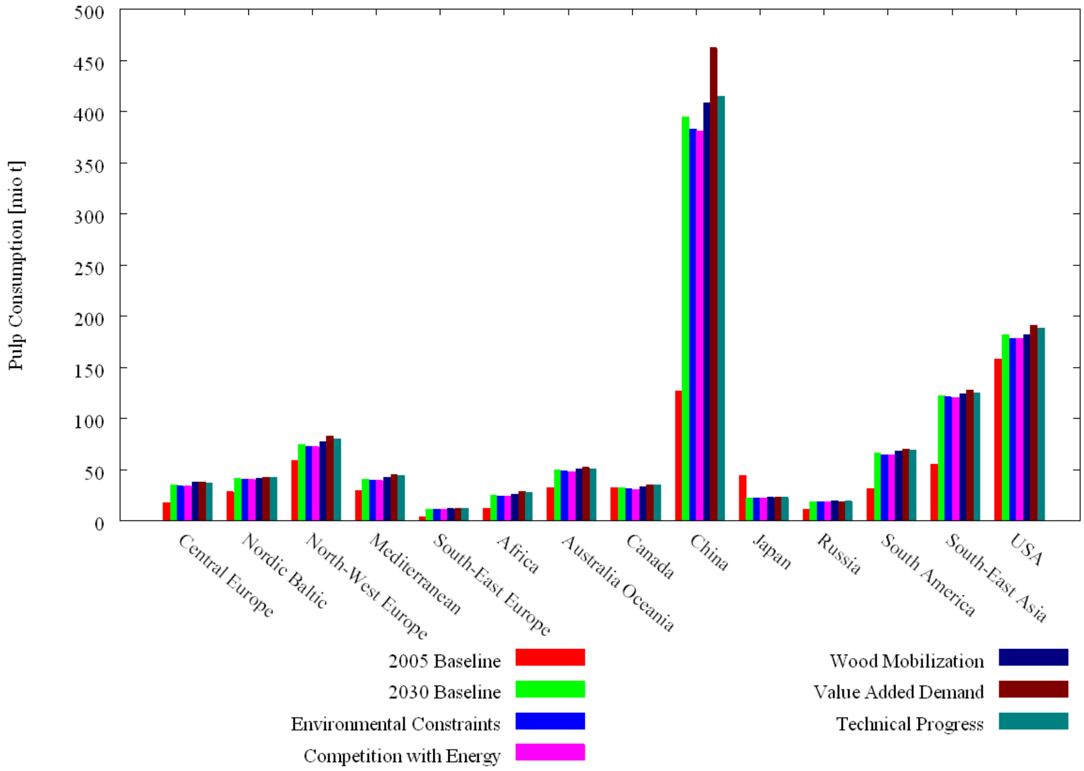

Figure 20: Expected consumption of paper and paperboard in million tons by global region and according to different scenarios.

Figure 20 shows that consumption of paper and paperboard is projected to increase by a factor of two in China and in the southeastern European region. By the year 2030 China will have overtaken the currently leading region in consumption terms, the USA, by an order of magnitude to reach a consumption level of paper and paperboard of some 350–400 Mt. Other global regions such as Africa, South America, and Southeast Asia are projected to double their consumption by 2030. The consumption of the whole of Europe is projected to increase by some 50%, with the highest growth in Eastern European countries. US growth is projected to be modest at around 20%, and Japan is projected to cut its consumption substantially. Overall, the scenario effects regarding consumption are small, with the exception of China which will experience high growth in consumption due to the effects of product quality improvement, for example, better packaging grades, as well as cost reductions and technological progress in the pulp and paper sector.

3.1.4. Pulpwood, paper, and paperboard: Effects on prices and costs

There is greater similarity between marginal pulpwood prices in relative terms in 2030 than in 2005 (*Figure 21*). This effect is inherent to partial equilibrium models that, by assumption, mimic a perfectly globalized market yet take into account transaction cost items, such as trade transaction costs, or even trade barriers, such as quotas. The latter were removed in the globalization scenarios presented here. These results also assume a comparatively elastic supply schedule in all world regions with the result that the pulpwood price index appreciates on average by some 20–40%. In Central Europe and Russia the price index increases by some 80%, followed by Africa, South America, and Southeast Asia, where prices climb by around 60%. In terms of the price effects, it is worth mentioning that the scenarios show wood mobilization to have the strongest relative effect, reducing prices below baseline levels by some 20%. Prices in European regions are projected to stay competitive.

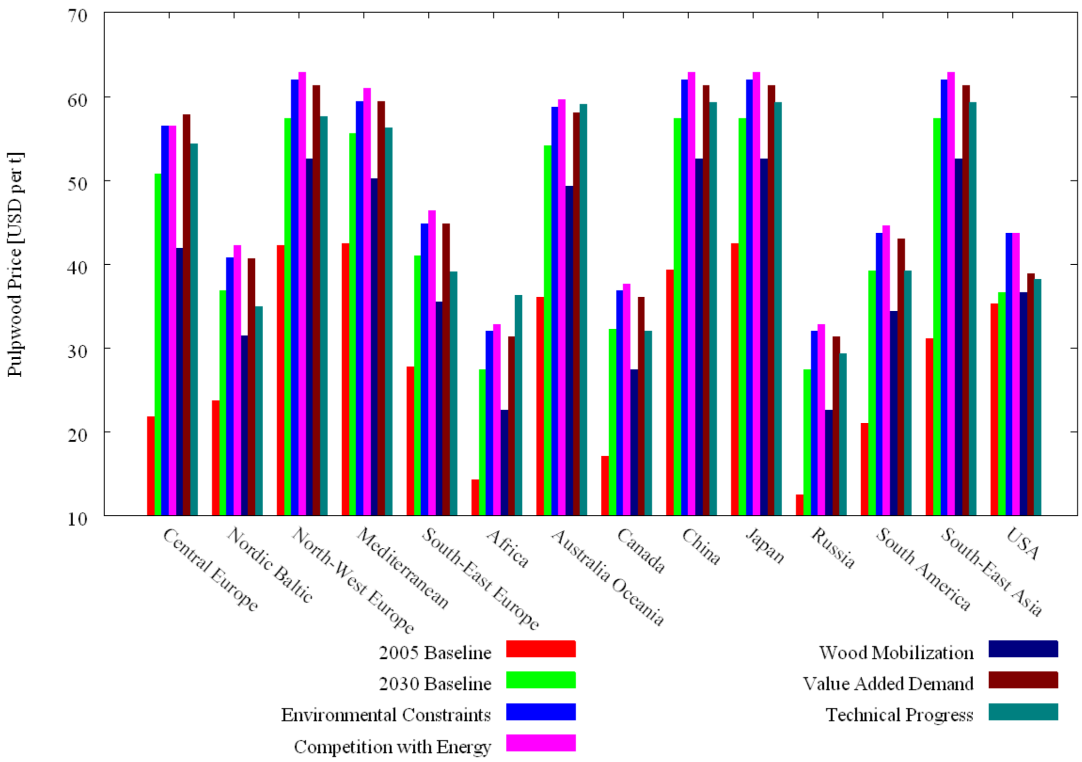

Figure 21: Prices of pulpwood by region and according to different scenarios.

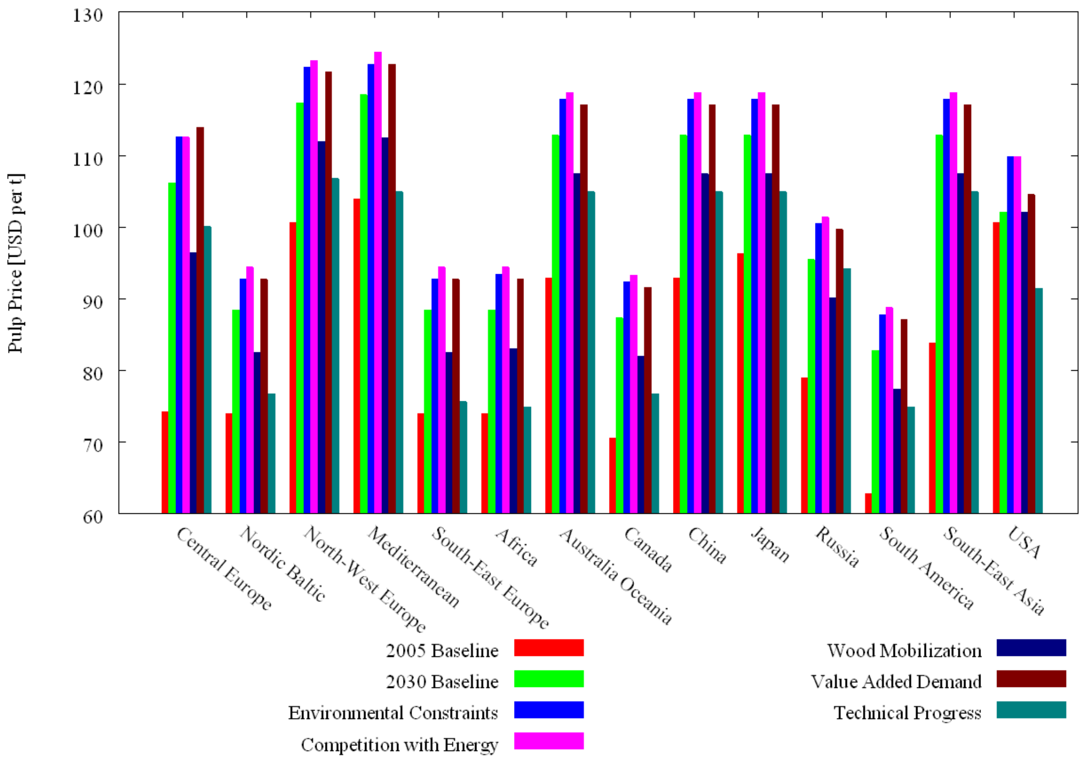

Figure 22: Prices of paper and paperboard products by global and European regions and for different scenarios.

Following the trends of pulpwood prices, paper and paperboard product prices also converge because of globalization (*Figure 22*). The sharpest price increase of around 30% is found in Central Europe, Southeast Asia, and Latin America. Note that the Latin American price level is comparatively low in 2005. For the rest of the regions, paper and paperboard products are projected to increase by not more than 20% with an average of around 15%, depending on scenario type. First, technological progress and second, wood mobilization are the single most important factors determining cost-competitiveness. Technological progress combined with globalization even leads to a negative price trend in the USA in the composite paper and paperboard index.

3.2. Results of BeWhere

The BeWhere model served a dual purpose in this study. First, BeWhere performed a geographically explicit analysis of mill location and mill size depending on the respective geography of economic wood supply; this helped to parameterize the supply functions of the global trade model of the forest sector 4BSM. Note that the 4BSM results shown in this report were generated without forced calibration through inverse calculations and through calibration of the supply side from BeWhere runs. This indicates that BeWhere seems to generate realistic results of the current situation. Moreover, as the latest technology assumptions from more detailed studies (e.g., virtual mill studies using Aspen software) were used to appraise future greenfield investments, we are fairly confident about our predictive capacity. The second purpose of the BeWhere model was to downscale results from the more aggregate models such as the 4BSM. Downscaling a subsequent plotting helps with the visual inspection of model results and thus helps to validate model outputs.

The BeWhere model was developed and applied at global scales for this study. However, because of space limitations we present here only a few selected case studies to show the purpose and the principal capabilities of the model.

3.2.1. Case study 1: Sawmill locations and capacities in Europe

This case study describes sawmill locations and, at the same time, assesses economies of scale in order to assess shapes and parameters of supply schedules. To achieve these ends we forced the model to produce sawnwood for a hypothetical demand increase of 50% in the whole of Europe for each European country individually.

The first plot (*Figure 23)* shows the projected sawmills in the base year 2005. The red dots indicate the locations of existing sawmills, while the green dots indicate the predicted additional capacities and their locations, which should come online by 2030. Note that the base distribution of mill locations is calculated by the model and not from geographical databases. It is assumed that sawnwood is consumed at consumption centers within the country. No international trade is assumed. In the second plot (*Figure 24)* the additional future sawmills for 2030 are presented at four different levels of their capacity covering the assumed 50% demand increase. These mills produce at optimal levels using a complex solution algorithm of the BeWhere model. Using this methodology allowed us to assess economies of scale in a realistic fashion and thus cost-benchmark individual locations in Europe with those of global regions. This is a unique approach, never before applied at such large scales. It appears that transportation costs of sawnwood justify to establish new capacity in the vicinity of consumption centers.

The optimal location in 2005 and 2030, as well as the optimal plant size of the additional plants in 2030, have been predicted countrywise by the BeWhere Model. As we consistently applied the same algorithm across Europe, the distribution map of geographic production is not always realistic, but for our purposes of constructing supply schedules for the trade model, the results served their purpose. Thus, *Figure 25* must be read as a cost map, with the largest mill locations being the most competitive.

The model results for this case study indicate substantial economies of scale at the individual mill level (*Figure 24*). Further it might be concluded that mill size was found to be an important determinant of cost-competitiveness of new capacities within the observed countries.

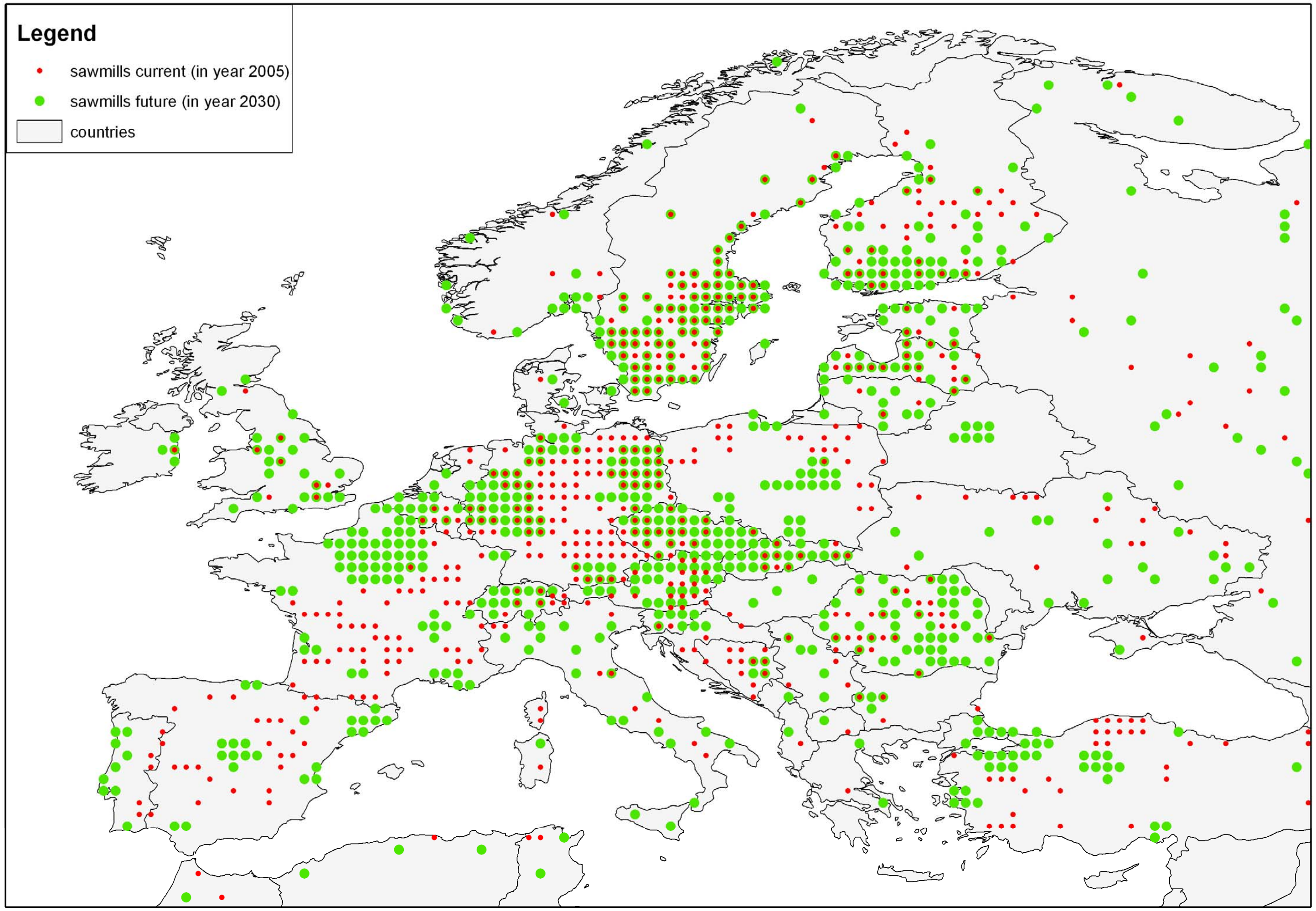

Figure 23: Potential supply of sawn wood by country: Geographic explicit distribution of the estimated location of current sawmills and the location of potential future major sawmills in Europe (2005, 2030).

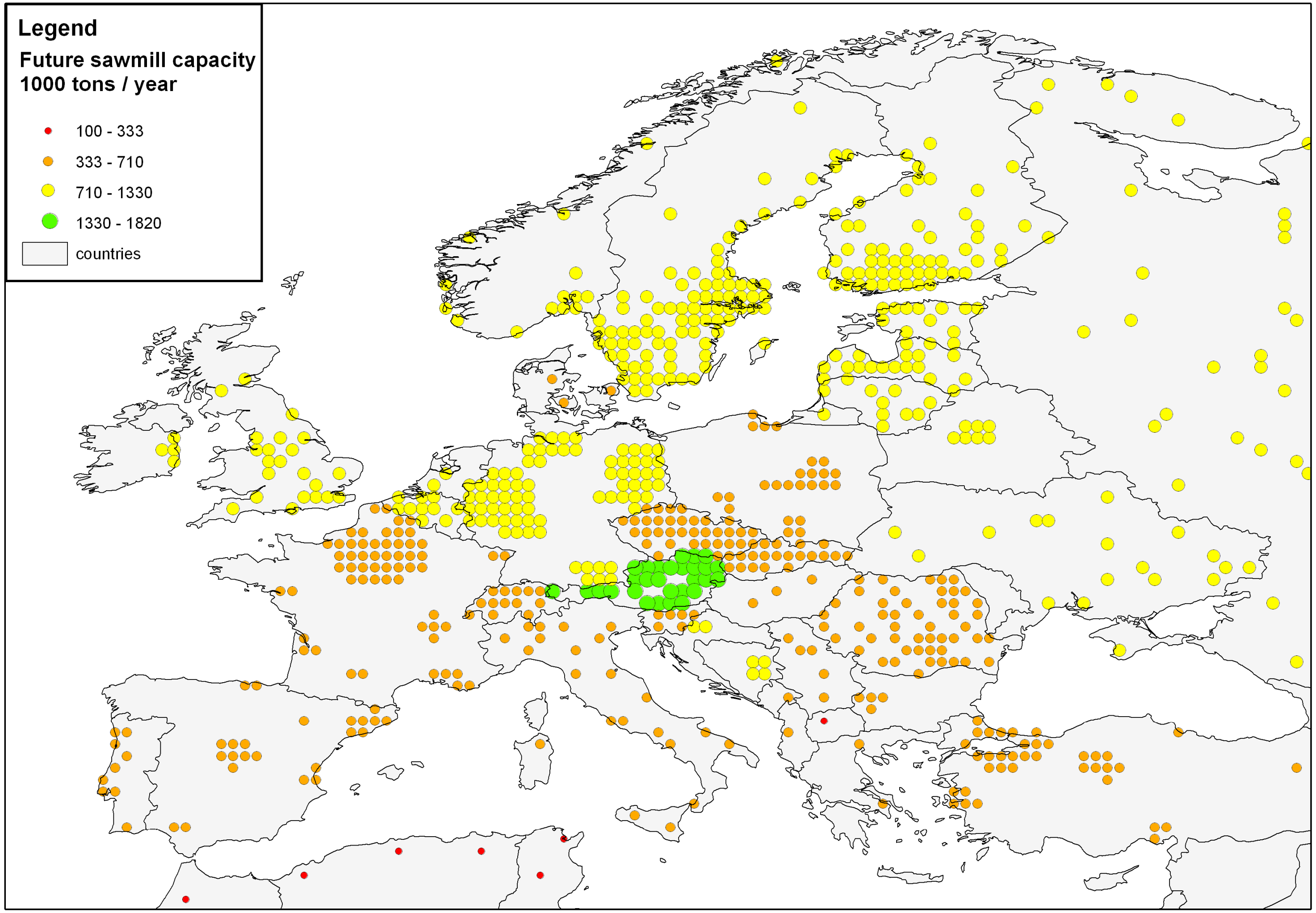

Figure 24: Economies of scale of new production capacity: The potential mill location and size in 2030 for production capacity of greenfield sawmills in Europe is shown under the scenario of 50% demand increase in each country.

3.2.2. Case study 2: Pulp mill locations and capacities

In this case study we downscaled the results of the 4DSM model under a number of assumptions. The 4DSM model predicted a production increase of some 50% in the Nordic Baltic Region (2005, 2030). We also made a number of additional simplifying assumptions in the execution of the model.

Figure 25 shows the geographic distribution of existing mills from the plots database (red dots) and future mill locations as computed by the BeWhere model. The BeWhere model for pulp and paper mill location uses detailed engineering models for individual pulp and paper mills in order to assess optimal size, location, and costs, depending on the local supply and demand conditions. Locations of new pulp capacity were modeled by increasing domestic consumption by 50%. The scenario did not allow for international trade, which explains that new pulping capacity is located inland. Costs are inversely correlated with size because of economies of scale which are naturally constrained by increasing wood supply costs due to increasing transportation distances. Mill size is plotted in *Figure 25.* Note that the new locations take into account wood demand from the other mills; however, in these scenarios, competition with the bio-energy sector was not included.

It might be concluded for this case study that economies of scale are most apparent in the southern regions due to higher forest production. Larger scales are prohibitive in more northern regions due to increased transportation costs.

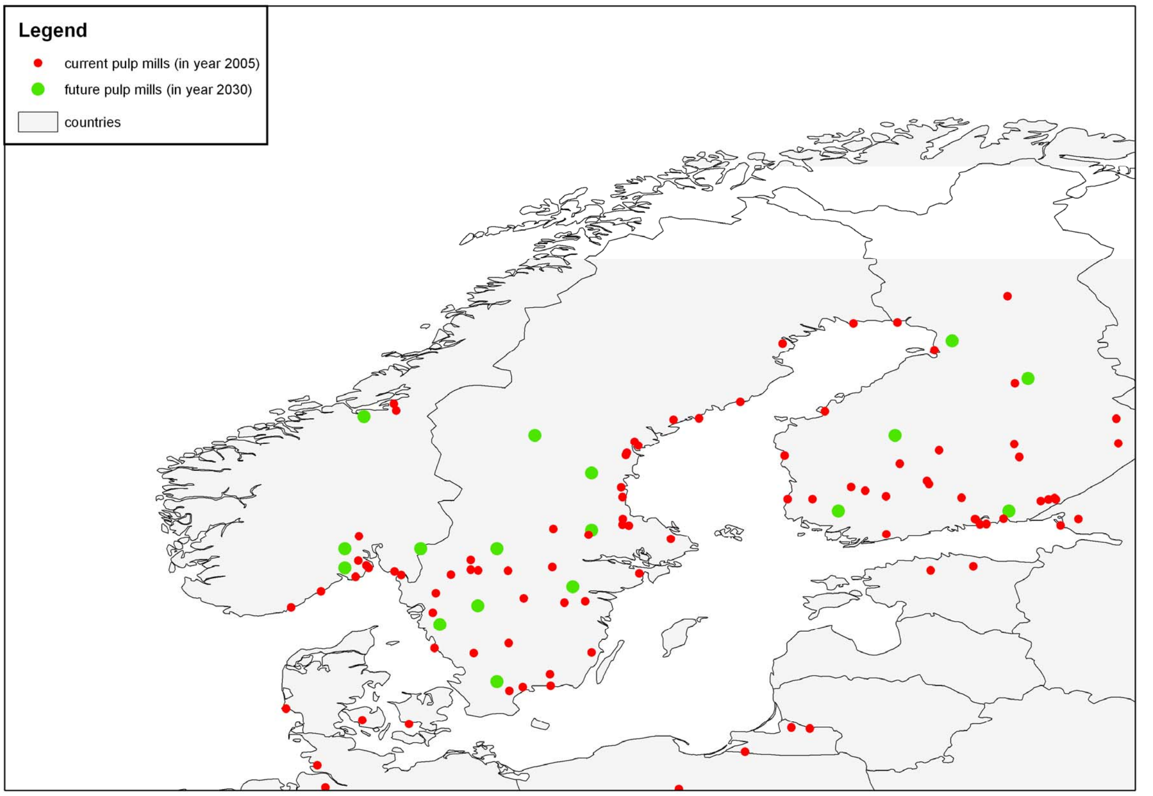

Figure 25: Geographically explicit distribution of current and potential future major pulp mills in the Nordic Baltic Region (2005, 2030).

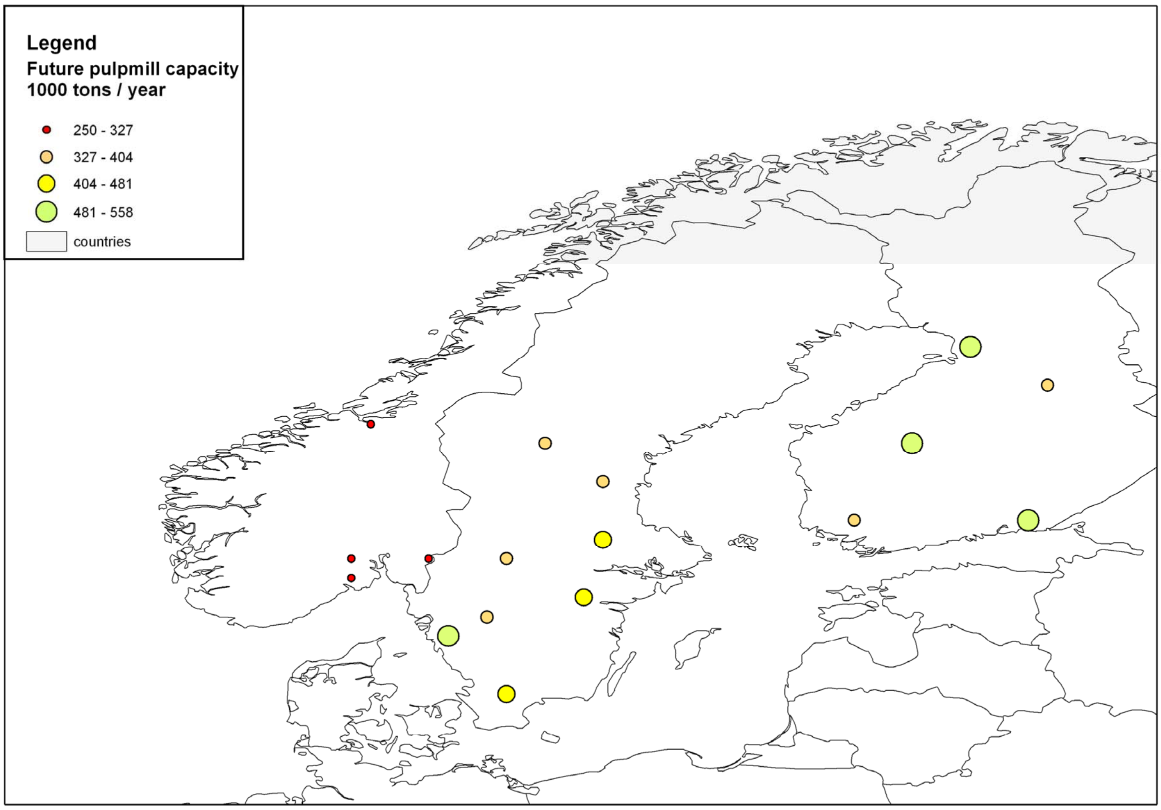

Figure 26: Economies of scale: Downscaled baseline scenario 2030 for production capacity of greenfield pulp mills in the Nordic–Baltic Region of Europe (2005, 2030).

3.3. Results of BFSM

The Bilateral Forestry Sector Model (BFSM) is a simulation scenario model that mimics the basic processes of the forestry sector and product market. The results of the entire model cannot be presented in a comprehensive manner because of the space limitations of this report (the model consists of more than 250 dynamic variables). Instead, we present here two separate sub-models of the BFSM forest sector model. First, we will present the results from scenario runs of demand for paper and paperboard, given a number of different IPCC socio-economic marker scenarios in terms of population development and economic development measured by GDP per capita. The second case study will be presented on the issue of intersectoral competition for wood among the sawmilling, pulp and paper, and bio-energy market.

Demand scenarios

Basic demand for forest products is modeled according to the IPAT identity. Impact = Population x Affluence x Technology. Thus, changes in demand patterns are driven by population dynamics, changes in economic affluence measured in gross domestic product (GDP), and changes in consumption patterns due to lifestyle changes. To model demand we define an initial EU population for the stock variable “EU Population” (*Figure 27* shows the part of the model as implemented in VenSIM). The stock variable is connected through a positive/negative feed-back loop with a flow variable, “EU Pop Change,” defined by a net population growth rate. We simulated three scenarios of world and European population development according to the revised IPCC SRES scenarios (A2, B2, B1) revised by IIASA for the 4th IPCC Assessment Report. All other parameters were kept fixed for the simulation experiment reported here. *Table 12* lists some of the parameters considered. Increase in future demand in this constellation of parameters can be explained only by population growth. The other state variable is the consumption per capita, which is dynamically impacted by the A factor (Affluence measured in terms of GDP) and the T factor here represented by a "consumption technology" expressed as "consumption coefficient paper." Total aggregate demand "EU Paper Demand" is then computed in a straightforward manner by simple multiplication.

Table 12: Population growth rate (average 2005–2030) according to IPCC/IIASA for different scenarios.

	Scenario		
Region	**B1**	**Baseline (B2)**	**A2r**
EU	0.24%	0.18%	0.20%
RoW	1.27%	1.39%	1.60%

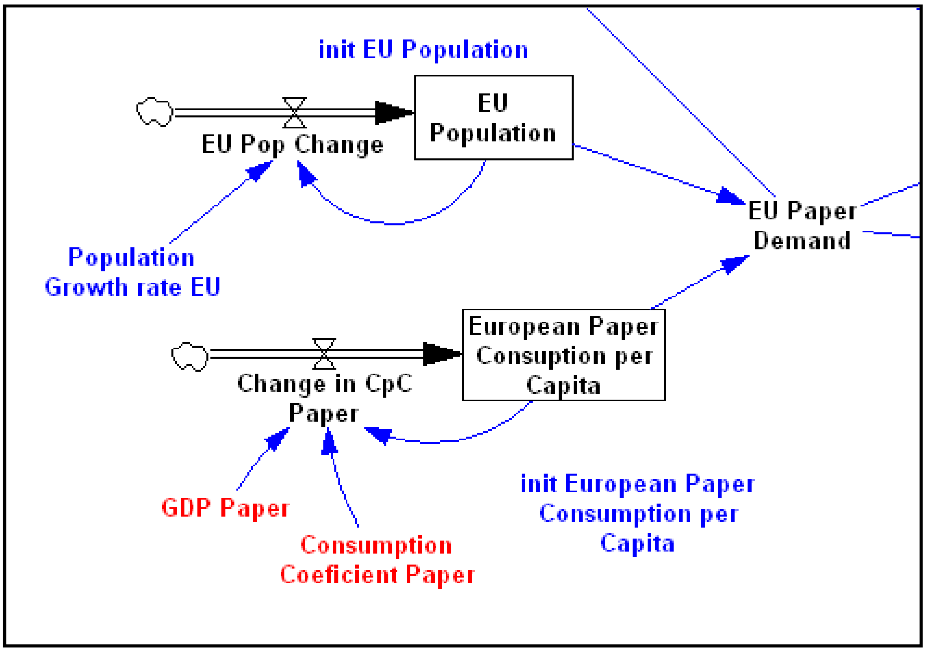

Figure 27: Snapshot of BSFM. Values: GDP Paper 0.01, Consumption Coefficient Paper 0.01, initial consumption per capita 0.155.

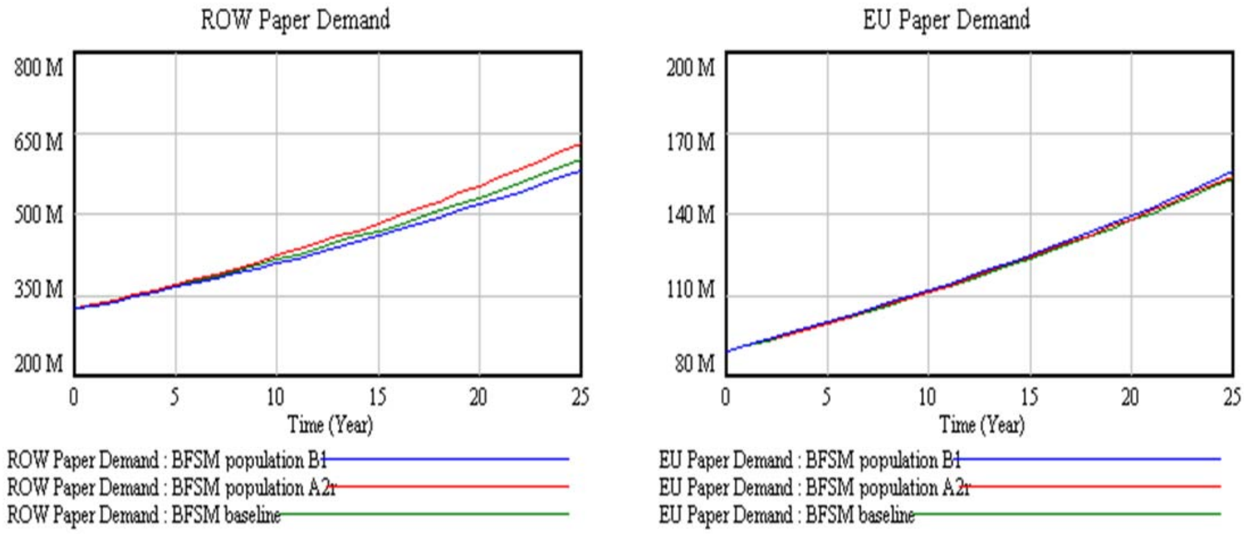

Figure 28. Demand projections for paper and paperboard for 25 years ahead. The left panel shows demand trajectories for Rest of the World (RoW) for the baseline population development of the revised IPCC 4th assessment report, B2 marker scenarios (green line), the high growth population scenario A2r (red line), and the low population scenario B1 (blue line). The right panel shows demand trajectories for Europe for the baseline population development of the revised IPCC 4th assessment report , B2 marker scenarios (green line), the high growth population scenario A2r (red), and the low population scenario B1 (blue). Consumption per capita development was, for reasons of comparison, held constant across scenarios.

Figure 28 demonstrates the sensitivity of demand with respect to different demographic developments in the Rest of the World region and for Europe. It can be seen that uncertainty with respect to differences in population development, at least on these high aggregates, is almost negligible. It should be noted that a large share of 2,030 consumers have already been born, which indicates that if there are no changes in the consumption behavior of the underlying population cohorts, global demand for paper and paperboard will more than double from some 350 million MT to some 800 million MT by 2030. Thus, increased analytical rigor has to be applied to establish detailed investigations on the A and T term of the IPAT identity (i.e., to find improved GDP elasticities in the classical estimation of demand elasticities and/or quantify changes in future consumption behavior and the associated technological changes, such as ICT- induced substitution of electrons for newsprint fiber for reading newspapers).

Total consumption changes in Europe are slower than in the Rest of the World region because of differences in population development and development of consumption per capita. Using an econometric relationship we find that consumption per capita is decreasing because of auto-correlation structures in past data. For European regions the consumption per capita up to 2030 almost does not change across socio-economic development scenarios. In contrast to the Rest of the World we see a change in consumption per capita; this is most pronounced for the high-growth A2 scenario which assumes less technological diffusion of ICT to developing countries. This, in part, explains the higher consumption rate for newsprint and graphic papers. Nonetheless, consumption per capita increases faster in the Rest of the World region because of increased affluence.

Competition between sectors

A large number of sensitivity runs with the BFSM model showed that the relative competitiveness of the European forest sector crucially depends on the future of the emerging global bio-energy market. The European forest sector is impacted directly by competition for fiber domestically in Europe or by competition over fiber in competing regions. The latter carries the implication that a rapid expansion of bio-energy in the Rest of the World would lead to increases in the relative competitiveness of European production sites. According to the latest IPCC scenarios the use of bio-energy will constantly increase globally, particularly in developing countries until 2030 (*Figure 29*).

Figure 29 shows the development, up to the year 2100, of commercial biomass for bio-energy-use purposes. Competition over land in the total land-use sector appears as a crucial competitor for fiber by mid-century: 1) because of high demand for energy; and 2) as technological insurance to guarantee the attainability of low long-term concentration targets consistent with the European climate change target of two degrees warming. Although agricultural production in terms of cereal and meat output are expected to double by mid-century, at the same time the amount of biomass used in the energy system is expected to increase by a factor of three. All these factors lead to competition over land and force prices for forest products to increase sharply. In these scenarios a doubling of cereal production will lead total arable land used to increase only by around 10% because of improved crop management. Most of the technological change, in particular in the developing world, is expected to occur in the first half of the 21st century. A failure to capitalize on agricultural production will lead to much larger agricultural land expansion, and thus increased deforestation, and clearly also to higher prices for fiber and significant changes in relative wood prices, depending on where new bio-energy plantations will come on line. Thus, the success of agricultural intensification has a very strong bearing on forest sector competitiveness in absolute and relative terms.

Figure 30 shows the geographic extent of bio-energy plantations, indicating that most competition over land is likely to happen in the tropical belt. However, this result strongly depends on country-specific investment-risk premium for land. If we introduce currently available country risk ratings into the analysis, we find that the temperate and boreal belt, particularly the European temperate and tropical belt, gain substantially in competitiveness.

From *Figure 29* we see that bio-energy use increases by 2030 (100 EJ) and beyond to mid-century in all scenarios to a level of about 150EJ, which is a tripling of today's use and almost one-half of today's primary energy consumption. At mid-century, second-generation bio-energy systems based on ligno-cellulosic feedstock dominate, indicating direct competition or large potential synergies with the forest sector. The favorable growth conditions in the humid tropical belt make developing countries the most competitive in the bio-energy market which, in turn, generates revenues to capitalize land management.

From *Figure 29* we can also conclude that the exact trajectory depends strongly on the climate change mitigation scenario. However, scenarios do not yet differ too much in 2030, where climate mitigation policies are unlikely to be applied globally, with subsequent high carbon prices. On average, about 100 EJ (approximately 13 billion m^3 of wood) will be used for bio-energy purposes in 2030, about 10% of this amount being sourced from Europe. This additional demand will feed back to the forest resources and decrease growing stocks globally. This means that the annual increment cannot compensate for the additional potential export of wood from the forest. Relatively larger decreases can be observed in Europe where wood mobilization to meet domestic demand is more limited. This decreasing stock behavior can be associated with higher costs and lower relative competitiveness of the forest resource stock.

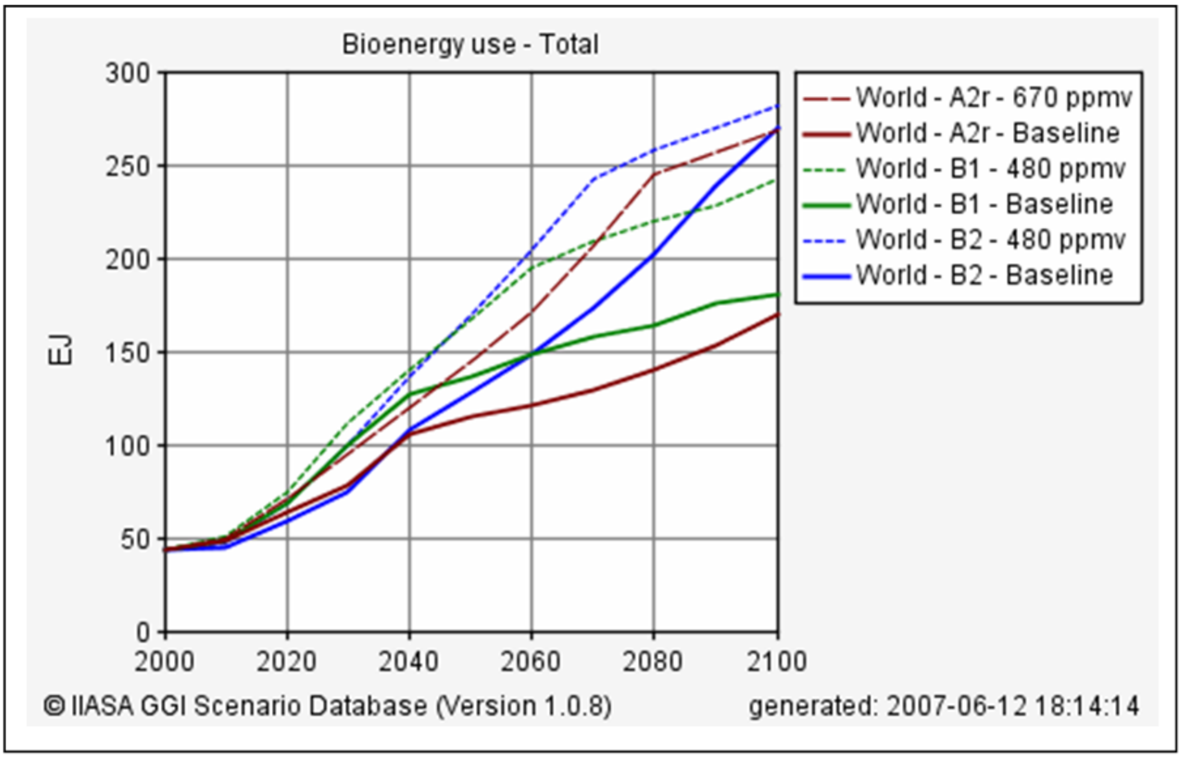

Figure 29: Global development scenarios of future bio-energy use in EJ, according to IPCC marker baseline scenarios and climate change mitigation scenarios. Scenarios include different assumptions on maximum tolerable concentration of CO_2 (values in parts per million by volume, ppmv).

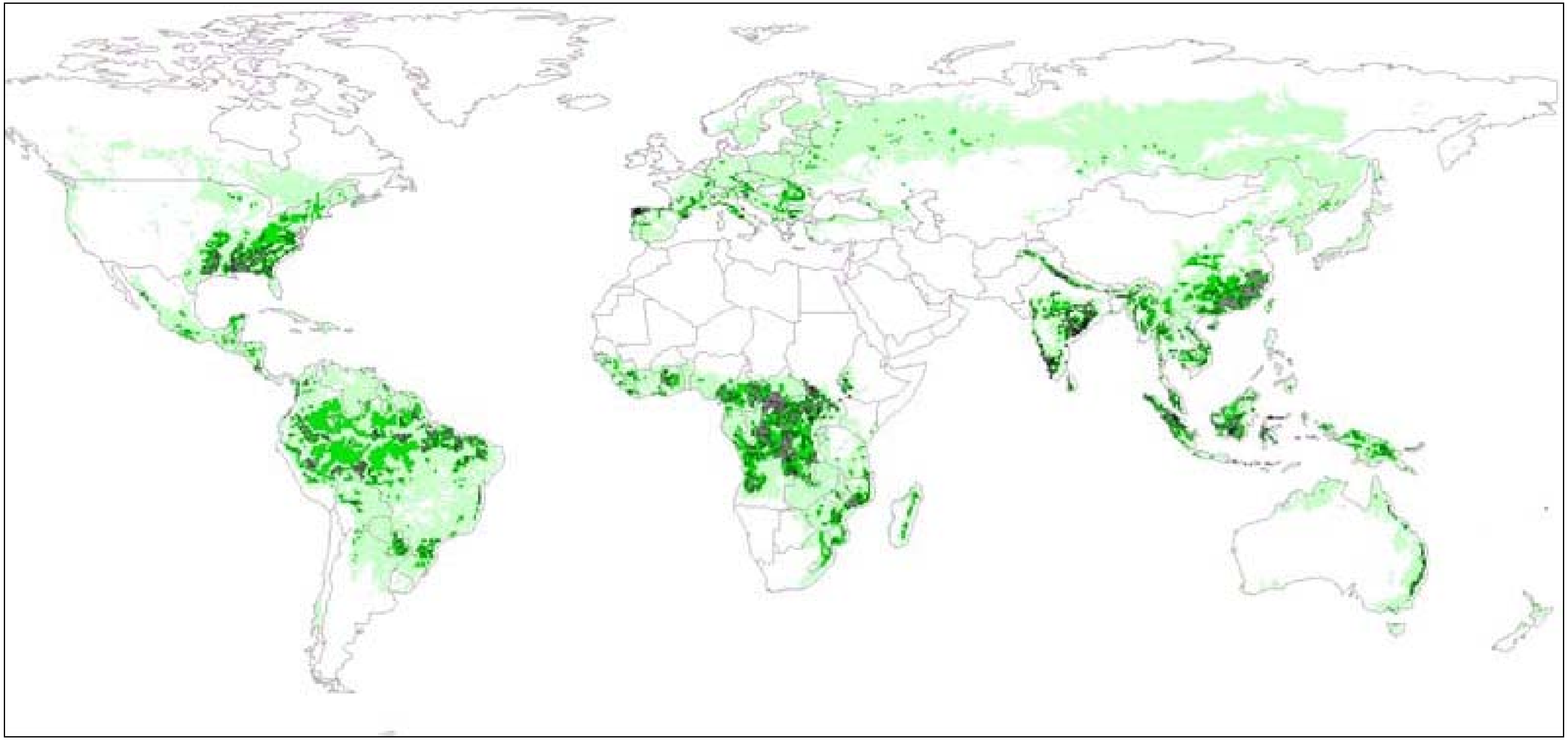

Figure 30: Cumulative biomass production for bio-energy between 2000 and 2100 at the energy price supplied by GLOBFORMOD based on the revised IPCC SRES A2r scenario (country investment risk excluded). The map delineates hotspots of potential biomass production. Dark areas show highest productivity, white areas no production.

We tried to measure the decrease in competitiveness by a composite proxy. *Figure 31* shows the development of this index over time, where we indexed both Europe and Rest of the World to 100% in 2005.

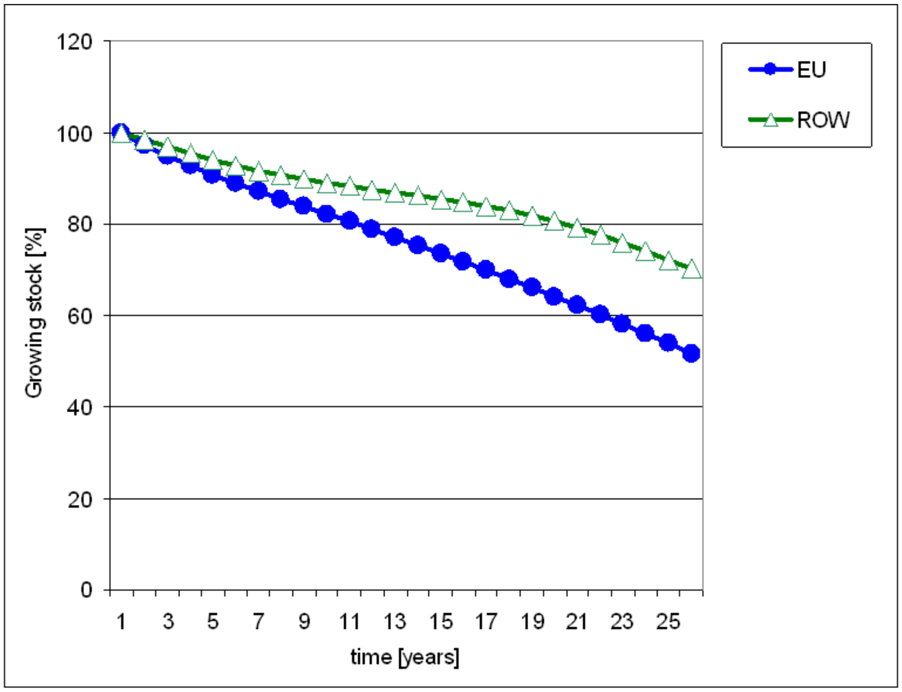

Figure 31: Relative development of the competitiveness measure of growing stock for the production potential of industrial roundwood (reference is baseline scenario) in Europe (EU) and Rest of the World (RoW).

The initial conditions of the dynamic bilateral trade model are presented in *Table 13.* The conclusion from this scenario is that over-aging of European forests would not occur as a result of increased demand for total fiber production from existing forest resources because of the rapidly developing bio-energy market. BSFM scenarios also reveal that additional growth due to afforestation or tree improvement in existing forest resources will be necessary measures to maintain forest stocks and guarantee sustainable forest management both in Europe and globally. In the BSFM model such a sustainability rule is implemented by assuming the onset of, first, tree improvement programs and, second, plantations when the growing stock falls below a certain limit (EU decrease of 10% compared to initial growing stock, RoW 20%) and is unable to exceed a threshold level of 1% of the initial growing stock.

Figure 32 illustrates the results from the BFSM model in terms of potential additional increment to guarantee sustainability of the existing forest resource in the Rest of the World. It can be seen that, under a rapid bio-energy development scenario (green line), measures to implement additional increment must come on stream immediately (note the delay factor of forest growth). Note that in the baseline, without additional biomass for energy demand, additional increments are not actually required. This suggests that the global forest industry could sustainably source its wood demand from existing forests only for the next decade. Beyond that point in time, additional supply sources will be needed.

Table 13: Initial values (2005) of the forest resource, growth, and harvest levels for the BFSM model analysis (source FAO) for Europe (EU) and Rest of the World (RoW).

Parameter	EU	RoW
Population	576,830,000	5,478,310,000
Growing stock 2005	24,347,000,000	359,404,000,000
Removals 2005 total	492,775,000	2,519,901,000
Removals 2005 roundwood	406,137,000	1,392,919,000
Removals 2005 wood fuel	86,638,000	1,126,980,000
GS increment	63,682,800	469,569,600
Gross increment = GS increment + removals	469,819,800	1,862,488,600
Gross Increment % of GS	1.93	0.52
Removal % of GS	1.67	0.39
Roundwood	303,619,005	1,104,014,163
Industrial roundwood	366,380,553	1,383,983,796
Other indust roundwood	16,606,145	165,023,414
Sawlog % of IRW	0.63	0.63

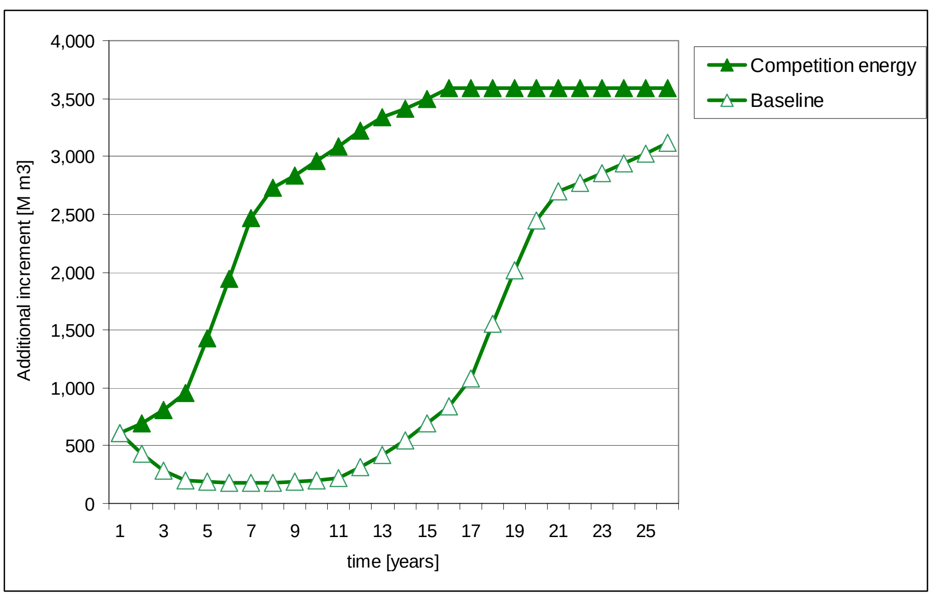

Figure 32: Potential annual additional increment in the baseline projection and with competition for bio-energy outside Europe (RoW).

4. Overall Conclusions

Before discussing the overall conclusions from the model analysis, it should be pointed out that only overall trends can be discussed and that it is not possible to go into detailed and complex explanations.

The EU forest sector—A competitive sector

A European forest sector turns out to be a competitive region in a globalized world. We assess growth in the forest sector in all European regions. The analysis also points in the direction of increased product prices due to rapidly increasing global demand, which may help boost current sluggish European forest sector profits. The competitiveness of the European forest sector is robust across a large variety of different development scenarios. However, Europe is not assessed as a global growth powerhouse, as Latin America and Russia are. *The fate and direction of the competitiveness of the EU-based forest sector is determined mostly outside of Europe,* where, on the other hand, projections are more uncertain. This means that the EU must in the future carefully monitor the development of the global forest sector if it is to establish pertinent policies for the EU-based forest sector.

Tight wood supply

The global wood supply situation will become tight in the future because of current over-harvesting in a number of regions, increased environmental concerns, and the effects of climate change (such as insect outbreaks in Canada).

Under these conditions, the model analysis shows that Russia and Africa will substantially increase their role as wood suppliers to balance the global demand. Whether this will happen in reality is a crucial question. Both regions are complex from political and institutional points of view. With respect to Russia the overall question is if Russia will be a global partner in the forest sector or if it will act based only on nationalistic terms. It would seems to be important for the EU to look to Russia to become a trusted partner in the global forest sector in the future.

Africa is a difficult region to assess, but it would seem important for the EU to engage in this region to help foster the sustainable forest management of existing resources. This is especially important in the light of current Chinese and Indian operations in Africa.

South America: A high-growth region

South America is almost sure to become a high-growth region with vast land resources, and with uncertain but more-easily calculated investment conditions than countries like Russia, China, and Africa. However, in this region there are also political uncertainties, as illustrated by developments in Venezuela and Bolivia.

Energy development crucial

The global overall energy sector development, and especially global bio-energy development, will be crucial for the development of the conventional forest industry in Europe. European land, climate, and energy policies are likely to be conducive to the implementation of a substantial bio-energy sector in Europe. For the conventional forest sector this development can be both a threat as well as an opportunity. From our geographically explicit forest sector/bio-energy sector modeling, it can be concluded that economies of scale will turn out to be the major factor determining competitiveness between the conventional forest sector and the bio-energy sector. The conventional forest sector has strong experience of managing large amounts of wood raw material and could thus be an important partner with the energy sector.

Renaissance for the EU sawmilling industry
The EU sawmilling industry for years has experienced sluggish development and profitability. But because of foreseen increased global demand and increased energy prices, the dominant parts of the scenarios show something of a future renaissance for the European sawmilling industry.

Substantial growth in paper and paperboard production
There is also substantial growth foreseen for the production of paper and paperboard in the EU in the future because of globalization. This increase in production is driven by increased production of higher-value-added papers and paperboard products in the EU.

Centers of gravity
The Nordic–Baltic and Central regions will be the centers of gravity of the EU forest sectors in a globalized world.

Substantial growth
The forest sector of the southeastern European region is assessed to have substantial future growth due to increased productivity in the sector and to being a low-cost producer region.

Shift in demand
There will be a strongly expressed shift in demand for paper and paperboard (a shift that has already been under way for some years).

The dominant growth in future demand for paper and paperboard will be in China, India, Southeast Asia, and South America. This is also to some extent true for sawnwood. These dramatic increases in demand crucially define the global competitiveness landscape. European forest industries, as technology and business leaders in the sector, are challenged by such growth potentials and will attract European companies to invest in new capacities in these regions.

The EU probably cannot do much to avoid such a development. The only thing the EU may be able to do is to avoid introducing policies that will reduce the existing competitiveness of the EU forest sector. Reduced competitiveness would lead to the risk of a large-scale exodus of EU forest companies to the growth market regions.

5. Strengths and Weaknesses of the European Regions

Many interdependencies result from the complexity of the effects of globalization. It is thus difficult to define in a clear-cut way the strengths and weaknesses of the EU regions with respect to the globalization process. Moreover, what is be regarded as a strength by one stakeholder in the sector may be considered a weakness by others (such as increased industrial roundwood prices). However, we have tried to produce a consistent matrix of the strengths and weaknesses of the EU regions in the globalization process in *Table 14.*

Table 14. Strengths and weaknesses of EU regions in the globalization process according to the results of the sector projections until 2030.[8]

European Regions	Sawlogs		Sawnwood		Pulpwood		Paper & Paperboard	
	+	-	+	-	+	-	+	-
Central	High absolute production; A healthy mixture of all soft and hard techniques (scenarios) might lead to further (low) production increment; Stable prices, mainly because of improvement potential in wood mobilization (might even lead to decreasing prices)	Has already passed the peak of production increment; Maximum production might be reached soon and policy or technical improvements will not lead to high further increment; Competition with the biomass sector might increase prices by up to 30%,	High absolute production; Wood mobilization and value- added demand show potential for further production increment; High technological standards; Stable prices, mainly because of improvement potential in wood mobilization and high-end technology (might even lead to decreasing prices)	Weak increase rate; Underdeveloped wood mobilization;	Very strong production increase rate (100%) merely because of technical measures (scenarios); The strong price increment might be slowed by improved wood mobilization	Europe's highest price increment – might be driven by value-added demand, environmental constraints, and competition with the bio-energy sector	High production at the second highest rate of increase in Europe – mainly favored by value-added demand and wood mobilization	Further environmental constraints and competition with the bio-energy sector might slow down the increase rate somewhat;

[8] Matrix disclaimer: Strength and weaknesses: matrices like this help to generate a quick general overview. However, topics and issues in this matrix are quite ambivalent, and one should not forget about the many different interdependencies caused by the complexity of a global market under the effects of globalization. As an example, it could be stated that stronger environmental constraints in Brazil might lead to increased sawlog production in Sweden or similar. Moreover, prices cannot be seen as only positive or only negative. The evaluation of these factors strongly depends on which sector (e.g., forestry or paperboard production industry) the prices are seen from.

European Regions	Sawlogs +	Sawlogs -	Sawnwood +	Sawnwood -	Pulpwood +	Pulpwood -	Paper & Paperboard +	Paper & Paperboard -
Nordic–Baltic	Highest absolute production in Europe; Further environmental constraints as well as value-added demand and wood mobilization still show potential to increase production; technological leaders	Passed the peak of production increment already; Strong price increment; High price increment (35%) favored by environmental constraints (elsewhere) and competition with the biomass sector,	Highest absolute production in Europe; strong increment; further environmental constraints might have positive impact on production	Certain weaknesses in wood mobilization;	Strong production increase rate at about 50%; technological progress might slow down the strong price increment	Further production increment hampered by competition with the bio-energy sector; very strong price increment (60%);	Europe's biggest producer in absolute figures; Europe's lowest prices which might be driven by wood mobilization;	Competition with the bio-energy sector slows down the rate of increase but might also lead to increased prices;
Northwest	High absolute production	Passed the peak of production increment already; High price increment (35%) – favored by environmental constraints (elsewhere) and competition with the biomass sector	High absolute production, strong increment; shows highest demand of sawnwood in Europe;	Certain weaknesses in wood mobilization, highest price increase rate in Europe – even wood mobilization would lead to a price increment	Potential of growth in production because of wood mobilization; price increment might be slowed by improved wood mobilization	Lowest increase in production – perhaps because of environmental constraints and competition with the bio-energy sector; Strong price increment mainly driven by competition with the bio-energy sector	Second biggest producer in Europe; Wood mobilization driving the increase rate; shows highest demand for paper and paperboard products in Europe; Wood mobilization might slow down the price increment somewhat	Further environmental constraints would slow down the rate of increase; Second highest prices in Europe

European Regions	Sawlogs		Sawnwood		Pulpwood		Paper & Paperboard	
	+	-	+	-	+	-	+	-
Mediterranean	High increment rate of 100%, indicating high potential because of plantations	Low absolute production; Still far away from optimal wood mobilization and high-tech application in forestry; Investment in technological progress might drive the prices together with environmental constraints and competition with the bio-energy sector	High increment rate at 50%, all discussed measures would lead to Production increment; Wood mobilization improvement might hamper the price increment	Low absolute production, certain technological weaknesses, high price increase Rate which would be even favored by environmental constraints and competition with the bio-energy sector	Strong increment rate of over 50% in production , price increment Might be slowed by improved wood mobilization	Increment rate could be even stronger if wood mobilization is improved; Strong price increment, mainly driven by competition with the bio-energy sector	Wood mobilization is driving the Increment; Wood mobilization might slow down the price increment somewhat	Europe’s lowest increase rate (25%) – even enforced effects by further environmental constraints; Highest prices in Europe
Southeast	High increment rate of 50%, indicating high potential due to plantation forestry and technical measures	Low absolute production; Still far away from optimal wood mobilization and high tech application in forestry; Investment in technological progress might drive the prices together with environmental constraints and competition with the bio-energy sector	Highest increment rate at 100%; All the measures would lead to production increment; Wood mobilization improvement might hamper the price increment	Low absolute production,; Certain technological weaknesses; High price increase rate which would be even favored by environmental constraints and competition with the bio-energy sector; Shows lowest demand for sawnwood in Europe;	Strongest production increase rate in Europe (150%) which could be favored by value-added demand and wood mobilization, price; Increment might be slowed by improved wood mobilization	Technological progress does not seem to lead to increased production; Strong price increment mainly driven by competition with the bio-energy sector	Europe’s highest production increase rate of 150% , favored by value-added demand and wood mobilization; Together with Nordic– Baltic showing the lowest prices in Europe	Competition with the bio-energy sector slows the production increment somewhat; Shows lowest demand for paper and paperboard products in Europe

Table 14 illustrates many similarities at pan-EU level with respect to strengths and weaknesses, but there are also a number of differences. However, the overall picture is that the Central, Nordic–Baltic and southeastern regions probably have the most positive outlook in the globalization process.

VI. Identify how the main trends and factors of globalization relevant to forestry are affecting different regions of the EU

VI (i): Responses and Innovative Approaches in Forestry

1. Introduction

The review of existing studies on globalization and the forest sector emphasizes that the forest industry has undergone profound changes in recent decades and years, in large part driven by new technologies. The ongoing trend of further globalization continues to reshape the forest products industry, with moving centers of production and consumption, and fast- emerging strong competitors for the production of commodity products in particular. In addition, the rapid catch-up process of the former "countries in transition" has reshaped the competitive situation of all sectors of the European forest-based industries.

The results of the literature review on globalization factors and trends also confirmed the view that forestry is indirectly affected mainly through the "globalizing" or at least increasingly internationalizing of the forest-based industry. So far "globalization" has not received much attention in forestry, and few studies address forestry and globalization. With an increasingly globalizing forest-based industry or an industry affected by globalization factors, effects are also increasingly being felt in EU forestry. The rapid pace of the changes taking place in the EU forestry sector is driven by a number of the partly interrelated factors of globalization, climate change policies, energy policies, restructuring of the formerly centrally planned economies of Eastern Europe, and further changes in lifestyle. These changes require adaptations in EU forestry, both large and small, to respond to new threats and opportunities (see *Table 15*). The success of countries outside the EU and the strategic adaptation required in the EU forest-based industry have prompted many in the sector to investigate the state of innovation and the organization of research and development in the forest industry and, increasingly, in forestry itself.

The results of the analysis of the baseline state of forestry in the EU and its regions showed the diverse nature of forestry, including the highly fragmented pattern of ownership in (predominantly private) forestry. It also showed that, in combination with urbanizing lifestyles, a decreasing amount of time is spent in forest management and for the large majority of forest owners, revenues from forestry are a minor income source.

Table 15: Main globalization factors and dimensions and threats

Globalization factors	**Threats**
Investment	Increasing outward FDI, threat of stable or decreasing domestic investment, decreasing return on investment attractiveness in forestry
Economic activity—productivity, added value	Cost-competitiveness pressure on commodity material and increasingly on value-added production; decreasing importance of forest sector in national economies; decreasing economic attractiveness of forestry in specific conditions
Employment	Decreasing employment in forestry sector, with related effects on rural areas; low attractiveness of forestry
Trade	Decreasing export capacity, with increasing competition from imports
Technology, including know-how	Shift in technology leadership in key sectors; net outflow of R&D investment
Globalization dimensions	**Threats**
Policy	Further increasing relevance of non-state factors, including government and non-governmental international governance networks, further liberalization, decreasing ability to govern domestically
Society	Further urbanization of lifestyles in EU, further increase in resource scarcity due to rapid development of large national economies in developing countries
Environment	Increasingly visible and relevant effects of climate change, including increasing risk and frequency of damage (fire, storm, drought) and related effects (prices, quantity, resource scarcity)
Resources (Energy, raw material)	Increasing scarcity of energy, increasing scarcity and competition over biomass raw material resulting in increasing competitiveness pressure for some commodity product sectors

2. Objective and Overall Approach

This subtask systematically collects and analyzes responses, particularly innovative approaches, from different regions and the EU as a whole, regarding how best to address and to benefit from the specific effects of globalization. Many responses and innovative approaches are incremental local adaptations of individual forest owners; emphasis is, however, placed on the high potential and the scaling up of opportunities. However, it should be made clear that innovation is not one of forestry's particular strengths. A key aspect of the analysis will thus be the role of policy and initiatives to promote the search for and scaling up of opportunities, regardless of whether these have already been demonstrated in practice. The overall approach has been to collate information and case studies that highlight emerging responses and innovative approaches by regions as well as international initiatives that span regions or the EU as a whole.

2.1. Definitions and classification of innovative responses

The OECD (2005) defines "innovation" in its *Oslo Manual* as:

> the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

The minimum requirement for an innovation is that the product, process, marketing method, or organizational method must be *new to (or significantly improved by) the firm or organization*. This includes products, processes, and methods that firms are the first to develop and those that have been adopted from other firms or organizations (OECD 2005). A common feature of an innovation is that it must have been *implemented*. A new or improved product is implemented when it is introduced on the market or when it is taken into use by customers.[9] New processes, marketing methods, or organizational methods are implemented when they are brought into actual use in the firm's operations (OECD 2005). In addition to the definition by the OECD, we will include institutional innovations in our classification of innovation to cover, inter alia, important changes on the organizational level, changes in laws, and policies.

The *Oslo Manual* distinguishes four main types of innovation: product, process, marketing, and organizational innovations, which are further subdivided (see *Figure 33*). We further add institutional innovation as a separate category. Details of descriptions and definitions for the categories can be found in Annex 6

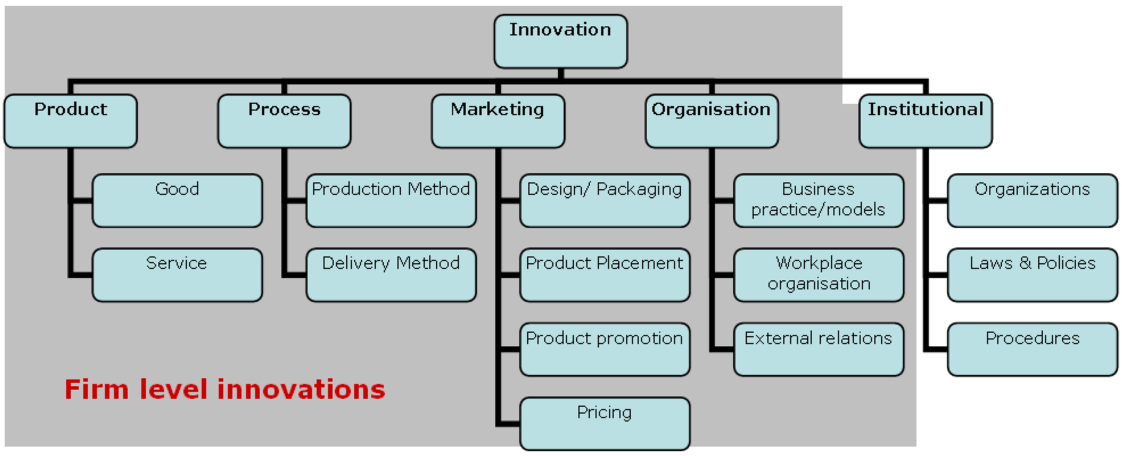

Figure 33. Typology of innovation, modified from OECD (2005)

Innovation support can take many forms, from direct funding of research and development activities to supporting the diffusion of innovations, improving the knowledge base, interaction of actors, and adapting framework conditions. Some of these support measures are targeted directly at fostering concrete innovation activities, others are of structural character. These measures may be introduced without the explicit aim of fostering innovation. One

[9] This includes also innovations in public goods that are not marketed goods and services. Further it includes such goods and services that are offered by for example public entities, are used but are not paid for by consumers. For example mountain bike routes in some countries are paid for in others they are offered for free.

useful classification for innovation support measures distinguishes the following categories (see a more detailed description in Annex 6.

1. Measures to strengthen Research and Development
2. Measures to support the diffusion of innovations
3. Measures to strengthen the knowledge base of forest owners/managers
4. Measures to promote interaction/ managing interfaces
5. Measures intended to create public demand for innovation
6. Measures to improve frame conditions for innovation

2.2. Innovative responses: "Common but differentiated responsibilities" of firms, the state, and other institutions

Changing conditions imply risks but also new opportunities. Given the right frame conditions, forest owners and managers can make use of new opportunities by supplying new products or services and adapting organizationally and technologically to new conditions in rural areas. In fact, innovation and investment are becoming crucial to the competitiveness of the single forest holding, as well as to forestry and rural areas and thus to the income and wellbeing of people living in rural areas. Innovative responses to changes in the market and competitive environment are primarily a task for firms or those active in the market. The degree of novelty of an innovation that firms or forest owners undertake may range from being new to a particular forest holding to being new for the whole forest sector, from incremental improvements in products and processes to innovations that radically modify both technologies and markets. Thus, innovation in a firm is often innovation diffusion within the sector (e.g., biomass, cooperation).

Policy plays a key role in setting appropriate frame conditions. This awareness that innovation is not the task of firms alone is, by now, widely held among innovation policymakers. Likewise, the traditional view that only a limited number of (larger, high-tech) firms are capable of producing innovations is now considered outdated. Today, innovation is seen as relevant for all sizes of firms, from low- to high-tech, as well as a large number of actors around them, particularly governments, associations, research, and training organizations.

The second typology used to map innovative approaches is a simplified innovation system, covering firm level, business-to-business interaction, as well as the context within which firms innovate, that is, those actors and their activities that influence the enabling environment for innovations by firms (the term "firm" includes individual forest owners, family forests, and forest enterprises, including state forest organizations) (see *Figure 34*).

The understanding of the role of actors, other than the firm, and their responsibilities has considerably changed over the last decades and varies from country to country. The two dominant approaches are the traditional "Science and Technology" policy approach as prevailed in most OECD countries in the post-war period and the "Systemic Innovation" policy approach that has gained increasing importance during the last two decades.

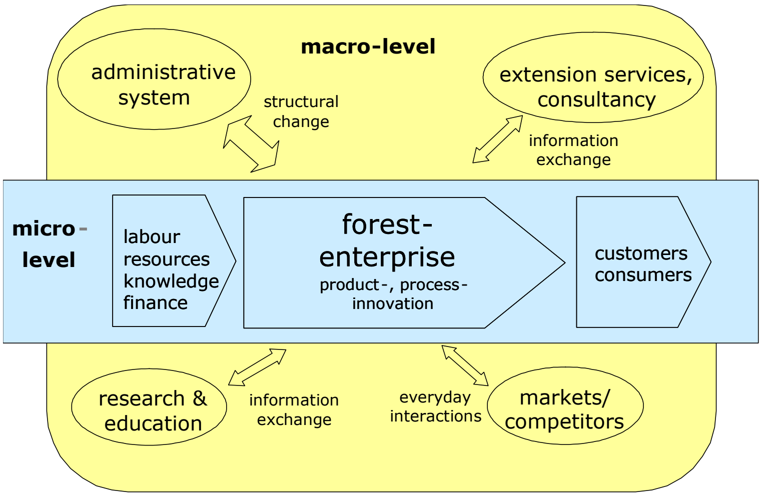

Figure 34. Innovation in forestry: firm level, business-to-business, and broader innovation system.

The traditional "Science and Technology" approach to promoting innovation is ideally typically characterized by the basic understanding of innovation processes as being linear, supply-driven, and technology-focused. It starts with laboratory science and moves through successive stages until new knowledge is built into commercial applications that diffuse in economic systems. The "Systemic Innovation" promotion approach is ideal typically characterized by the understanding of innovation as a complex process, taking place in an environment of interacting actors and institutions (innovation system), having multiple sources (apart from research activities), and running through multiple feedback loops between the different stages. The role of policy is to solve problems that occur within innovation systems, for example, by supporting the creation and development of institutions and organizations, supporting network development, facilitating transition, and avoiding lock-in (Edquist and Johnson 1997). This implies a broader focus on measures that should improve the enabling environment for individual firms to become more innovative and entrepreneurial.

3. Frame conditions for innovative approaches in EU forestry

3.1. Forestry business conditions frequently do not support innovation

Frame conditions in forestry are in many respects not supportive of innovations. To some extent this is because of the high fragmentation of the sector. The average size of private property in the EU27 is very small (some 12 ha) compared to the average size of public properties (>500 ha). The median size of private properties is considerably smaller than even that size. Compared to the number of forest owners in the EU 27, very few forest owners or managers actually work full-time in forest management. Much, if not all of the work in small forest holdings, is done by family members, or, increasingly, outsourced. An overall trend of decreasing time spent on forestry is quite likely, given the ongoing overall demographic shifts in employment and work from the primary to other sectors.

Usually, income from forests is not the main income source for the majority of forest holdings. The smaller the property size, the lower the percentage of income from forestry. The share of income from forestry in an average private forest holding of around 12 ha is possibly less than 10% of the total income of forest owners. Given the overall decrease in the number of persons depending solely on income from the primary sector (forestry and agriculture), an increasingly high share of total income is from sectors other than forestry or agriculture. These figures also indicate that an increasing number of people are becoming more and more detached from their forest property. A decreasing number of forest holders see forests as an asset to be used to generate a stream of income. For a quite large number, possibly the majority, of forest owners, forests are a way of maintaining their capital, which can be used as a collateral, a "savings bank," or a way of balancing out profitable business elsewhere. They follow one simple strategy to reach it: business as usual.

Not all of the factors above have an equal bearing on the innovative climate or the inclination of a forest owner to innovate. Nevertheless, each of most of these factors alone would be a structural obstacle for innovation. When more of these come together, they often add up to quite a barrier that individuals have to overcome in order to be innovative. Given this background, it should be clear that the overarching response of individuals owning forests in the EU 27 to globalization is: none.

3.2. Institutional frame conditions are frequently not supportive of innovation either

The legal frameworks for forestry in the EU member states, while highly diverse, show elements of a philosophy of "command and control" in areas where such a philosophy may not be necessary. This stifles innovation. A considerable number of areas regulated by legislation need to ensure the safety and health of society and of ecosystem and biodiversity (see e.g., Bauer *et al.,* 2004). From an innovation promotion point of view, detailed restrictive legislation in areas that do not fall into the safety and health category and where rights and rights exchange could be coordinated through other than legal mechanisms, including through markets, such a regulatory approach should be reconsidered (crowding out of private investment). However, it should be noted that innovative forest owners and managers seem to be more concerned with market-related impediments than legal impediments (Rametsteiner *et al.,* 2006).

At the same time, legal frameworks for forestry in EU member states contain legislative prescriptions whose enforcement in practice is subject to considerable interpretation, which, in turn, changes over time. This unclear legal situation creates "legal gray areas" that impede innovation by forest owners and managers. This situation is particularly relevant for innovations in recreational and environmental services (Mantau *et al.,* 2001). From an innovation-support point of view, efforts should be made to provide forest owners and managers with rules for conduct that are as few, and as simple and clear to follow as possible. In a number of areas, a change from detailed prescription of procedures to prescribing expected results seems a promising option.

Forest administrative traditions as well as limited administrative capacities can limit the innovative capacity of forestry. Strong forest administrative traditions and good forest administration is one of the main reasons for a successful model of sustainable multifunctional forestry in Europe over a long period of time. However, from an innovation support point of view, forest administrations that do not embrace a concept of change that is adequate in terms of their changing contexts risk effectively close the door to any successful adaptation on the part of forestry by impeding the search for successful and sustainable innovation opportunities (see e.g. Hirsch-Kreinsen *et al.,* 2006).

In the new EU member states the collapse of the former centrally planned economies and the restitution of private forest properties necessitate profound administrative changes. The resulting de facto radical "institutional innovations" frequently seem not to be perceived as innovations by the forest administration, as they were decided and enforced largely beyond its reach (see e.g. Salka *et al.,* 2006). In comparison, the forest-related changes due to the EU *acquis communautaire*, while acting as legitimization for change, seems to be a comparatively minor "innovation driver." The rapid change of contexts in the "countries in transition" puts administrations in those countries under particular strain to introduce change, to promote innovation, while at the same time effectively avoiding damage to forests and forestry due to excessive exploitation of short-term opportunities.

The institutional and organizational structures of non-governmental bodies, in particular forest owner associations, have an important role, but are currently ill-equipped to promote innovation. As with governmental structures, the situation of forest owner associations is very diverse across the EU. While in some countries they barely exist and are in the process of being built up, in others associations are undertaking restructuring efforts to maintain their traditional power and to provide useful services to their increasingly diversifying clientele also in the future (see e.g. CEPF (www.cepf-eu.org)). This increasing service orientation often seems to include elements to promote innovation; however, to date, none or very few of these organizations in the EU have developed policies or services to promote innovation among their clientele.

Research as well as education and training institutions, despite their central role in innovation and knowledge development and management, seem to have had a comparatively weak record in developing and promoting more radical types of innovations in forestry. These institutions have new knowledge development and its dissemination as their core role. While incremental innovation and adaptations of innovations from elsewhere are undoubtedly an essential contribution from such institutions, it seems that few radical innovations in forestry have been developed by such institutions over the last decades. This, if true, would imply that their role today is to administer knowledge, rather than one to co-produce and promote dissemination of more radical types of innovation.

4. General Characterization of Responses to Globalization in EU Forestry

The ongoing dynamic and accelerated changing context of forestry in the EU is widely recognized. There are hardly any forestry strategy documents nowadays that make no reference to this widely perceived situation (see e.g., FTP 2006). These changes mainly seem to be perceived as both a threat to current forestry models and as a potential opportunity to increase the economic performance of forestry overall. The threats are in many respects more real than some of the perceived opportunities. The recently increasing signals of potential resource scarcity, where they occur, have tilted the balance toward optimism in the short term.

Drivers of these changes are more than just globalization factors (investment, competitiveness pressures, trade, technology). They also include, in particular, climate change threats, energy security issues, and societal changes (see e.g. FTP 2006)**.** This mix of factors makes it impossible to distinguish among the individual causal contributions of these various factors to responses and innovative approaches in forestry.

The responses of forest owners and forest companies range from "wait and see" (by far the largest majority of owners in the EU) to—mainly—cost cutting and pushing productivity. Larger private forest holdings in the EU, by and large wood production-oriented companies, have in the main embarked on measures to enhance their price competitiveness. This includes mainly outsourcing and restructuring to increase labor productivity (see Rametsteiner *et al.*) which follows the textbook model of behavior of mature industries: competition over price and process innovation. What would be expected from other maturing industries is increasing degrees of industry concentration.

Innovations in forestry are mainly a consequence of innovation push for more and cheaper wood raw material by the forest industry. Other sources of innovation are environmental standards, bio-energy demand and, to a limited extent, societal pressure to provide services. According to information collected in the course of COST E51 (2006–2010) on innovation integration in the forest sector in Europe, the most widely occurring current innovation efforts across Europe are related to innovations for biomass for bio-energy solutions, from small household to large combined-heat-and-power appliances, as well as the related knock-on innovations related to mobilizing seemingly or de facto "underutilized" forest resources.

The most visible innovations in forestry in the EU include, in particular, technological innovations such as logistics, harvesting techniques, road building, and related organizational innovations, as well as producer cooperatives and associations for more efficient production and a more level playing field on the sales market. An increasing number of innovations relate both to the organization of energy services and to experimentation with diversifying into recreational services. Responses of forestry to globalization and other factors differ widely across regions in the EU, as to be expected, depending on the strength of the forest industries, the degree of their respective globalized business, and the degree of economic and technological integration of forestry and the forest industry in a region.

It seems that policymakers and forest associations are still working toward a better understanding of the different drivers of forestry and the overall strategic relevance of an open and "innovation"-oriented orientation for a low-tech sector such as forestry. Two surveys on how innovation is seen and addressed by forestry administrations and forest owners' associations across Europe (Rametsteiner 2007) show that innovation is recognized as an important issue. However, the virtually complete lack of any concrete or coherent strategies or measures indicates that the term "innovation" is used as a trendy catchword rather than an operational concept.

Policymakers and forest associations who try to defend traditional structures are sometimes acting on reflex, but this risks leaving forestry "locked-in" to outdated structures and "locked-out" from an increasingly interconnected competitive environment. It can also delay measures to achieve broader and effective collaboration and coordination across sectoral borders. Cross-sectoral coordination has been recognized as an essential area in European forest policy. However, not surprisingly, effective strategies to that end are found to be difficult to conceptualize and implement.

Well-designed innovation strategies and related support measures are missing in practically all EU member states. While the importance of innovation for forestry is recognized, forest policy in most countries has implemented only a few and weakly coordinated measures to address innovation in forestry. In countries with economies in transition in particular, there is a lack of strategies and programs fostering innovation. Most countries address innovation in general forest policy documents and programs, for example, the national forest program or strategy. In several countries targeted measures address specific areas of innovation, such as promoting forest owner associations or the diffusion of wood-based bio-energy technology. However, these are not embedded in a wider forest-related innovation policy (see upcoming COST E51 country report, expected December 2007).

Innovation approaches are typically characterized by traditional productivist resource- or supply-driven, technology-oriented innovation "push" measures for specific pre-identified targeted areas. Consumer- and market-demand driven, bottom-up emergent and "soft" people-centered innovation pull measures are a new and unexplored strategic orientation of innovation policies and measures in EU forestry. Compared to forestry administrations, forest owners' associations across Europe clearly see innovation in the traditional "science and technology" concept rather than from a more systemic perspective, and tend to favor (technocratic) managerial rather than "enabling environment"-based innovation policies (Rametsteiner and Bauer 2006). In countries with economies in transition, the traditional approach dominates while in countries with a longer market tradition the systemic approach is more widespread. Only the most advanced countries in the EU in terms of innovation policies increasingly orient their policies away from technological to broader concepts of innovation promotion, including innovation for services. The success of previous EU LEADER programs and their inclusion in the current EU rural development regulation acts as an opportunity to mainstream more demand-driven, non-predetermined and bottom-up-oriented concepts of innovation policy.

Potentially crucial areas for value-added production such as "non-shipping goods" like forest-based services are explored only in regions dominated by the urban societal demand-driven forestry model. The exploration of possible business model solutions for forest-based services, including payment for environmental services and recreational services, are often either suppressed or pursued reluctantly in many EU member states (see e.g. COST E39 "Forests for recreation and nature tourism" results). Only in a limited number of countries, it seems, has the potential strategic value of services production been recognized as an important model for operating forestry successfully in a further globalizing world.

Investment support measures, as one area of innovation support to firms, focus mainly on the traditional supply-side, technology-oriented model, supporting productivity-enhancing measures. Investment promotion and support focus on technological upgrading in logistics, harvesting and infrastructure upgrading, and tax breaks for domestic investment in afforestations (in particular, in plantation-oriented "Atlantic Rim" regions and regions with policies to afforest previously agricultural land).

5. Responses and Innovative Approaches: Regional Characteristics and Examples

Not surprisingly, awareness of the issue of globalization and responses to it are quite widespread in export-oriented Nordic countries, particularly Finland. This region, together with the possible exception of the plantation-oriented forestry "Atlantic Rim" region, increasingly takes action to mobilize forestry in the face of globalization. Globalized forest industry sectors, particularly the pulp and paper industry, depend on secure, commoditized, raw material supply. This close dependency on the actions of globalized industries leads to search processes for viable solutions to remain price-competitive. At the same time, however, it triggers the search for alternative concepts for the use of wood in case the dominant industry (here: pulp and paper) decides to stop investing.

In comparison, in all other regions across the EU, the topic of globalization seems to be overshadowed by the rapid developments in relation to bio-energy. The drive toward more independence from global energy markets or specific suppliers (Russian gas, oil from the Middle East, and other unstable regions) and a more long-term orientation toward more energy supply from renewable resources is, in many ways, connected with globalization, but not driven by it. In some regions biomass for bio-energy will potentially see larger areas under small-rotation forestry. This is particularly so in those regions with considerable areas of land that are either currently comparatively unproductive (Mediterranean region) or of marginal agricultural land that will not be needed for production under surging agricultural productivity in Eastern Europe. In other regions, allocation and logistics systems will be increasingly sophisticated to ensure higher efficiency in utilizing scare wood resources. In virtually all regions in the EU that are oriented toward wood production, efforts are under way to investigate and implement measures to mobilize real or perceived underutilized forest resources. In the following, the seven regions of the EU identified in the typology will be discussed.

5.1. Globalized forest industry-oriented raw material production oriented regions in Nordic countries, and related supply regions in the Baltic states

Sweden and Finland are both leading countries in the EU in terms of R&D spending as a percentage of Gross Domestic Products as well as in the share of R&D from other than public sources. Finland and Sweden in particular show strong innovation leadership in the EU and the region.

Product innovations and related technological development:
A comparatively high share of both private and public funding is invested in technological development, both for new applications for wood products, such as thermowood (e.g., www.thermowood.fi). Thermowood should be a substitute for pressure-impregnated timber which uses heavy metals, causing environmental problems. Thermowood should also provide an environmentally friendly method of protecting timber and strengthening its durability. For instance, Stora Enso introduced ThermoWood into the market in 2002. Other new product developments include wood composites and other natural fiber composites, including some for extruding, or flaxwood (www.flaxwood.com). Considerable investments are likewise being undertaken into developing biomass energy-generation technology, including heat (particularly also large combined-heat-and-power generation with up to and over 100 MW and biomass appliances of over 10 MW), fuel, and electricity generation. Some prominent areas of research in the pulp and paper sectors focuses on developing advanced products based on lignin and other chemicals for wood (biorefinery), the further improvement of hygiene and health care products, and for food packaging, (e.g. SustainPack, BioSafe), including developing functional packaging solutions.

Service innovations:
The Nordic region is an attractive tourist region for nature-based outdoor travel. Accordingly, Nordic countries, particularly Norway, are exploring viable options for market-based tourism and related organizational services, including regional collaboration in tourism service

provision and promotion (see Case 3 in Annex 8). In comparison, Baltic countries have, by and large, not yet started to explore options and experiment with nature-based recreation services as a diversification option in forestry. Furthermore, there are a number of initiatives currently in existence to devise contractual solutions for nature protection and conservation (e.g. Metsakeskus). Energy-related services are described under products above.

Technological process innovations:
Technological process innovations seem to focus on biotechnology to increase production (see, for example, the Wallenberg Prize 2007 for breeding acceleration [www.mwp.org] or understanding genomes, for example, the Swedish *Populus* EST [expressed sequence tag] Database), harvesting technology to increase labor productivity and advanced logistics and information technology, including the use of wireless software in wood harvest and transportation, and in supply chain management. Substantial investment is also being made in technology development for integrated bio-energy production, including combined heat and power and second-generation bio-fuel, as well as commoditization of wood for energy in both Sweden and Finland. The further processing of wood-automated production, including scanning techniques to grade timber qualities, has allowed considerable progress over the last decade. This includes, for example, "Wood Heart" of StoraEnso, which uses X-ray device to sort logs qualitatively, according to their heartwood content. A further focus of innovation research focuses on reducing energy needs, raw material needs for products, and boosting environmental performance (e.g., EU Integrated Project "EcoTarget").

Organizational and business model innovations:
Many large industrial forest owners in Nordic countries have changed their strategy regarding forests and other assets toward focusing on core competencies of firms. Most large companies in the Nordic countries have sold off forest land as non-core businesses over the last decade. Consolidating companies, through transnational mergers and acquisitions and foreign direct investment into greenfield operations, have become bigger and transnational. At the same time they were breaking up conglomerates of business units, becoming leaner, less diversified, and less vertically integrated. The result is that forestry has emerged as a new asset class for investors, instead of an asset primarily owned by manufacturing companies and small woodlot owners.

Two innovations that have made vertical integration relatively less attractive are long-term contracting and long-term cooperative relationships. These facilitate investments in specialized assets without the high costs of vertical integration. For instance, from 1999 to 2001, Assidomän in Sweden had a strategy of divesting themselves of all their non-forest assets in order to become a pure-play forest operating company. In Finland, M-Real has consolidated 112,500 hectares of forest and beach areas to create a pure forest operating company as a new investment alternative. Similarly, StoraEnso has decided to divest itself of its forestlands in Finland (600,000 hectares) and in the United States (130,000 hectares) in the early 2000s. In 2004 Stora Enso finalized the restructuring of its forestland ownership in Sweden. The group's Swedish forests were transferred to Bergvik Skog AB with the majority of its shares being sold to institutional investors. Norske Skogindustrier ASA of Norway has sold its forest assets in Sweden and Brazil. Holmen and UPM-Kymmene are less likely to divest themselves of their forestlands, having both emphasized the importance of their forest ownership to their strategy.

Developing institutional innovations:
Finland in particular has invested considerable resources into developing organizational and institutional innovations that should help sustain a vibrant forest-based sector in the country. This includes the Finnish Forest Cluster Ltd., the WoodWisdomNet, the Future Forum on Forests, the Networked Center of Expertise for Wood Products (see Case 2), the Forest Academy for Decision makers as well as the Finnish Thermowood Association (Case 1). In both Sweden and Finland organizational models, supported by logistics, are in place for advanced production systems for prefabricated house construction.

5.2. Raw material production-oriented regions in Central Europe supplying forest industries, and related supply regions

In Central Europe, the role of being the innovation leader largely falls to Austria, whose main forest industries sectors (sawmilling, pulp and paper, panel) have undergone typical industry changes in a globalizing economy, as described for the Nordic countries above. In common with Nordic industries, Central European industries have expanded their reach into Central-Eastern and Eastern European countries to secure raw material supply and to develop processing capacity and future markets. In general, the innovative approaches taken in Austria are similar to those in the Nordic lead countries, but often on a smaller scale, and with some delay.

Product innovations and related technological development:
Some of the most relevant product innovations currently pursued in Austria are wood composite materials, thermal wood treatment for improved surface properties as well as thermowood, and wood chemicals "biorefinery" research, particularly on lignin. A considerable amount of research is conducted in the context of the "Wood KPlus" Competence Center, a governmental initiative to bridge industry and research institutions (see also institutional innovations). A second large pillar of product innovation and related technological development focuses on bio-energy production from biomass, which saw a strong increase in initiatives and activities in a short period of time and has had an annual growth rate of over 10% over the last decade. In comparison to the Nordic countries biomass for heating in Austria is more focused on the development of small to medium-sized appliances (0.5–10 MW) (see Case 4). Austria's competitive strength thus lies in small-sized furnaces, decentral systems, and related services development. A number of activities are also under way to bring wood based biogas production to a level to be introduced to the market, as well as progress on small units (up to 2 MW) for the production of electricity.

Service innovations:
Service innovations are pursued in many Central European countries; however, there seems little infrastructure support to further build up and exchange knowledge, with the exception of hunting, a traditional service where the law provides adequate room for private initiative, as well as, more recently, forest educational programs in Austria. An important service, particularly for small forest owners or entrepreneurs, is service provision to other forest owners or managers (Case 11). Most other service innovation initiatives are undertaken by "true" innovators, as their number and frequency has not yet reached the stage where more early adopters and institutional support would further refine and develop workable business models. The main recreational services developed in a forestry context are the renting out of huts and apartments.

Technological process innovations:
Technological process innovation focuses on harvesting technology (harvester, cable crane) and infrastructure development (road construction). The focus of development is to increase labor productivity and advanced logistics and information technology, inter alia, for supply chain management and optimized transportation for forest industries. Considerable investment is also being made in technology development for more efficient raw material use and logistics for bio-energy supply as well as for testing the properties of wood products.

Organizational and business model innovations:
Organizational innovations in Central Europe are dominated by the establishment of forest producer cooperatives and networks (horizontal cooperation) in Austria (see Case 6), restructuring of forest ownership in some of the surrounding countries, and a revision of the business models of state forest companies, for example, in Austria in the 1990s, and in the Czech Republic and Slovakia (municipal forests). Producer cooperatives are either joint sales cooperatives or cooperatives to organize forest management (sharing equipment, organizing services related to production), and in some cases, to explore options for further value-added production. Regional wood-focused cluster concepts were or are being established in a number of countries. Furthermore, new auction systems are being introduced, for example, in the Czech Republic (commodity exchange) and Austria (hardwood auctions). New business models are also explored by companies in non-wood products (see e.g., Case 5).

Developing institutional innovations:
In Austria, a number of governmental and non-governmental initiatives have supported the development of competence centers to bridge industry and research (KPlus, Kind), several of which undertake research relevant to forestry. Moreover, a number of regional initiatives have been undertaken to establish regional wood-centered clusters (Holzcluster Steiermark, Holzcluster Oberösterreich, Holzcluster Niederösterreich). A project center of the European Forest Institute (Innoforce) focuses on innovation and entrepreneurship research. In several countries in the region, reorganizations have been undertaken to better bundle the interests of the forest sector. As in other regions, the new Rural Development Regulation 2007–2013 is used to support measures that are intended to strengthen the transformation and catch-up process of forestry in countries such as the Czech Republic and Slovakia.

5.3. Production regions based on plantations, mainly supplying to pulp/paper forest industry, in "Atlantic Rim" Western Europe

Given high forest productivity, efforts have been redoubled to further establish plantation forestry and related industries in Northern Portugal, Northern Spain, South-West France, Ireland, and Scotland. This is mainly financed by investments into innovations promoted by regional governments and with the assistance of forest industries.

Product innovations and related technological development:
One important product innovation focus is biotechnical and biogenetic research to produce a better understanding of wood properties, enhance productivity, and improve the stress resistance of plants. Plantation forestry in these and other regions, including surrounding regions, are expected to accelerate in the coming decade, as marginally productive agricultural land is reclaimed, and demand for fiber and energy becomes high and increases. The improvement of wood properties is aimed mainly at classical breeding and marker-aided selection programs, by identifying quality traits earlier. Improving productivity, including the

sue of fast-growing short-rotation crops, aims, inter alia, to speed up breeding cycles and micropropagation. Throughout the region, a number of universities and research institutes have substantial forest biotechnology research programs.

Service innovations:
Service innovations seems not to be a focus of innovations in most areas that follow the plantation-oriented forestry model, with the exception of Scotland (and Ireland), where a rather weakened forestry tradition and the surge in urbanized lifestyles has promoted a forestry model oriented toward provision of recreational services (Case 10). This model clashes with the model for efficient mass production of standardized material (see urbanized forestry regional type).

Technological process innovations:
Technological process innovations seem to focus mainly on transfer and adaptation of technologies developed elsewhere by technology leaders, in particular, for logistics and raw material supply chain management.

Organizational and business model innovations:
A number of organizational and business innovations have been undertaken to link private forest owners, for example, through developing private forest owner cooperatives (FORESTIS, Portugal), and forest associations in Northern Spain, Portugal, and Aquitaine (South- West France) developing a program on wood-energy (ENERSILVA). Similarly, associations develop joint marketing initiatives. The *Société de Développement de l'Economie Forestière* (SODEF) works on developing financing models for sustainable forestry in the region.

Developing institutional innovations:
Institutional innovations relate to the establishment and refinement of business service-oriented models of private forestry associations such as FORESTIS in Portugal. The European Institute of the Cultivated Forests (IEFC) (Case 8), an EFI Project Center, promotes programs of cooperation between research institutes in the regions, and also with professional organizations and associations (USSE). In Scotland the Scottish Forest Industry Cluster (Case 7) has been influential in developing the forest industry in that region.

5.4. Broader, multifunctional forestry oriented regions with industries mainly catering to domestic consumption in Western and Central Europe

This region is characterized by countries with highly diverse situations with regard to forestry, with some regions following a clear production orientation, similar to the production-oriented regions (e.g., Eastern France, Southern Germany), while others conduct forestry in highly urbanized regions. In France some of the Southern-Eastern regions show the characteristics of the Mediterranean type of forestry. Consequently, responses and innovative approaches in this region are highly diverse. In both countries the large consumer base seems to have helped in reducing the need for domestic industries to respond rapidly to globalization pressures, for example, through rapid consolidation, as was the case in other countries. This reduced the pressure to be competitive in export markets. In Germany considerable investment has been made into new production capacity in commodity products, both in the east and the south of Germany.

Product innovations and related technological development:
In both Germany and France, several technologies have been developed to modify timber, including, for example, compressed timber or reconstituted wood or to change the properties of wood through such processes as chemical interlacing of wood or treatment to increase fire resistance. In both countries novel solutions for wood construction are an important research and development area, in particular, for engineered wood products (e.g., Oriented Strand Board at CBTA, France). As in other regions, the issue of bio-energy and related product development is currently being pursued by a number of initiatives, some of which relate directly to forestry, such as the development of bio-fuel solutions (e.g., Bio-fuel Wendland, Germany) and biorefinery.

Service innovations:
Recreational service innovations are important in this regional type, inter alia, because of the large urbanized consumer base and large percentage of public forests. Consequently, a considerable number of innovations can be found in both countries, but usually having similar difficulties in developing viable business models and significant income streams as is the case in other regions. Overall, recreational services, contractual nature protection, and forestry conservation services seem to be more developed in Germany than France. One example is Case 9.

Technological process innovations:
As in other regions technological process innovation focuses on logistics, including the development of information and communication technologies (GPS, Radio Frequency Identification Device, e.g., NAVLOG in Germany) and harvesting technology (harvester, cable crane in France). In Germany, in particular, one focus, driven by regional development concepts, is regional supply chain development and optimized transportation.

Organizational and business model innovations:
Also in this region, new timber selling organizations, wood mobilization schemes, and wood procurement platforms are being developed by private and public forest owners. Moreover, to establish cluster management, there is frequent organizational innovation in many regions in Europe. Likewise, larger service organizations have recently emerged to manage forest harvesting and logistics (e.g., TTW, Lignis in Germany). In France, in particular, a number of wood and non-wood forest products such as berries or honey are branded and marketed with official regional labels (e.g., “AOC Bois des Alpes”).

Developing institutional innovations:
Institutional innovations focus on the development of lead initiatives for innovation and the bundling of initiatives. This comprises cluster management approaches, such as those organized through the EU LEADER or Innoregio projects (Case 14). In Germany “*Regionen Aktiv*,” or other integrated rural development programs have been instrumental in catalyzing institutional innovation. In France the initiative “*France Forêt Bois*” or initiatives to establish “*poles de competitivité*” serve as examples for such efforts (e.g. Pôle d’Excellence Rurale and territorial forestry charters).

5.5 Regions with forestry dominated by urbanized societies and comparatively little raw material production-oriented forestry in northwestern Europe

This region is characterized by considerably less focus on commodity raw material (wood) production, less intention to use forests as productive assets, and more attention to developing services. Some countries have also developed strong business models for non-wood forest products.

Product innovations and related technological development:
Product developments in wood-related applications are mainly adaptive. Product innovations tend to be stronger on non-wood products, including, for example, high quality Christmas trees in Denmark and decorative foliage in Ireland.

Service innovations:
Recreational services are an important innovation area in this regional type, given the high demand pressure from urbanized consumers. In the UK forest schools and education, health initiatives ("green gym"), and other outdoor recreational services, including mountain biking, have been developed to such a degree that the business models developed in Scotland and the UK can be considered as the leading models for service-oriented and consumer demand-based forestry in the EU (see Case 10). However, considerable further development and adaptations are needed to make these economically viable on a larger scale and under different, particularly private forestry, conditions.

Technological process innovations:
Given the limited pressure of globalization on prices, productivity, and competitiveness, technological process innovations are not a strong topic in this regional type.

Organizational and business model innovations:
Along with the development of new services, a number of new business models are being explored and applied, many of which seem to take advantage of knowledge in the service and tourism industries. Innovators from outside forestry seem to be playing an important role in forest-based business model development.

5.6. Regions dominated by restitution issues, "countries in transition," little private forestry tradition, weak infrastructure, and non-competitive domestic forest industries in Eastern Europe

"Countries in transition" is a term that groups together a diverse number of countries. The term is used to define the most characteristic element of innovation in all of these countries, including the new EU member states and EU accession states. In comparison to the need to reinvent forest ownership, management, and administrative models, the external innovation push exerted by the EU *acquis communautaire* is of comparatively minor importance.

Product innovations and related technological development:
Product developments in wood-related applications are adaptive, a struggle to catch up with knowledge and capacities of peers. However, with better access to funding and technologies within the EU, such catch-up processes can be fast, in particular, if foreign private investors are pushing to develop export-oriented production. For instance, the production of commodity wood products for bio-energy has become an important topic in many countries in the region.

In at least some countries, the development and marketing of non-wood forest products is more important than in other regions.

Service innovations:
In many countries hunting is an important service, and will continue as a very relevant area. Along with the rising interest in nature tourism, many of these countries are exploring and trying to develop ecotourism services (Case 12).

Technological process innovations:
As with product innovation, the emphasis is strongly on technology transfer and local adaptation, including infrastructure (road building), harvesting, and logistics.

Organizational and business model innovations:
Large state forest enterprises in particular have had and often still have to reassess their business models. Many owners of restituted small forest properties are looking for business models that allow them to take advantage of their newly acquired assets.

Developing institutional innovations:
Virtually all countries and organizations in this regional type have implemented a large number of far-reaching institutional innovations, in particular, restitution of property from public to private ownership, as well as a change from a technocratic planning model of resource allocation to a market model. This, in turn, triggers a number of fundamental changes in the roles and, consequently, organization of forest administrations. Given the absence of private forest owners, one major institutional innovation is the establishment of private forest owner associations and the development of business support services by such organizations (Case 13). This effort more difficult, as "cooperative" organizational arrangements are often associated with previously planned economies, and the new private forest owners are often not interested in utilizing their forest assets and do not possess the required knowledge, education, and information on forests and forest management. This is not helped by extensive bureaucratic requirements and fairly frequently changing rules and regulations.

5.7. Regions dominated by low forest management intensity (if any), comparatively high importance of non-wood forest products, forest fires in Southern Europe

In this region responses and innovative approaches to globalization are either non-existent or focus mainly on possible opportunities for environmental services (carbon sequestration, other "externalities") or on the development of products and markets for non-wood forest products, including cork.

Product innovations and related technological development:
Product innovation tends to concentrate on the development and marketing of non-wood forest products, while wood products for bio-energy has also become an important topic in many countries in the region.

Service innovations:
In several countries there are initiatives to develop low-impact rural ecotourism services in the context of rural development programs.

Technological process innovations:
Genuine technological process innovation, rather than technology transfer and local adaptation, tends to focus on processing technology for non-wood goods, including further processing of food and products like cork and resins.

Organizational and business model innovations:
Organizational and business model innovations tend to focus on developing and improving organizational models for producer cooperative and value-added production, including local partnerships. Growers or producer associations are found to improve the value of non-wood forest products business activities, for example, chestnuts in Italy.

Developing institutional innovations:
In terms of institutional innovation, as in many other regions, the most important is the build-up of local, regional, or national associations of forest owners, particularly for joint production and/or local and regional marketing of products Moreover, in fire-prone areas research continues to investigate and develop effective models for organizing fire prevention and fire fighting. Research capacities on the— for this region particularly important —topic of forest externalities have been strengthened through the EFI Project Center "Medforex" in Spain.

5.8. EU-wide innovative approaches: Institutional innovations

There are a number of institutional innovations of relevance across regions, which are examples of relevant "innovative approaches," This includes:

- The MCPFE as a participatory policymaking mechanism across different countries and stakeholders;
- The Forest Technology Platform as a largely private initiative pushing collaboration on research along vertical value chains;
- The ESF COST as a research support infrastructure that allows the formation of networks on emerging topics in their early stages; and
- The EU LEADER program encouraging local, cross-sectoral "bottom-up" emergence of initiatives.

The MCPFE as a pan-European forest policy development and coordination platform
The "Ministerial Conference on the Protection of Forests in Europe" (MCPFE) is a high-level political initiative for cooperation among 46 European countries, including the European Community and a considerable number of forest-related stakeholders as observers. The MCPFE addresses common opportunities and threats related to forests and forestry and promotes sustainable management of forests in Europe. Launched in 1990, it is the political platform for dialog on European forest issues. This process is based on a chain of conferences at ministerial level and follow-up mechanisms. At the conferences, aspects of the highest political interest and concern are dealt with by the ministers responsible for forests. Following the Ministerial Conferences, the decisions taken by the ministers are further specified and put into action at expert meetings. The MCPFE was instrumental in bringing Eastern and Western European countries closer together on forest-related matters, as well as in translating major developments in the governance of forests and forestry into concrete policies (e.g. the Rio conception of sustainable forest management (SFM), the criteria and indicators for SFM, and

national forest programs). It addresses forest issues from a broad perspective, including the economic viability of forests, where it has also addressed the issues of competitiveness and innovation.

The Forest Technology Platform as a successful platform for communicating within the forest sectors and promoting innovation

In 2004 the European Confederation of Woodworking Industries (CEI-Bois), the Confederation of European Forest Owners (CEPF), and the Confederation of European Paper Industries (CEPI) took the initiative to set up a Forest Technology Platform (FTP) for the forest-based sector. This platform aims at defining and implementing the sector's R&D roadmap for the future and is supported by a wide range of stakeholders. Its main activities so far, in addition to the successful launch of a platform (a major success), are the development of a Vision Document, a Strategic Research Agenda, the establishment of National Support Groups in a number of countries, as well as organization of a series of international events. This work was made possible, inter alia, through a number of future-oriented activities, including the "Roadmap 2010" of CEI-Bois.

The FTP initiative can possibly be traced back to the Nordic countries and the pulp and paper industry. However, the approach and efforts to develop the Vision Document (2005) and Strategic Research Agenda (2006) through a broad stakeholder and open consultation, as well as the establishment of National Support Group have been particularly instrumental in making the FTP a broad-based initiative. The Strategic Research Agenda, which is based on proposals from across Europe, encompasses the complexity and variety that the sector represents, from paper to packaging, from building with wood to bio-energy from wood, from trees to new trends.

The aim of the FTP is to mobilize private and public investment into joint innovative R&D activities in order to strengthen the competitiveness of the sector and also to contribute to improving the quality of life of European citizens.

The European Forest Institute and COST Actions: Strengthening networking, collaboration and coordination among forest research organizations across Europe:

The European Forest Institute (EFI), founded in 1993 as a member organization of forest research institutions in Europe, has the purpose of undertaking research at the pan-European level to promote the conservation and sustainable management of forests in Europe. In the late 1990s it expanded its European network structure across Europe through the subsequent establishment of a number of project centers across Europe, one of which focuses on innovation and entrepreneurship in the forest sector (EFI Project Center Innoforce). By 2006 EFI was transformed into an international organization established by the European states. With its nearly 130 associate and affiliate members and seven project centers, it offers the best forest research contacts and acknowledged collaboration at the European level.

The European Science Foundation "Cooperation in the Field of Science and Technology" (COST), through its Actions in the domain "Forests, their Products and Services" (FPS). COST is an intergovernmental network of 35 member countries and one of the longest-running instruments supporting cooperation among scientists and researchers in Europe. In the COST FPS domain a large number of actions are established that address key areas of innovation in the forest sector, including innovation policy, forest-related services on health and recreation, and valuation of forest "externalities," the latter being a range of research related to technical and other innovations in construction, pulp and papers, and panels, among others.

EU LEADER as a successful model of innovation support measure

The European Community Initiative "LEADER" aims to promote rural development through a new, small-scale approach to rural development in particularly lagging areas. It was started as a program in 1991 with LEADER I (217 initiatives supported), continued with LEADER II (1994–1999, 998 local action groups and other collective bodies supported), and is now in its third phase, LEADER+ (2000–2006).

The LEADER concept is based on the elaboration and implementation of a "local action plan" which has to be put in action within a period of six years based on a partnership between local public and private actors. It is thus following an area-based approach whose focus is to provide opportunities for funding small-scale initiatives developed by local groups, by building on region-specific contexts. It puts a strong emphasis on capturing innovative ideas and answers to existing problems through local multisector integrated approaches. The public–private interaction at the local level should enable joint learning and network building.

According to an independent evaluation of LEADER II, the program proved to be adaptable to every rural socio-economic and governance context. It brought local actors, administrations, and support structures closer together and mobilized the potential of voluntary work among local people. It fitted well into small-scale area-based activities and projects in lagging regions and vulnerable rural territories. The efficiency of the initiative was reduced when the local group started late and did not have enough time to implement the local program. Another hindering factor was a disempowering administrative environment, namely, cumbersome decision-making processes, sectoral barriers to the territorial approach, and lack support for the local group (ÖIR, 2003).

The same evaluation showed that LEADER II effectively closed the gap between a top-down program and the local people, their needs, aspirations, and potential. It conveyed responsibility to local partnerships and contributed by re-linking public and private, profit-making and non-profit activities, as well as infrastructural and entrepreneurial activities. It induced a mentality change among local actors from passive to active. The leverage effect on private funding turned out to be higher than expected almost everywhere. The effectiveness of the initiative was reduced if the implementation time was too short to let the local group come into direct contact with the people's initiatives, and if the local leaders generally disregarded the bottom-up approach. This was often combined with a weak and unrepresentative local partnership (ÖIR, 2003).

It opened up new avenues, creating added value in rural areas and synergies between existing value-added chains. It contributed to capacity building at local level in and around the local partnership. Many local programs integrated environmental concerns into social and economic development at a strategic level. Public and private actors started to act in common or intensified their cooperation. The initiative could not contribute to sustainable development if the local partnership and technical assistance were disrupted by having its funds cut at the end of the programming period. . It had also difficulties if a single sector or public actors dominated proceedings and constituted a barrier to meeting the development needs of the area.

The design of this program is one of the best documented examples of a bottom-up local development initiative that does not predefine the areas to be developed but leaves it to the local community or to local actor networks to identify opportunities and develop ideas on how to bring them to fruition. While the program design faced some skepticism at the beginning for its low level of top-down orientation, it has proved to be one of the best accepted and most effective programs and is being further developed into mainstream development policy for rural areas in the EU.

Until the end of 2006 LEADER+ continued its role as a laboratory to encourage the emergence and testing of new approaches to integrated development (EU, 2000). In future, the LEADER principles will gain in importance as the new EU Rural Development Regulation 1698/2005 contains a fourth "axis" based on experiences of the overall LEADER approach and introducing possibilities for locally based bottom-up approaches to rural development.

The LEADER program is not designated as a forestry program. It rather addresses *all* relevant public and private rural actors. This is reflected by its low degree of visibility and political support for forestry in LEADER+. For this reason the majority of forestry actors have little experience in the new integrated programs and are not well enough informed about the opportunities that these include to be able participate in LEADER+.

6. Concluding Remarks

Regarding the current situation of responses to globalization and innovative approaches in forestry, a range of observations can be made:

1. Overall, there is little concrete response to globalization and very little innovation activity in the sector, especially in small forest holdings;
2. Large forest holdings respond mainly by cost cutting through outsourcing. This is driven by price competition to which the forest industry is subject in globalized commodity markets. Responses to globalization are thus triggered by the forest industries and their respective demand rather than linked directly to globalization;
3. Innovations are incremental and usually not new to the sector. They tend to follow existing paths ("more of the same") and traditional supply-side approaches. Customers and consumers play virtually no role as a source of improvements of products or services.
4. Institutional innovations are a potentially important driver of innovations to respond to globalization. However, when they do occur they tend to be trend-following initiatives based on conceptions of forestry as an efficient raw material supplier and traditional concepts of innovation support. There is little strategic, future-oriented, and systematic response to the opportunities for and threats to EU forestry in the face of globalization.

Responses to globalization are wood-focused, aiming to compete on price for global raw material commodities. Innovation-oriented research for developing higher value-added wood products as well as products and services other than timber is very underdeveloped. For most non-wood products, products and markets have seen little change over decades and markets are underdeveloped, partly because effective demand is low. For others, new products can possibly be developed if the respective technological research is undertaken, for example, on biochemicals. Other forest products find limited market possibilities because of existing legal restrictions. Innovation is slow, underfunded, and incremental. Research into possible strategic, future-oriented alternative business models that include the search for alternative institutional frame conditions is lacking.

Many forest services for which a high demand exists in society are regarded as public goods, for example, recreation in the forest, nature conservation, protection against natural hazards, etc. For some of these services, marketability is intrinsically difficult; for some, the necessary conditions could be created by a clear definition of use rights. Many of these services could be marketed if specific additional benefits are offered, for example, a guided tour through the forest creates recreational benefit and can be offered exclusively to paying clientele. There is marketing potential for many of these forest services, but it is restricted. Again, research into possible strategic, future-oriented alternative business models that include the search for alternative institutional frame conditions is lacking. For many recreational services related to forests, "crowding out" of private initiative by governments is an issue that would require strongly increased attention if diversified forest-based rural development is seriously considered. "Payment for environmental services," although gaining some attention, has not yet been developed or addressed in Europe. In fact, progress in Europe in exploring options is considerably slower than in a number of other regions world wide.

In general, comprehensive innovation policies for the forestry sector that answer the challenges of globalization do not exist in EU countries. These would require a more strategic and more comprehensive search process to be carried out for alternative options, strategies and policies that support such exploration, and testing of opportunities with systematic innovation-oriented concepts, strategies and measures. Currently, innovation measures, if they exist, focus on traditional and incremental, supply-side measures, trying to push specific production, services, or procedural innovations. Usually the programs support the diffusion of certain innovations considered important ("managerial steering of sectoral development"). Relevant innovation-oriented programs outside the forestry sector exist, but cross-sectoral openness and coordination is underdeveloped, and such programs are therefore hardly used. In fact, the opportunities that such programs provide are often not known about by forestry actors. Research and, in particular, research funding often seems to be geared toward incremental improvements in well -established fields and a reluctance to explore more radical alternative options. This is in line with the often-observed strong focus on traditions, the limited emphasis on the future, and the overall avoidance of risks in the forestry sector as a whole.

VII: Identify Threats and Opportunities in Adapting to and Benefiting from the Effects of Globalization in EU Forestry

1. Introduction and Objective

Based on the results of previous tasks this chapter investigates in-depth into the options for adapting and, as far as possible, benefiting from the effects of globalization with a view to maintaining economic viability and strengthening competitiveness—and the related threats and opportunities.

2. Method/Overall Approach

In this task the individual results of previous work is combined to identify a number of strategic options for adaptation, their respective characteristics, threats, and opportunities. This includes an assessment of the possible or likely effects of the various options on the main dimensions of forestry state and development. The overall approach is as follows:

Step 0 identifies major opportunities and threats to EU forestry driving adaptation needs and opportunities (building on major opportunities or addressing major shortcomings, based on findings of previous tasks, see previous chapters.

Step 1 identifies overall strategic options for adapting to and benefiting from globalization and the overall effects of different scenarios of possible developments.

Step 2 describes these strategic adaptation options per region and the regional implications of different scenarios

Step 3 analyzes the effects of different strategic options on globalization factors and dimensions as well as on dimensions of sustainable forest management.

3. Overall Globalization Opportunities and Threats for EU Forestry

The tables in this section list the opportunities and threats of globalization (direct and indirect) to forestry in the EU. Note that these lists can be neither objective nor exhaustive. The tables show factors that emerged repeatedly over the course of the project as relevant for a closer consideration with regard to adaptation. *Table 16* suggests that, overall, a range of opportunities emerge from globalization. These include both opportunities directly emerging from gains in competitive advantages and opportunities to expand on strengths due to pressure to respond to globalization.

3.1. Globalization opportunities for EU forestry

A range of opportunities exist with regard to "investment" in forestry due to the globalization factor. However, few concrete short-term opportunities are on the horizon if one considers investment in management of natural forests (as opposed to plantation-type forestry). A range of investment streams would either require substantive progress in more radical types of technologically oriented product R&D (not a strength of forestry research in the EU) or institutional and regulatory restructuring.-related to economic activities, including value-added production and enhancing productivity for competitiveness, EU forestry has had comparatively high relative competitive advantages in raw material production and supply due to resource endowments, early technological developments to increase labor productivity, and comparatively good investments, often from public funds, in road and infrastructure. This competitive advantage is now at least partially under pressure, but new demands on forests are becoming increasingly visible, creating a push to explore new opportunities, for example, in business models for forest-related services or in forward integration of value-added production.

Table 16. Main globalization factors and dimensions and possible opportunities for forestry

Globalization factors	Opportunities
Investment	Increasing demand for raw material for commodity products (standardized raw material production in plantations)
	wood for bio-energy (short-rotation forestry),
	biotechnology after breakthrough commercialization (raw material production, specialized materials and chemicals)
	recreation facilities around urban population centers
	land property investment as part of financial risk management
Economic activity—added value, productivity	New business models for forest-related services (protection, recreation); forward integration of value-added production
Employment	Limited opportunities based on territorially bound services, particularly recreation, wood for bio-energy (highly standardized, comparatively low labor intensity).
Trade	Production of non-shipping goods (territorial services). Limited opportunities for export of forestry technology (for forestry technology suppliers) and know-how.
Technology, including know-how	Bio-technology research infrastructure and know-how in the EU (largely outside forestry, partly outside the forest sector)
Globalization dimensions	**Opportunities**
Policy	EU integration, policies safeguarding SFM; sustainability-oriented general EU policy framework (resources, energy)
Society	Recreation needs for urban and aging societies
Environment	Climate change leading to productivity gains in some regions
Resources (Energy, raw material)	Resource scarcity driven by high raw material demand, leading to higher prices;
	Demand for renewable resources

In terms of employment, higher productivity, and thus higher competitiveness, is usually achieved only through less labor per unit produced. Increased employment is thus only an opportunity if new businesses provide services demanded on the market, or if wood for energy requires the establishment and management of (highly standardized and mechanized) short-rotation forests (which, administratively, would be considered part of agriculture in many EU countries). "Trade" in forestry is largely trade flows of raw material, not necessarily considered part of forestry. However, trade also comprises the exchange of other than physical goods. Trade in services has hugely increased with globalization, both in terms of contribution to GDP and in its diversity. Trade in services of forests is today a global business, a fact that would have been incomprehensible in professional forestry circles less than a decade ago. Opportunities are also emerging from the fact that globalization represents an incentive to remain competitive or to gain in competitiveness through technological innovation (innovation competition).

Further opportunities, or at least drivers for adaptive change, arise from beyond the simply economic dimensions of globalization. With regard to policies, these include institutional structures and comparatively stable and predictable policy frameworks on forest matters as well as continuing economic integration within the EU and open economies based on markets rather than on planned economies.[10] Population dynamics forecasts assert further increases in the share of older people with specific requirements (including calm environments) as well as affluent urban societies demanding recreation as one of their pastimes. Further, society regards “nature” and “environment” as valuable and thus supports their protection, unsustainable use, and prevention of damage to them.

3.2. Globalization threats to EU forestry

Table 17 below shows that (not surprisingly) the amount of threats to EU forestry are at least equal to opportunities. These threats range from decreasing (private) investment in forest industries, to remaining stuck in the role of a high-volume low-cost raw material supplier. Major industrial sectors, including forest products industries, experiencing higher competition and reduced profitability have compelled manufacturers to consolidate, to more rapidly reduce labor inputs and production costs, to outsource supplies of materials or goods to other countries, or to move production capacity abroad. Related to this is decreasing demand and sales markets for valuable high-quality raw material. Decreasing return on (private) investment in multifunctional forest management reduces the investment by forest owners, large and small, of their time and money. Governments may not be willing or able to increase or maintain support through (tax) budgets.

Cost-competitiveness pressures and related (costly) technology investment in an often highly fragmented sector with inexistent economies of scale in many countries are making the sector increasingly less attractive. This is not helped by the fact that forestry is often considered as a mere low-tech raw material supplier. Added value from forests in terms of services is often not recognized, as it is a commodity not traded via markets.

Threats are also emerging from globalization dimensions beyond economic and technology factors. These include politically incompatible regulatory frameworks that affect forests and forestry in the face of increasing and increasingly diverse demands. Society, used to free services from forests that they often do not recognize (such as protective services or free recreation space), may pose requests that are difficult to finance or contradictory (e.g., cheap energy from renewable sources, that leaves nature intact). Evidently, environmental changes, in particular climate change, increase the risk of larger-scale and more frequent damage, with all its economic, social, and environmental consequences.

[10] While the merits of liberal versus protective policies are hotly debated, as there are obviously winners and losers as a result of any policy, most would assert that open economies and stable institutional conditions enable wealth creation regardless of specific factor endowments. According to economic theory, globalization and free trade should enhance economic prosperity on a global scale, as capital moves more freely to the most productive uses and locations. However, that does not automatically mean that global prosperity will contribute positively to Sustainable Forest Management in the EU.

Table 17. Main globalization factors and dimensions and possible threats for forestry

Globalization factors	**Threats**
Investment	Increasing outward FDI, decreasing domestic investment by forest owners and industry, decreasing return on investment attractiveness in forestry;
Economic activity—productivity, added value	High fragmentation and resulting inexistent economies of scale result in low productivity, while the pressure of cost-competitiveness on commodity materials is growing and increasingly affecting value-added production; decreasing importance of the forest sector in national economies; decreasing economic attractiveness of forestry;
Employment	Decreasing employment in forestry sector; related effects on rural areas; low attractiveness of forestry as a profession; continuing secular flow of labor out of the primary sector; drain of human capital from rural areas,
Trade	Increasing competition on raw material markets from imports
Technology, including know-how	Shift in technology leadership in key forest products industries; net outflow of R&D investment; low and decreasing level of (private) technological R&D beyond process innovation
Globalization dimensions	**Threats**
Policy	Dirigiste managerial behavior of governments as owners of forests; incompatible regulatory regimes of different sectors (forestry, energy, climate, protection).
Society	Further urbanization of lifestyles in EU, increasing mobility of people, who are demanding recreation and protection services free of charge
Environment	Increasingly visible and relevant effects of climate change, including increasing risk and frequency of damage (fire, storm, drought) and related effects (prices, quantity, resource scarcity)
Resources (energy, raw material)	Increasing scarcity of energy and competition over biomass raw material at low levels of value added and cost

In many of the opportunities or threats outlined in the above, forestry and the forest industry (or specific sectors of the industry) face the same situation. In some others, opportunities exist for forestry that are seen as a threat by the current main industries (mainly commodity producers, often competitive export-led), or vice versa. For instance, increasing raw material scarcity drives up profits for forestry, but is a very real threat to industries in cost-competitive commodity markets with “razor-thin” profit margins. On the other hand, forestry would lose its main revenue stream (sales of wood) if the forest industry were to invest abroad but not domestically; this would lead to relocation of industry production sites and a decline in market demand and income.

3.3. Globalization Opportunities and Threats: Forestry versus Forest Industry

Table 18 shows a cross matrix of some of the most frequently identified issues related to the threats and opportunities of globalization from the perspective of forestry and of the forest industry. Not considering regional differences, and with different conditions for production in different segments of the industry, it shows that some globalization factors and dimensions provide opportunities both for economically viable forestry and for an economically viable forest industry—this includes the fact that wood is a renewable material, which society recognizes as a very positive feature. It also shows that for some aspects opportunities emerge for the forest industries that are, or can be seen as, threats to forestry, and vice versa.

Table18. Cross matrix of some of the most frequently identified issues related to the threats and opportunities of globalization from the perspective of forestry and of the forest industry

		Forestry	
		Opportunity	Threat
Forest industry	Opportunity	• Sustainable resource supply • Wood-based bio-energy—polyproduction • More efficient business relationships, including business intelligence • Productivity gains through increased technology use, including logistics • Biotechnology R&D breakthroughs • Domestic/regional outsourcing of production to enhance productivity • Increasingly stable and reliable global institutions and regulatory and operational frameworks (e.g., Kyoto) • Societal support for renewable resources, green image of wood	• Foreign direct investment outside the region (forest industry relocation) • Low import barriers for industrial raw material • Import competition for raw material/globalization of natural resource sourcing • Job losses due to productivity gains • International/global outsourcing of production of components • Increasingly imperative global institutions and regulatory and operational frameworks (e.g., WTO) encouraging foreign direct investment abroad
	Threat	• Increasing raw material scarcity leading to higher prices • Wood-based bio-energy • Alternative non-production-oriented business models • Policies that restrict wood use but are viable business models for forestry (including e.g., recreational services and, to some extent, carbon sequestration) • Society demanding increasing use of forests for environmental protection and recreation, with viable business models in forestry to provide these	• Forest industry consolidation • Rising import competition pressure for parts, components, or finished products • Reduced export-competitiveness • Declining forest industry profitability • Policies increasingly regulating SFM, but with little scope for developing market-based solutions and experimentation • Increasing degree of urban population viewing forests as ideally "untouched nature" and increasing stakeholder involvement requesting non-economically viable management without alternative income opportunities • Climate change

4. Strategic Options for Adapting to and Benefiting from Globalization

All stakeholders and market players are affected by and adapt to globalization, including producers and consumers, governments and administration, research institutions, and other stakeholders, such as interest groups for businesses or environmental protection NGOs.

Forestry aiming to be an economically viable sector of the economy must respond to globalization and its opportunities and threats in ways that are adequate for the respective context in terms of assets and asset potential as well as current and likely future market demand for products and services from forests. There are four overall strategic options for forestry, three of which regard forests as an economic asset that is actively managed for income or profit.

- Option 1. "Cease commercial operation" = cease active income- or profit-oriented forestry
- Option 2. "Get out of the way" = diversify into alternative and niche income streams
- Option 3. "Compete with the masses" = cost-competitiveness in the global commodity market
- Option 4. "Develop next generation products" = technological and business model innovation

In practice, of course, individual businesses have pursued one or a mix of any two or all of the three strategic options for some or all assets, and are developing these further, continuously or periodically, as the need or opportunities arise.

4.1. Strategic Option 1: "Cease commercial operation"

Strategic Option 1: "Cease commercial operation" is a strategic option that has been pursued for many forests in regions where traditional commercial assets are low (e.g., in the Mediterranean region), or where forest holdings are considerably below a commercially viable size (i.e., no market transfers have been undertaken for several years, and utilization of forest assets is for subsistence only).

4.2. Strategic Option 2: "Get out of the way"

Strategic Option 2: "Get out of the way" as a strategy for businesses is characterized by responses to globalization that move toward business options that are not or are only slightly dependent on or affected by globalization factors. It builds on strategies of diversification into niche markets and local forest products and services provision, thus avoiding brutal international competition in the production of raw commodities, where undifferentiated commodities are produced by whoever can produce them at lowest cost—globally. The competitive niche of small- to medium-sized forestry enterprises is—according to proponents of such strategies—expected to be in differentiated products that offer higher margins. Of course, there are no guarantees that these are indeed materializing.

Globalization generally favors larger-scale or more capital-intensive firms that profit more than small firms from increases in efficiency and product quality gains obtained through: 1) more automated or computerized control of manufacturing processes; 2) standardized systems for sourcing of raw material and delivery of goods produced; and 3) better developed business and market intelligence systems. Such firms also outrun small companies in technology leadership, particularly in process innovation and technologies allowing flexible customized production. This makes it increasingly difficult for small-scale enterprises to compete successfully in most forest product markets, even in the area of customized products or niche markets for standard products. Development of customized products and niche markets is a fairly common business strategy, even for larger firms. Understanding and the ability to rapidly respond to quickly changing customer delivery requests is an increasingly important prerequisite for global companies wishing to compete on localized markets, including, for example, packaging. This, and other factors, has resulted in a continuous decline in the number of small-scale forest product enterprises in recent years.

Local small-scale-enterprise development in the traditional forest products sector is confined primarily to production of fuelwood, which has a relatively low market value, and to some niche opportunities in small-scale sawmills. Evolving opportunities for diversified sources of forest revenue (non-wood products, recreation, protective and environmental services) may offer a variety of new forest investment opportunities. Globalization being, economically, mainly a trade-related phenomenon, the strategic option builds on businesses: 1) that are non-tradable over larger distances (such as localized services); 2) where substitution by products or services from other producers is limited (including being protected by government regulation); 3) where location or territorial assets other than forests alone are a factor; and 4) where wood is not a clearly dominating asset. With the exception of territorial services this is an option that responds to threats of globalization in forests' main commercial products (wood) and tries to take advantage of opportunities of globalization in other "niches" of commercial products (non-wood goods) and, in particular, services.

Services taking advantage of landscape and recreational amenities by developing a discernible package of consumer benefits as a marketable "service" are increasingly valued by affluent urban societies where people want to get out of cities and into rural areas to enjoy some tranquility and recreational opportunities. With the EU's aging population, more and more senior citizens are looking for pleasant places to live in their retirement years. They are attracted by the lower cost of housing, more tranquil life, and smaller communities. Health services packages in tranquil rural areas with an attractive forested landscape are another potential area of diversification. Such urban consumer-services-oriented strategic options are mostly suited to regions with already urbanized models of forestry.

As many of the services and diversification options in this strategic alternative are dependent on strategies that focus on territorial entities, such as communities or regions, rather than on specific sectors, it is imperative to recognize and build on the role that forestry, as one sector, can play. Reorienting policies, institutional structures and instruments to facilitate and promote such local and regional cross-sector collaboration are particularly important. Such collaboration is mainly pursued in and suited to regions with diversified forestry or ownership patterns and that have local or regional (non-globalized) forest products producers. Rural communities, on the other hand, need to recognize that their communities will change if they pursue economic development. Entrepreneurship, an essential element in local diversification, appears to be less abundant in many rural communities than in cities. Factors impeding entrepreneurship in forestry thus often need to be addressed through policy measures, particularly access to finance, risk mitigation, and information.

4.3. Strategic Option 3 “Compete with the masses”

Strategic option 3 “Compete with the masses” is a strategy suitable for regions with globally competitive forest industries producing commodity products such as pulp, paper, or panels, as well as largely standardized production of homogeneous raw material (plantations or largely planted semi-natural forests). Competition on costs requires largely automated production and business models for faster production, delivery and service (i.e., a focus on process innovation). As the cost-competitiveness of forest product technology generally increases with scale of production, increased automation, computerization, and capital intensity, surviving firms in these highly competitive segments tend to be larger, more capital- and skills-intensive, and generally more automated and technologically advanced. More labor-intensive or smaller-scale and less capital-intensive enterprises experience proportionately greater decline (e.g., furniture production). Given that a large part of primary and many secondary processed wood products are commodities, cost-competitiveness strategies concern most wood products as well as bio-energy (heat) production. Competing on cost and on the basis of commodities is more suited to regions with larger average forest holding sizes (limited forest ownership fragmentation) and/or well-developed, integrated, and IT-supported forest-industry supply chains.

There are two broad business strategies that producers of commodity products can choose. One is to compete on cost and price, with mass production and economies of scale. The second is market differentiation with customer service and value-added products. In many forest product markets businesses, there is a need to pursue both, including, for example, in the paper packaging sector. Dominant trends are thus often characterized by consolidation, automation, and internationalization in procurement and sales, and in parallel product differentiation, customization, or niche markets. IT systems in particular allow more rapid adjustments in sourcing, production, and marketing, while maintaining high levels of product quality control.

While forestry firms are usually not too keen on designing new strategies for moving up the value chain, moving up for the subsequent forest industry sectors is a matter of survival. Moving up means acquiring the capability (managerial capability, organizational renewal, and workforce skills) to handle customized product/service innovation. For instance, sawmills increasingly compete further through developing value-added products for the construction sector. These are not “niche” strategies in the narrow sense, as they follow the trend of downward integration of production (toward end products) and increasing globalization and commoditization of such secondary processed products. Some regions, such as southeastern Europe can become or remain a player in global furniture production, which is comparatively labor-intensive. Overall, strategic option 3 is the dominating strategy of forest industries in the EU, as a large share of wood products are global commodities or largely standardized and internationally traded.

Cost-competitiveness as a strategy to respond to globalization calls for all actions that reduce the cost of production of a range of commodity, or increasingly commoditized, products and, where competitive, gain market access or deepen market penetration of international markets. Improved productivity will be necessary to compete on cost, but this alone may not be sufficient. As the dominant strategy for a range of commoditized products is automation of production, one standard request to forestry is to integrate into standardized and secure raw material supply and production chains and to keep raw material prices at cost-competitive levels (“a healthy forestry needs a healthy industry”). Such integration creates indirect economies of scale of production; however, the center of decision power, in the view of forestry, (further) migrates from forestry to the sales departments of forest industry companies or distributors. As raw material costs range from some 40–60% of all costs of production of such commodity products, the strategic role and behavior are co-decisive for the feasibility and viability of whole value-added chains in these product markets.

Where such strategies of integrated supply and production chains are pursued or developed, pilot projects are often initiated among participating firms to address the many small and specific issues in chain development raised by the partners (e.g., in construction or furniture production). Aligning production along value chains also requires a process of co-innovation, involving the private sector, knowledge institutes, and producer organizations, or co-adaptation, in order to build up sustainable arrangements between the participating companies. It also needs increasingly to include expanded use of imported components and sub-assemblies, along with "just-in-time" manufacturing methods and improved supply chain management. However, it is far from clear whether increasing the scale of production or productivity through automation or lean manufacturing can alone compensate for the cost advantages of producers in low-wage countries, which often have not only wage advantages but also access to advanced technology. Globalized production also demands standardized components and uniform product quality, favoring modern capital-intensive production and computer-controlled or -aided quality assurance.

IT-based integrated production systems are also emerging as a response to globalization and increasing competition in more complex production systems with a lower degree of possible automation, such as furniture production and to a certain degree of prefabricated houses or housing components. In these sectors, increasingly individualized customer orientation and interaction in product design (e.g., for prefabricated housing), product-service packages, together with outsourced "lean" manufacturing and coordinated co-production in clusters, are already or rapidly becoming industry standards. Product customization and efficient production have been recognized as a key to competitiveness in the furniture sector, rather than just "mass production." While proximity to EU customers should result in a better understanding of national or regional consumer needs, in fact, such explicit consumer orientation is often still rather rare. Moreover, today, global communication and global integration of distributed production in global enterprises (see, e.g., IKEA and, also increasingly micro and small enterprises which are outsourcing production of components internationally) allow instantaneous communication of information such as custom product specifications and any related business transactions to any part of the globe. Thus, the real competitive advantage lies in: 1) having the business intelligence to respond to shifting trends in a variety of market sub-segments; and 2) being able to minimize the "product-to-market" time span through well-coordinated local production clusters that allows rapid and repeated interaction between different parts of the production chain and efficient distribution systems (see e.g., "Zara" clothing production).

Wooden panels and construction materials tend to lose building market shares to newer value-added products with more efficient use of wood in engineered wood products and components such as KVL, LVL, laminated trusses, prefabricated wall panels, and non-wood products, including wood composites. Efficiency is also enhanced through prefabrication and IT-supported assembly, reduced building times, reduced waste on site, and more energy-efficient construction (see also related emerging certification systems for buildings).

For forestry, from an industry-competitiveness point of view, participating in such complex customized production requires IT-based "just-in-time" interfaces for customized raw-material supply of standardized components in reliable quality— just as for any other supplier of components. Just as in forest industries this implies a trend toward more customized production systems, more capital-intensive, more IT- and skills-based production, and more production-chain- or assembly-line-oriented business strategies, thinking, and practice. It requires either larger management units or organizations structures that can bundle supply from a larger number of micro-forest holdings in order to become a viable and reliable partner in the production chain. For a range of applications, including, for example, wall panels, this requires or allows smaller diameters or assortments, with respective implications for the type of forestry (rotation) systems to be used.

All the issues discussed above are developments related to trends in the globalization of wood products and forest products industries. However, similar developments are occurring throughout manufacturing and trade, including current or potential future substitute products. In competition with such substitutes, forest products may be recognized in the market for their strong environmental performance, such as lower energy input or less use of non-renewable resources relative to other materials.

4.4. Strategic Option 4: "Develop next-generation products"

Strategic option 4 oriented toward getting ahead of the competition by developing future products and business models is a strategy that is not only suitable for and appropriate to the global forest industry but also at the frontier of forestry competitiveness. It is the only strategy that is more long-term oriented, as it does not compete on cost (a daily business) but on market- and business-paradigm-changing advances in technological and business models. Being highly dependent on know-how and R&D investment, it is suitable only for regions that have developed such assets and is considered the most appropriate strategy for long-term competitiveness. Given global business know-how, and if successful, it takes full advantage of globalization opportunities. This option concerns new products that subsequently become commoditized, such as wood composites and other "bio-based" products, bio-fuels, and chemical substances used in a range of applications, as well as new business models, including models for large-scale construction, global carbon markets, or forestry investment that explore institutional investor or equity investment models.

Biotechnology based on molecular biology is generating steady advances in genetic knowledge and the capacity to change the genetic makeup of trees and forest plants. This could potentially not only lead to more resistant and productive trees, but also change the use of trees and forest plants, given the many other components of forest plants, including potentials in the use of cellulosic and lignin components. Despite this potential, the complex issues of biosafety and bio-ethics must be addressed. Similarly, considerable risk is involved for investors in such research; it must thus be controlled, either by reducing risk through public research or research support and/or by increasing the potential for rewards through intellectual property protection.

4.5. Implications of different scenarios for strategic adaptation options

Different scenarios as specified in the scenario runs tend to shift the emphasis of options. As *Table 19* shows, most main scenarios of future developments favor certain options, while negatively influencing others. For instance, it is likely that more strict environmental policies and larger areas put under partial or full biodiversity-protection-oriented management would increase the cost of management (assuming added costs are not covered by governmental support) and act as a impediment to cost-focused commodity-oriented production options. However, in practice, this causal relation seems not to be as grave as is sometimes argued, as biodiversity protection measures tend to be implemented in areas that are commercially less attractive. Over the last decade at least, it seems, biodiversity measures have been considerably enhanced in forests in general, while many sectors of the European forest industry have been very successful on the global market.

Bio-energy for heat production is one potential future development that is viable even on a very small and local scale where there is little investment for raw material collection, even for otherwise commercially uncompetitive small forest holdings. If biomass for bio-energy, particularly for local energy production, were widely adopted, it would reduce the likelihood of individual owners ceasing commercial operation, allowing many forest holdings to diversify into energy production. On the other hand, there is increased competition over raw material, particularly also over small-diameter wood, if wood for energy is promoted on large scale. Wood for (second-generation cellulose-based) transport fuel would fall into next-generation products, whose commercial future is yet unclear.

Efforts to strengthen wood mobilization would comprise measures to facilitate management and harvesting for small-scale forest holdings, as well as in less productive areas that might otherwise consider ceasing operation or have already ceased. Wood mobilization, as frequently conceived, would be used for commodity products, either for products produced as described in Option 3 (cost-competitive commodities) or for bio-energy. In the case of the former it would possibly do little to increase diversification.

Emphasis on value-added production in the future would likely build on and try to expand current production strengths. This, in many cases, would include competitive commodity production but not alternative value-added production, including wood and non-wood, or it could also include more radical new products. This future scenario is likely to have little effect on which segments of forest holdings would consider ceasing commercial operation—at least, in the short term. Technology change characterizes a future scenario that foresees breakthrough research and innovation in next-generation products, production systems, or business models. It is thus Option 4 successfully pursued. Depending on the type of change, it can strongly benefit Option 3 and also Option 2. Option 1 is again not likely to be affected in the short term.

Table 19. Implications of future development for strategic adaptation options

Scenario	Option 1: No commercial operation	Option 2: Niche/diversify	Option 3: Commodity competitiveness	Option 4: Next-generation products
Environment policy	++	+	--	+-
Energy	--	++	+-	+
Wood mobilization	--	+-	++	+-
Value added		+-	++	+
Technology change		+-	+	++

5. Opportunities, Threats, and Strategic Adaptation Options in Regions

The following section describes briefly which regions are more or less likely to succeed in the strategic options as outlined in section 4, as well as the implications of different scenarios (see *Table 20*).

Type 1: Globalized regions/Nordic–Baltic

This region has developed globally leading forest industries, profiting considerably from the opportunities provided through globalization. It enjoys technological leadership and the level of skills and know-how to manage globalized production systems and to further benefit from globalization by further developing global business models and pushing commoditization of standardized products in a range of other areas outside the traditional commodity products. Existing industries in commodity products will without doubt continue to pursue opportunities elsewhere, particularly as cheap raw material supply from Russia is bound to tighten in the future, with or without the effective implementation of recently announced export duties. At the same time the rising demand for bio-energy and increased research into biotechnology (bio-fuels) open up new strategic business areas and models, ideally enabling flexible poly-production. Leading sub-regions within this region are destined to pursue Option 4 by strengthening their lead in innovation competitiveness. Other sub-regions are likely to benefit from their supply proximity, which should largely exclude Option 1 for individual producers in the region. Given a largely homogeneous and productive resource base, the region seems well suited to further pursue Option 3, particularly in terms of products that require more complex and customized production or assembly systems, including construction. Nordic regions in particular with their scenic beauty in remote areas or around urban areas can also benefit from pursuing Option 2 for the development of attractive recreational services. In terms of scenarios (see *Table 20*), this region would gain most from technology change as this is a regional competitive strength that will possibly create considerable opportunities for future income streams based on wood and other forest products. It would also benefit from future scenarios that emphasize value added.

Type 2: Wood-production-oriented regions/Central Europe

This region has built up strengths in traditional commodity products, and like the Baltic–Nordic region, has benefited from the opportunities of globalization by pushing consolidation and IT-supported automation of production, albeit on a smaller scale and with less well developed business and marketing know-how. Likewise, its research and development base seems to be comparatively less developed. Further, production conditions for raw material (forestry) in the alpine regions are less suited to large mass production of standardized commodities, raw material procurement systems are not as integrated and automated as in leading Nordic countries, and the area lacks easy access to large shipping ports. Compared to global innovation frontiers, the existing but not necessarily top-level infrastructure of public and private research makes it possible to pursue Option 4 in developing next-generation products and business models—however, only with substantial investment in some areas. The strongest relative competitive advantage of the region possibly lies in Option 3, in particular in the further development of value-added product commoditization and automation (e.g., construction components). This would require less standardized and less integrated production, but the cost-competitiveness pressure exerted by globalization will require adaptations in the forestry-wood production chain as described in section 4 under this option. As in many other regions, utilizing wood for local bio-energy supply systems is an option for supply of raw materials directly from forests or from wood-production residues, as in Option 2, as is generating alternative incomes from developing new institutional and business models for recreational and environmental-protection services. In terms of scenarios, this region would thrive comparatively well with the scenarios of successful value-added product development, wood mobilization, and bio-energy, and would be more negatively affected by strong environmental policies than other regions.

Type 3: Plantation-oriented/(mainly) "Atlantic Rim" Western Europe
This region has, over the last decade(s), invested in the establishment of plantations in land that was formerly underutilized for agricultural use because of low productivity and often promoted through investment tax benefits. Some parts of these plantations have excellent growing conditions due to the maritime climate along the Atlantic Rim. They range from Northern Portugal and Northern Spain to Southwest France, Ireland, and Scotland. These conditions and the standardized raw material supply puts this region in a competitive position with regard to Option 3: cost-competitive commodity production, especially if private investment can be attracted to establish value-added production or clusters. This has so far been successful, for example, in Scotland. However, considerable public investment has been needed. As several of these regions have been established comparatively recently, further investment in Option 4, based on know-how and technology leadership, is likely to be difficult to attract. With the exception of bio-energy (as a co-product of commodity production), the conditions needed to develop a diversity of recreational services in particular, are somewhat impeded by the production necessities of commodities (Option 2). This region would thrive comparatively well with the scenarios of successful value-added product development and, like Type 2, would possibly, in comparative terms, be most negatively affected by strong environmental policies in all regions.

Type 4: Broader, multifunctional forestry-oriented regions/Western Europe
This region comprises countries, such as Germany and France, large economies with considerable domestic consumption, where many of the other regional conditions are present in some sub-regions. Consequently, many options in general exist for the region, where—overall—the default is commodity or value-added production, often for domestic rather than export markets. This region would benefit from successful wood mobilization, value-added product development, and bio-energy development; it could be negatively effected by stronger environmental policies.

Type 5: Urban society service-influenced regions/Northwestern Europe
In this region the pressure of urban societies to provide services and amenities that they, as consumers, demand, and the overall benefits that forests provide to society, has in general overpowered wood production. Commercial forestry without considerable governmental support to provide environmental or recreational amenities does not play a dominant role. Forestry in this region is thus in an advantageous position with relation to Option 2, diversifying in a range of territorially bound services to meet the high demand for recreation, health, housing and other services from urban consumers. However, most of this potential has so far been stifled, having been provided via governmental regulations and subsidies rather than through markets. It is yet unclear whether and how forestry could develop business models that are economically viable for a larger number of forest holdings through catering to urban demand (i.e., business models that do not allow economically viable niche strategies for a few only). It is clear, however, that two of the main leverage points are the legal and policy frameworks and the consumer attitudes to such alternative business models. In contrast, it is possible that pursuing Options 3 in these regions is not seen as a viable choice. However, if forest-related R&D could be joined up with industrial, medical, or biotech R&D, which are strong in the region, Option 4 could lead to fruitful cross-fertilization. In terms of scenarios,

this region would likely welcome and develop well with strong environmental policies, but not so with strong pushes in bio-energy or wood mobilization.

Type 6: "Countries in transition" regions/Eastern Europe
This region is still "catching up" in terms of industrialization and wages for labor. It thus enjoys some of the advantages of low-wage countries, including comparatively high levels of new investment in forest industries and advanced state-of-the-art technology. This current comparative advantage may not last, as wages are likely to rise, particularly given the skills needed (the skills to run modern production and information technology) and the limited number of people possessing these skills, coupled with low tolerance rates for below-par product quality and the requirements of just-in-time delivery logistics. However, some sub-regions have abundant raw materials that can be accessed through new road infrastructure investment; it has thus proven to be an attractive area for forest industry investment, for both commodity production and more labor-intensive furniture production (including e.g., the relocation of furniture clusters from northern Italy to western Romania). Low wage costs and abundant labor also allow diversification into the production of non-wood forest products and other options (including recreation) that are more difficult to organize commercially elsewhere. In all these options, technology and skills levels in the areas of automated production, quality control, and marketing are crucial factors for success. This region would not directly gain from scenarios of strong technological change, but they would gain from wood mobilization and advances in value-added production.

Type 7: Low forest management intensity regions/Southern Europe
This region, for centuries rather than decades, has had low forest management intensities for a number of reasons, including climate and ecological conditions. The challenge in the region is to make better use of unutilized or underutilized forestry assets and to keep or make forestry a partially commercial option in rural areas. As Options 3 and 4 are, in general, not viable or difficult from a raw material availability or regional know-how point of view, forest owners, industry, and other stakeholders, including public policy, has focused and continues to focus on Option 2. The development of bio-energy as a local "value-added" production option in particular allows more forest products in many regions to become economically viable than before. This is in addition to the non-wood forest products focus pursued traditionally in the region, including cork, mushrooms, and a range of other goods (often successfully marketed through regional brands). As a result of the recent increase in forest area, much of which seems to be promoted through co-funding by the EU Rural Development regulation, the asset base for exploitation is increasing. This potential for increase in forest area and the large areas of land with low productivity (including "other wooded land" areas) also open up the potential (and hope) for further afforestation and improvement of assets on such land through "payment for environmental services", concretely, for carbon sequestration. This region would possibly gain from environmental policies, which would improve the attractiveness of landscapes for services; it would also gain from wood mobilization, particularly for bio-energy.

The strategic options on response to globalization for the seven typology regions of EU are summarized in *Table 20.*

Table 20. Strategic options to respond to globalization and their regional suitability (stars indicating general suitability, increasing from "rather not" (no *) to "highly" suitable (***))

	Option 1: no commercial operation	Option 2: niche/diversify	Option 3: commodity competitiveness	Option 4: next generation products
Type 1: Globalized regions/Nordic–Baltic		*	**	***
Type 2: Wood-production-oriented regions/Central Europe		**	***	**
Type 3: Plantation-oriented/(mainly) "Atlantic Rim" Western Europe		*	***	*
Type 4: Broader, multifunctional forestry-oriented regions/Western Europe		**	***	**
Type 5: Urban society service-influenced regions/North Western Europe	**	***		*
Type 6: "Countries in transition" regions/Eastern Europe		**	***	
Type 7: Low forest management intensity regions/Southern Europe	**	***		**

6. Effects of Adaptation Options

The effects of adaptation options in the context of this particular study focus on two main dimensions: 1) the effects of different adaptation options on globalization factors and dimensions and their related strengths and weaknesses (for opportunities and threats, see respective adaptation option description); and 2) the effects of different adaptation options in the context of globalization on the overarching goal of forestry in Europe, namely, sustainable forest management, and related strengths, weaknesses, opportunities, and threats.

6.1. Effects of strategic adaptation options on globalization factors and dimensions

Table 21 shows the likely effects on different globalization factors and dimensions, if a particular strategic adaptation option is pursued. As both the factors and dimensions as well as the adaptation options require hypothetical assumptions about magnitudes of likely concrete future developments, these effects can best be assessed descriptively on an ordinal scale, indicating the likely direction of change from the current situation. The subsequent text further outlines the particular strengths and weaknesses of different options. Opportunities and threats are referred to only if they are in addition to opportunities and threats as outlined in chapter 4.

Table 21. Effects of adaptation options on globalization factors and globalization dimensions

Globalization factors	Option 1: no commercial operation	Option 2: niche/diversify	Option 3: commodity competitive-ness	Option 4: next generation products
Investment	Decreasing considerably	Stable or decreasing	increasing (continuous & considerable investment);	Increasing considerably (strategic & risky)
Economic activity – productivity, value added	Decreasing considerably	Stable or decreasing	Considerably increasing	Stable or increasing (short term)
Employment	Decreasing considerably	Stable or increasing	decreasing	Stable (short term)
Trade	n.a.	stable	Stable or increasing	Stable or increasing
Technology, know-how	Decreasing	increasing	increasing	Considerably increasing
Globalization dimensions				
Policy	n.a.	n.a.	n.a.	n.a.
Society	Likely neutral response	Likely neutral or positive response	Likely negative response	Likely neutral response
Environment	Likely positive, except for health risks	Likely neutral or positive	Likely negative or neutral	Likely neutral (short term)
Resources (energy, raw material)	Likely negative	Likely neutral or positive	Likely positive	Likely positive

Investments are essential for the long-term viability of sustainable forest management as currently conceptualized (see below). They ensure that forests are an asset that is utilized to produce added value for society and they indicate the future trust in return on investments. Private investments on a larger scale are only to be expected in Options 3 and 4, while investments in Option 2 mainly depend on the type of niche pursued. In the case of bio-energy, private investment is possibly considerable in the aggregate, but small on individual sites. As is the case with Option 4, in Option 2 public funds and public incentives are often needed as seed funds and to encourage private investment. Option 2, moreover, depends considerably on institutional (including legal) restructuring to facilitate and promote cross-sector initiatives. Option 1 would signal the abandonment of forests as an actively managed economic asset, which over time could become a liability for society (see below).

Economic activity in terms of value-added production and productivity increases are to be expected mainly in Option 3, where survival crucially depends on productivity increases, and increasingly on value-added production beyond simple commodities. While there are considerable opportunities that can be pursued in a range of subsectors and markets where automated production and thus productivity have not yet peaked (e.g., construction), it is evident that cost-competitiveness strategies need to be complemented by market-oriented customization. This requires more complex and flexible systems that are better suited to compete with products from other regions. For forestry, this would mean increasing integration into the production chain that is more or less the furthest from the final consumer. Alternatives for value-added production (apart from bio-energy) in forestry lie in a range of services with more direct access to (often urban) consumers, such as recreational and health-related services. However, this would require considerable changes in traditional business models, including enhanced communication skills and cross-sectoral business model development. Given that currently such services are inexistent or contribute a very minor share to the average revenues of forest enterprises, it would also require institutional changes, probably at the communal level in particular, to make such business models viable.

Employment has slightly decreased in the EU in forestry and the forest industry over most of the last decades, mainly driven by the need to enhance productivity to stay competitive. This trend is likely to continue in most regions of the EU as the main/default strategy of the EU forest sector to globalization, as per Option 3—take on cost-competitiveness challenges by reducing costs and increasing productivity. Only Option 2—diversification—is likely to change employment outlooks for many rural areas with forests, particularly if local bio-energy supply systems are promoted, which create one or a few jobs per location. But these add up to a considerable number in total.

Trade in forest products has soared among countries over the last decade. Roundwood import from Russia has grown considerably, but is now likely to be scaled back with new roundwood export duties being introduced by the Russian government to discourage raw material export and to promote domestic value-added production in forest products. Exports of commodity products, including sawnwood, paper, and panels have likewise strongly increased. International trade is mainly a commodity product phenomenon in the forest sector, which implies that options promoting commodities are likely to keep trade volumes at high levels, while alternative options are not likely to promote further and increased trade.

Progress in technology and know-how, and their commercial exploitation are a key component of competitiveness, and are likely to be further developed on a larger scale only if competitive industries invest in (private) R&D, either in pragmatic "on-the-job" development of solutions to problems as they appear or in more strategic research and development. Without returns on such private investments, the current level of technology and know-how will be difficult to maintain. This implies that Option 3 (where the private sector has a visible stake to invest) and Option 4 (where public R&D will probably be needed to act as initiator and to share costs and risks) are likely to boost this factor more than Option 2 (where public policies and framework frequently need to change to allow and enable know-how build-up through experimentation).

Society—both in terms of demographic change and lifestyle (including related attitudes to forests and forestry)—is a very decisive factor for future policies and for business. While the contemporary views on forests and forestry are in general rather well known (namely, forestry is acceptable and supported, if protection and preservation are appropriately taken into account), it is less clear how far attitudes would change in the case of large-scale promotion of bio-energy (renewable energy), and related changes in the visual attractiveness of landscapes. It is, however, rather well understood that (notwithstanding regional variability) monocultural plantation forestry is not well accepted, and decreasingly so where urban lifestyles dominate. This puts Option 3 at risk of low social acceptance. On the other hand, Option 2, based on a diversity of services for urban society, would likely meet expectation and demand considerably better than current forest utilization patterns in many regions (except for the fact that it is unclear it these services will be paid for if income from wood is decreasing).

Environmental issues cover a broad range of topics. Possibly most prominent with regard to forests are biodiversity protection and climate change. The effects of climate change and climate-change policy on forests can have far-reaching implications, both economically and environmentally. Yet, however important, they are not the focus of this particular study on globalization. In terms of the options for strategic adaptation responses, commercial operations would have little overall effect on the carbon sequestration balance, as it is unlikely that large areas of highly productive forests would be affected. However, in the medium term, such forests would likely become a more severe health risk to forests in terms of damage through fire, insects, storm, and other events. As forest fires in the news each summer testify, a forest fire can quickly turn into much more than just a forest issue, and climate change is more likely to exacerbate such risks rather than decrease them. Preserving biodiversity is more likely in Option 2 where recreational services are part of rural diversification strategies. On the other hand, biodiversity could, at least locally, be more negatively affected by cost-competitiveness strategies (fragmentation, more uniform forests).

Resource availability for raw material or energy purposes decreases slightly when areas are taken out for commercial operation, but likely to be positive in most other strategies, given existing raw material demand.

6.2. Effects of strategic adaptation options on dimensions of sustainable forest management

In Europe sustainable forest management (SFM) is defined through the Ministerial Conference on the Protection of Forests in Europe (MCPFE) Helsinki Resolution H1 and further specified and operationalized through the MCPFE criteria and indicators for SFM as adopted by Lisbon Resolution L2 (and the indicator revisions endorsed by the MCPFE Vienna Declaration in 2003). This analysis of the effects of strategic adaptation takes these criteria and indicators as a reference (see *Table 22* for an overview).

Forest resources, both in terms of area and growing stock, have been increasing in the EU for some time. This trend is likely to continue in the EU overall if considerable areas of formerly agricultural land are converted to forests in Central and Eastern European countries, as planned, and afforestation policies are continued as they have been in the past in regions of the Atlantic Rim, where growth conditions for plantations are good. Different adaptation options will have different local or regional effects within countries that will be negligible or discernible in international statistics over time. There are two specific globalization-related adaptation factors (i.e., excluding climate-change responses) that might change current trends: one is wood mobilization for bio-energy; the other is wood mobilization for cost-competitive mass production.

Forest ecosystem health and vitality, as already described above under the environment dimension of globalization, will likely see little change in all options except in Option 1 in the medium term.

Table 22. Effects of strategic adaptation options on sustainable forest management dimensions

MCPFE criteria - SFM	Option 1: No commercial operation	Option 2: Niche/diversify	Option 3: Commodity competitive-ness	Option 4: Next generation products
Forest resources and carbon	Increasing growing stock, age structure, carbon stock	Little change (except large-scale bio-energy: see 3)	Decreasing or stable growing stock, age structure, carbon stock or expansion of forest area	Stable or increasing
Forest ecosystem health and vitality	Increasing forest damage risk (fire, insects, storm)	Little change	Little change	Little change
Productive functions of forests	Decreasing wood production	Stable or decreasing wood production, increasing non-wood and services production	Increasing wood production, more balanced increment/ felling ratio; stable or decreasing services	Little change (short term)
Biological Diversity in Forest Ecosystems	Increasing naturalness, dead wood, etc.	Stable or increasing	Decreasing naturalness, increasing introduced species	Little change (short term)
Protective functions in forest management	Little change	Little change	Little change	Little change
Socio-economic functions and conditions	Decreasing net revenue, employment, contribution to GDP	Little change, possibly increasing net revenue, employment	Increasing net revenue, wood consumption and trade, contribution to GDP, decreasing employment	Little change (short term)

The production of wood and non-wood forest products and services would all be differently affected by the different options. In Option 1, production of wood would likely be reduced somewhat, while it would increase most strongly in Option 3, where more of the increment would be utilized. Non-wood goods and services would be considerably enhanced in Option 2, while they would likely be of decreasing importance where Option 3 is pursued.

Biological diversity, as described under the globalization dimension "environment," would likely be of most benefit in Option 1 and with regard to recreational service provision in Option 2, where there would be increasing naturalness, tree species composition, natural regeneration, and more dead wood. On the other hand, more efforts would be required to balance the production and conservation of biodiversity under Option 3, as this would tend to favor more standardized production and introduced tree species for higher yields. The aggressive promotion of bio-energy would also require volumes of wood to be increased considerably, both from newly established short-rotation forestry and existing forests.

Different aspects of socio-economic functions and conditions would change in different ways. With effective policies pushing Option 3, the number of forest holdings might decrease because of the need to create more cost-efficient production units. This can and is more likely to be reached through larger sizes of average areas being managed jointly or of raw material being marketed jointly. Option 3, in the short term, may also be the most promising option to keep or enhance net production revenue, as both Options 2 and 4 will not be able to replace revenue streams from commodity and commoditizing value-added products. In all options the contribution of the forest sector to GDP is likely to decrease further as other sectors of the economy grow stronger. The forest sector workforce (see globalization factors) is likely to decrease further, given that the dominant strategy in most regions, Option 3, will be to increase labor productivity and rationalization in state forest enterprises (while, at the same time, increasing investment in forest industry in some regions seems to create more jobs). More jobs in forestry are rather likely under Option 2 through bio-energy and niche strategies.

7. Concluding remarks

Strategic adaptation options are taken by individual forest owners and managers. Whether they abandon forest management, find niches, compete on cost in commodity markets, or develop advanced products and business models, will be decisive for the character of EU land use and forest management. The millions of forest owners and managers, working with very different assets and in very different business conditions across the EU, will pursue and explore a large variety of strategic adaptation options, often within small regions at the same time. Their behavior can only partly be influenced by policymakers or stakeholders. However, in the aggregate, the most frequently chosen options will make a big difference to the forest industry and to society as a whole.

VIII. Generalized Findings and Conclusions

VIII (i). Responding to globalization: issues and lessons for the Forest Sector

1. Globalization and the State

Martin Wolf of the *Financial Times* describes globalization as "a hideous word of obscure meaning, coined in the 1960s, that came into ever-greater vogue in the 1990s" (2004, p. 13). Three economists at the IMF (Coe *et al.* 2007, p. 35) agree that the term globalization is used in many ways but select as a working definition:

> the rapid increase in international trade spurred by advances in technology that have decreased the cost of trade, where the latter is broadly defined to include not just the cost of transportation but also the cost of search, information, communication, and so on.

This is a useful definition provided trade costs are interpreted broadly to include the tariff and non-tariff costs imposed by governments. It is true that technological advances have reduced the cost of transport and communication, making the world a smaller place, but it is equally true that governments have contributed by dismantling many of the artificial barriers to international trade. Indeed, globalization is driven as much, if not more, by changes in government policies as it is by advances in technology. Technology attracts more attention because policymakers have little control over the pace or direction of its development.

Regardless of technological change, globalization is not inevitable. Governments can always reverse the process by imposing import tariffs, quantitative restrictions, and controls on exchange of currency. This, precisely, was how the impressive globalization of the late 19th and early 20th centuries came to collapse during and after World War I. Globalization today could be reversed just as swiftly as it was a century ago, should governments choose to withdraw their countries from the world economy.

Globalization promises benefits to each trading country, but not every resident gains in the wake of its "creative destruction." Governments are necessary handmaidens to globalization: only they can ensure that everyone benefits or, at least, that no one is made worse-off. Without policies to redistribute income from gainers to losers, the option of autarchy becomes appealing, even though it results in lower incomes on average. Governments are necessary for markets to function. Hays *et al. (*2005, pp. 473-4) explain this very succinctly:

> Because trade causes economic dislocations and exposes workers to greater risk, it generates political opposition that democratically elected leaders ignore at their peril. Thus … political leaders have had to be aware of and actively manage public support for economic openness. To do this, governments have exchanged welfare state policies that cushion their citizens from the vagaries of the international economy in return for public support for openness.

Theirs is just one of many studies, including Cameron (1978), Rodrik (1998) and United Nations (2001), which show that countries with open economies tend to have bigger governments. Mayda *et al*. (2007) confirm researchers' suspicions as to why such a correlation exists: analysis of international survey data reveals that risk-averse respondents are more likely to be anti-globalization; moreover, the larger the government, the less hostile it is to globalization

By providing social safety nets and redistributing income, governments can have it both ways. Countries can reap gains from specialization and, at the same time, enjoy the security of income that would otherwise require at least a partial withdrawal from the world economy.

2. Intra-industry trade and specialization

When the costs of trade are high, a country will export those goods for which it has a strong comparative cost advantage, produce for domestic consumption goods that are "non-tradable" because trade costs are high relative to production costs, and import all goods for which the total cost, including trade costs, are less than the cost of domestic production. When trade costs fell, economists expect more and more "non-tradables" to become "importables" or "exportables," with each trading country specializing in fewer industries. What actually happened as a result of the post-war expansion of trade among the industrial countries was unexpected, even though foreseen by the Swedish economist Bertil Ohlin.

What economists, beginning with Verdoorn (1960), Balassa (1966) and Grubel (1967), observed in trade between developed market economies was the simultaneous export and import of goods classified in the same industry. Germany and France, for example, exchanged automobiles. Specialization, apparently, was *within industries* (intra-industry) rather than *between industries* (inter-industry). "Competing firms," Ohlin (1933, p. 95) had noted many years before, "—whether in the same or different countries—rarely produce absolutely identical articles." In the past, it was:

> assumed that a country will export things it can make cheaper than other countries and import the rest. That statement clearly assumes that the goods are identical in quality; as soon as this condition changes the relationship between prices and international trade becomes more complicated.

He then provided examples, adding (p. 96) "A study of international trade statistics will reveal many similar cases." Economists were rediscovering, without realizing it, a phenomenon that Ohlin had already documented.

"Intra-industry trade" became something of a growth industry for researchers, who uncovered high and growing shares of this type of trade in the imports and exports of countries around the world. (See, for example, Willmore, 1972; McMillan, 1973; Giersch, 1979; Hu and Ma, 1999; Petersson, 2002; Lloyd and Lee, 2002.) Because of the apparent importance of intra-industry specialization, economists increasingly have moved to the micro level to study the effects of globalization on individual plants or firms that make up each industry (Willmore, 1992; Bartelsman and Doms, 2000; Bernard *et al*., 2003; Bartelsman *et al.* 2004), drawing at times on empirical work of industrial organization (especially Olley and Pakes, 1996; Levinsohn and Petrin, 2003).

The finding of growing intra-industry trade in a globalizing world is incompatible with traditional or "old" trade theory, which predicts inter-industry, or even inter-sector trade and specialization based on comparative advantage. Trade flows in the old theory are determined solely by comparative advantage, regardless of whether the advantage stems from classical

("Ricardian") productivity differences or from neo-classical ("Heckscher-Ohlin") differences in factor proportions.

Alternative models of trade, known as "new trade theory" (NTT) accommodate intra-industry trade by borrowing freely from industrial organization. New trade theory (Helpman and Krugman, 1985; Krugman, 1995) emphasizes product differentiation, economies of scale, and home markets. The NTT has explicit firms, each of which produces a unique variety of a product. This allows for intra-industry trade: firms in each country can specialize in the production and export of unique varieties. But, in these models, globalization has no effect on productivity and if one firm in an industry exports, all do. The reason why this happens in the NTT models is that, except for scale effects, all firms are equally productive, produce varieties that are desired by consumers, and face no fixed costs of exporting. These assumptions are at odds with the real world, where few firms export, and those that do export rank among the most productive of their respective industries.

A fast-growing collection of models of "new new" trade theory, with contributions from Melitz (2003), Bernard *et al*. (2007) and others (Greenaway and Kneller, 2007), incorporates greater heterogeneity in the underlying characteristics of firms and is able to model entry into and exit from domestic and export markets. Entry and exit lead to aggregate changes in productivity as market shares change. *Ex ante* productivity determines the decision to enter or exit an industry and the decision to export. This is the familiar Schumpeterian process of "creative destruction." More controversial is the effect, if any, that globalization has on the productivity of individual firms *after* they enter export markets and *after* they survive import competition. Some of the new models allow for this, but theory cannot resolve the issue; empirical research is required to determine the relative importance of competitive elimination of the least efficient firms compared to competitive pressure on firms to raise their productivity. Another potential source of increased productivity is easier access to imported inputs, including capital equipment, which might allow gains from improved raw materials and intermediate goods, from specialization (outsourcing) and from technology embodied in machinery and equipment.

If globalization is essentially a reduction in the cost of trade, it is important to examine empirically just how this affects industries and firms. Trade costs change most quickly when governments dismantle high barriers to international trade, and two Latin America countries—Chile and Brazil—provide us with such a natural experiment. Chile until the 1970s and Brazil until the 1990s ranked among the most closed economies of the world. Each country embarked on a radical trade reform, Chile in 1974 and Brazil in 1990. Chile's reform was completed in five years, and Brazil in three, but both countries experienced problems due to overvalued exchange rates, so there was subsequent partial reversal of the liberalization measures, a reversal that turned out to be temporary in the case of Chile.

We focus attention on these two countries because their globalization experience was so strong and so unique. Studies exist for many countries, including European countries, relating openness to trade with productivity, but static differences between industries tend to dominate changes over time, given the relatively small changes in trade barriers. (See, for example, Del Gatto *et al*., 2007 and the studies surveyed by Greenaway and Kneller, 2007.) This is a literature that is expanding very quickly, but all studies to date have found without exception that exporting firms tend to be larger and more productive than non-exporters. More mixed and less conclusive is evidence relating to the learning by exporting, i.e. to productivity gains over time of exporters compared to non-exporters. In some countries, and some industries, it might be the case that productive firms 'self-select' into exporting. Because of exit of firms with low productivity, it is still possible for globalization to have macro effects on productivity even if it has no effects at the micro level. The effects would be larger and dynamic rather than static, of course, if the micro effects reinforced the macro effects. López (2005) makes the plausible argument that even if firms self-select into exporting, it might be "conscious self-selection" in the sense that firms improve their productivity with exporting in mind, prior to actually entering export markets. In this case, globalization would yield dynamic productivity gains via its direct effect on firms' productivity. Testing this hypothesis demands detailed case studies and is a high priority of the current research agenda.

3. The Case of Chile

In Chile, prior to its 1974 reform, import tariffs averaged more than 100%, with some imports fully exempted from duties and others subject to tariffs of more than 700%. In addition, there were outright import prohibitions, requirements of prior deposits of up to 10,000%, and a multiple exchange rate system with fifteen different rates. By June 1976 the average tariff was 33% and by August 1976 all quantitative restrictions had been eliminated. By June 1979 there was a uniform import tariff of 10%, with the exception of automobiles. In 1978 the exchange rate became the main anti-inflationary anchor, and in 1979 was fixed to the US dollar. A significant real appreciation of the currency developed because of the low speed of convergence of domestic to international inflation rates and because of capital inflows. The fixed exchange rate became increasingly unsustainable and a major balance of payments crisis erupted in 1982, leading to a sharp fall in GDP and increased unemployment. The government reluctantly devalued the peso several times, moving eventually to a crawling peg system. The uniform tariff was raised to 20% in March 1983 and 35% in September 1984. There were no quantitative restrictions on imports. This reversal of trade reform was itself reversed beginning in January 1985, when the tariff was reduced to 30%. The import tariff was reduced further to 20% in June 1985, 15% in mid-1988, and 11% in mid-1991. The common external tariff was then reduced by one percentage point a year beginning in January 1999, reaching 6% in 2003. (For details, see Edwards and Lederman, 1998.)

Three detailed studies have analyzed Chile's experience with trade reform. The results of each are summarized briefly here; Annex 9 contains a more complete description of the research and findings.

Tybout, de Melo and Corbo (1991) is an early study comparing data from the industrial census of 1967 (pre-reform) with data from the industrial census of 1979 (post-reform). Unexpectedly, they found no evidence of an improvement in *overall* industrial efficiency between the two census years. But the researchers did find that plants in industries subjected to the greatest reductions in protection became more productive *relative* to plants in other industries, which is evidence of a beneficial effect of globalization on productivity and growth.

Pavcnik (2002), in a much-cited study, analyzes plant-level data from annual industrial surveys from 1979 through 1986. She notes that plant exit was very important in Chile over the sample period, especially during the severe recession of 1982–1983. More than 35% of plants active in 1979 had ceased to produce by 1986. These exiting plants had employed 25% of the 1979 labor force and accounted for 13% of 1979 investment and 16% of the output. Pavcnik's most interesting finding is that two-thirds of the 19% increase in total factor productivity between 1979 and 1986 was due to a shift of resources from less to more efficient producers and only one-third due to increased productivity within plants. In other words, Schumpeterian "creative destruction" appears to have been twice as important as "learning by competing" (with imports or in world markets).

Bergoeing *et al*. (2006) also look at data on manufacturing plants drawn from annual industrial surveys, but they use a longer series—1980 through 2001—and work with less industrial aggregation than that used by Pavcnik. They pay particular attention to plant entry as well as exit and find that nearly all the 43% increase in total factor productivity between 1980 and 2001 was due to entry of new plants. Productivity in Chilean manufacturing accelerates around 1988. At this time within-plant efficiency gains become very important, accounting for well over half of the 80% productivity gain recorded in 1988-2001.

In sum, there is strong evidence from these three studies that Chilean manufacturing responded positively to the very rapid globalization of its economy. Productivity gains in the early years seem to have come largely from "creative destruction"—a reallocation of resources from less efficient to more efficient producers—but in later years there is evidence of globalization-induced productivity gains at the plant level as well.

4. The Case of Brazil

Until the end of the 1980s, Brazil had extremely high nominal tariffs that were in general redundant, that is, the difference in price between domestic and international prices was much less than suggested by the tariffs. Imports in practice were restricted not by tariffs but a list of prohibited imports (the "law of similars," which prohibited the import of goods already produced in Brazil). Most actual imports were exempt from tariffs under special regimes used by exporters or by importers of non-competitive capital and intermediate goods. In 1988 there was a cosmetic reduction in the degree of redundancy in nominal tariffs and a partial removal of non-tariff barriers, but these measures had no impact on trade. The real reform began in 1990 when the Collor de Melo government commenced tariff reductions that were completed in just three years (July 1993). Average nominal tariffs fell from 50% in 1989 to 14% in 1994, and Brazilian manufacturing firms were without doubt less protected than before.

The liberalization of imports resulted in an initial depreciation of the currency in real terms, but appreciation started in 1992, continuing with the Real Plan in mid-1994. As in Chile, the nominal exchange rate was used as an anchor to attack inflation and the currency became increasingly overvalued, supported by capital inflows. Protectionist lobbies in 1995 were successful in convincing President Cardoso to increase tariffs on automobiles, consumer electronics and appliances, and ten textile products. In February 1999 the Real was devalued and allowed to float, resulting in sizeable real depreciation of the currency and increased international competitiveness for Brazilian manufacturing industry.

A salient fact of Brazil's manufacturing sector is that labor productivity was stagnant in 1985–1990 and then suddenly began to grow at more than 7% per annum in 1991–1995. This has attracted considerable attention from researchers. We summarize the results of five such efforts below and in more detail in Annex 9. Two of the papers analyze industries rather than plants or firms; a third assembles a balanced panel of large manufacturing firms, aggregated to estimate firm-level total factor productivity from a single production function; two recent papers assemble unbalanced panels and are very similar to the studies of Chile by Pavcnik (2002) and Bergoeing *et al*. (2006), except that the data refer to firms rather than plants.

Moreira and Correa (1998), updated by Moreira (2002), examine the impact of trade liberalization on manufacturing industries rather than individual firms. A key finding is that the economy responded with intra-industry trade and specialization: there was a generalized increase in import penetration *and* export ratios in all industries over the period 1989-1998. Rather surprisingly, given dismantling of tariff protection, a shift/share analysis reveals that output gains and losses over the period owed more to changes in domestic demand than to the impact of trade liberalization.

Ferreira and Rossi (2003) estimate total factor productivity in each broadly-defined manufacturing industry, then regress productivity growth on nominal and effective tariff protection. The estimated coefficients are significantly negative, consistent with the hypothesis that trade reform increased efficiency in Brazilian manufacturing.

Hay (2001) examines the productivity of firms rather then industries, assembling data for a balanced panel of 318 large manufacturing firms operating in the period 1986–1994. He estimates each firm's total factor productivity, which he regresses on import protection, the real exchange rate, year dummies, and a full set of firm dummies. Coefficients on the protection variables are significant with the expected negative sign, but the impact is reduced very much when year dummies are included in the regression. Hay concludes nonetheless that "the greater part of the [productivity] gains should be attributed to trade liberalisation."

Schor (2004) analyzes a much larger panel of 4,484 manufacturing firms in the period 1986-1998. She finds a surprising amount of heterogeneity among manufacturing enterprises, and productivity fluctuates a great deal from year to year in most industries. Nonetheless, comparing 1998 with 1990, 20 of 27 industries register an increase in productivity, which is consistent with the hypothesis that globalization has increased the efficiency of Brazilian manufacturing.

To test more directly the effect of trade liberalization, Schor regresses total factor productivity of a firm on the nominal tariff on industry output and the average tariff on industry inputs, using year dummies to control for changes in macroeconomic policy and adding a dummy variable to control for the fixed effects of each of the 4,480 firms in the panel. The coefficient on nominal tariffs is significantly positive and that on input tariffs is significantly negative. This suggests that increased import competition and better access to imported inputs both contribute to enhance productivity following globalization of the economy.

Muendler (2004), examines an even larger panel of approximately 9,500 medium and large manufacturing firms operating in the 1986–1998 period. He regresses firm-level productivity on a wide variety of variables in order to assess the relative importance of three separate channels by which trade liberalization might increase productivity, which he calls 1) *competitive push*, 2) *foreign input push,* and 3) *competitive elimination*. The first channel refers to within-firm productivity gains, the second to imported capital and intermediate goods and the third to exit of inefficient firms. He finds the first channel—competitive push—to be by far the most important.

To determine the importance of the competitive channel, Muendler regresses firm-level productivity on nominal tariffs and import penetration, controlling for firm-level variables such as imported inputs and relative firm size. Interestingly, he finds that "firms that start to use more foreign inputs suffer a slowdown in productivity in the subsequent year" because "they face implementation costs, may need to retrain workers and carry out adjustments to the production process" (p. 20). Reduced tariffs and import penetration both induce firms to improve efficiency. This is the "competitive push".

Regarding the foreign input channel, Muendler finds no evidence that technology embodied in imported equipment or imported intermediate goods are sources of immediate productivity change. Possibly for this reason, 80.4% of all manufacturing firms surveyed in 1986–1995 used no imported equipment and 56.9% in 1996–1998 used no imported intermediate inputs. The competitive elimination channel, though significant, is only a small, source of productivity gains.

In sum, Brazilian industry has recorded large gains in productivity from globalization. In contrast to Chile, these gains so far appear to have come more from increased productivity within each firm than from Schumpeterian creative destruction.

VIII (ii). Conclusions and Recommendations on How to Maintain Economic Viability and Improve Competitiveness of Forestry in the EU

1. Introduction and Objective

The globalization process, having been severely interrupted through world wars and the depression in the early 20th century, again accelerated in the second half of the 20th century and has developed significantly over the past 20 years. Globalization particularly accelerated after 1989. In a globalizing economy multinational enterprises (MNEs) are perceived to be a key vector through which globalization has evolved and continues to evolve. Forestry is mainly affected indirectly, through the "globalizing" or at least increasing internationalization of the forest-based industry. This trend affects forestry profoundly as it directly affects the economic viability and competitiveness of the European model of sustainable forest management (SFM) and of "multi-functional forestry," including the secured provision of many other services that forests provide (often outside markets and without market-based income streams). This part will generalize the findings of individual tasks and provide conclusions regarding the study.

2. Method/Overall Approach

Globalization, as used here, focuses on the economic dimension and is defined as the integration of economic activities, primarily via markets. Economic globalization has, in turn, cultural, social, and political consequences, which are not the focus of this review. The objective of the review is to identify the main trends and factors of globalization affecting forestry in the EU. The term "forest sector" is understood to comprise the "forestry" and the "forest-based industries" sectors.

The study covers globalization mainly through the four main "globalization factors" and their related indicators: a) foreign direct investment, b) economic activity, including employment, c) trade, and d) technology/know-how. Three other dimensions of the PESTE framework (i.e. policy, social including demography, as well as environmental and resource aspects) which are less comprehensively covered, are also discussed as "globalization dimensions." This part is a synthesis report, summarizing results of chapters and addressing the aspects listed in the call text.

3. Globalization Factors and Trends Affecting EU forestry

EU forestry, mainly because of its interconnectedness with the forest industry, is affected by all four main globalization factors reviewed in this study: foreign direct investment, economic activity (value-added production, productivity, employment), trade and technology/know-how. Many of these factors influence EU forestry indirectly, yet potentially profoundly. EU forestry is also influenced by the effects of globalization on political and institutional frameworks, societal developments, including growth in wealth elsewhere, which directs attention to and investment in emerging markets, global environmental phenomena (particularly climate change) and global resource sourcing.

The globalization of financial markets has triggered sharp growth in international investment. By the year 2000, FDI had grown to $1.271 billion—nearly 20 times the level two decades earlier. By far the largest part is net private capital flow, which is concentrated in a few countries, including China. Forest sector FDI is estimated to be around US$8–10 billion a year and is concentrated in the pulp and paper segment and in countries with a low wooden raw-material cost and high export market potential, like, for instance, Brazil, China, Russia, and some Eastern European countries. Investments are also made in panel industries, mostly for MDF and OSB production and other wood industries, particularly wooden furniture production. Of the total forest sector investments, around 30% is estimated to go into forestry, where direct (domestic and foreign) investment is concentrated mainly in developed countries and on forest plantations. For a number of reasons, in the USA and some Nordic countries in Europe, the forest industry has been divesting itself of its ownership of forestlands over the last decade. These two developments (divestment of industry from forests, investment in (mainly non-European) plantations) are the only significant direct evidence of forestry investment changes that can be linked to globalization factors. **Developments in forest investment imply that forests are becoming less attractive as an asset for active exploitation and more attractive as a securitization asset. New and possibly more efficient business models are becoming thinkable for the financial management of forest assets, given the vastly expanded global financial infrastructures and range of sophisticated services.**

In the forest sector total GVA globally has not changed much during the last decade, half being accounted for by the pulp and paper industry, around 30% by the solid wood processing industry, and forestry activities around 20%. GVA also seems to have remained rather stable in Europe. While growth rates in production have soared in some countries, such as China, this is partly an effect of low (base) levels of absolute production. Import competition and global (export) competitiveness have put high pressure on European companies to increase productivity. These are on average 3%/worker/year in the wood industries and forestry (FAO 2004), that is, below the global industry average. Industry relocation due to import competition in the forest sector concerns several sectors, including furniture, pulp and paper, and panels. Overall, economic studies imply that EU forestry will face a range of issues, including production costs, decreasing attractiveness of forestry, the financing of "multifunctional" forestry where demand for services grows (while the main source of revenues to finance the model is (still) industrial wood raw material only). However, import competition has, to date, been considerably less threatening to EU forestry or forest industry segments than, for instance, textiles, leather, or some steel industries. Because of the seemingly comparatively low level of direct threat, few concrete and substantive actions have been taken to date against potential threats of globalization to forestry by exploring and developing alternative business models or by the forest industry seeking ways of stemming imports through, for example, the World Trade Organization (WTO) (several cases are pending involving China). Rapid technological progress and trade in goods have placed downward pressure on labor markets, particularly unskilled labor markets, that is expected to become more acute in the next 25 years. In the European forest sector employment has been declining substantially over the last decades to about 3.9 million full-time equivalents. In the future, reductions in employment levels are expected to be largest in Central and Eastern Europe. **The economic paradigm of financing all functions of "multifunctional" forests through wood (a raw material commodity) is coming under pressure in a globally competitive commodity market (and with the increasing utility of forest services to society). Productivity and cost pressures due to global competition also imply decreasing employment.**

The tremendous growth in international trade over the past several decades has been both a primary cause and an effect of globalization. The real value of forest products exports rose by nearly 50% over the last decade to reach a level of $US144 billion in 2000, increasing at a rate much faster than the increase in production. Five countries—the United States, Germany, Japan, the United Kingdom, and Italy—imported more than 50% of world imports of forest products in 2000, while Canada, the United States, Sweden, Finland, and Germany accounted for more than half of exports. Only six years later, China leads the world in both roundwood imports and furniture exports. Russia has recently established export taxes on roundwood to force the industry to make investments in Russia and secure value-added production within the country. Given the large volume of raw material imported from Russia, in particular by Nordic/Baltic producers, there are substantial direct effects on raw material supply. **Open trade in commodities has benefited industrialized countries hugely in the past. These benefits from "simple" commodities are now slowly and increasingly being accrued by developing countries.**

Information and communication technologies have been one of the most decisive factors in accelerating the process of globalization. ICT implementation in the forest industry and wood production sector has been gradual and slow rather than ground-breaking, with similar slow effects on productivity gains. The structural changes in communication paper markets due to ICT will probably be substantial both in terms of volumes and prices. Speeding up the transition of the sector from being largely resource driven to being market and knowledge driven is integral to success, as is the amount of private sector funding for R&D. Some major technological innovations have started to become more widespread, for example, engineered wood products and bio-fuel technologies. R&D in the forest-based industry is slowly responding to globalization, with knowledge centers creating larger units by merging to stay competitive and reach critical mass in a global world. Technology and ICT have also reshaped forestry, particularly through improved harvesting technology and logistics. This is expected to continue. Demand for raw material from fast-rotation forestry for bio-fuels using cellulose-based production techniques, could dramatically change European forestry in some regions. **In the EU forest and biotechnology sectors, the technological and knowledge capacity exists to compete at the leading edge of technological innovation, but awareness of the need to boost private R&D and research infrastructure in order to do so is only slowly emerging.**

States are also strongly affected by globalization in their efforts to coordinate the development and management of policies, both nationally and internationally. In an increasingly interdependent world, many issues are emerging that transcend the boundaries of national sovereignty and require international coordination, for example, on effective rules and collaboration in phytosanitary regulations to contain potentially severe human impacts (avian flu) or environmental impacts (e.g., beetle epidemics, invasive forest species), on the regulation of environmental threats (e.g., climate change), trade in services, and intellectual property rights protection. The last decades have seen a rise in international governance institutions, for example, UN bodies, international non-governmental organizations, and technical standardization bodies (multi-level governance). Another key trend is the emergence of new actors, particularly environmental NGOs that enjoy high levels of legitimacy in society. Policies that follow the high expectations of society on environmental quality and recognize and act upon the realities of resource scarcity, will continue to push the sector toward sustainable production and better utilization of renewable and non-renewable resources, including through recycling and reuse. **International (forest and other) policies**

have been the source of major policy impulses, and this is likely to remain so. What will likely receive increased attention are the local and regional levels, as adaptation to globalization is strongly local or regional asset-dependent. This "local contextualization" requires both better vertical cooperation among levels of government and, in particular, adaptive governance across sectors.

Societal shifts in Europe can be characterised by three trends: aging societies, shrinking societies (after a peak expected in 2025) and workforces (expected from 2007 on), and further urbanization of lifestyles (if not in physical relocation). In terms of demographic trends, the EU as a whole displays a combination of high and growing life expectancy and an extremely low fertility rate. Old-age dependency ratios will rise substantially (overall from 39% in 2005 to 80% in 2050), which means more elderly people with less disposable income per head. These demographic trends are forecast to continue. Other changes are also taking place in EU society which are having an impact, including changes in women's employment, family sizes, definition of gender roles, minority ethnic communities, increasing home ownership, increasing gap between rich and poor, changing patterns of employment and retirement; longer working lives and change in pension provision, and the growth of private markets both in care services and leisure provision. Urban centres have higher percentages of young people, generate more jobs, have better functioning labor markets (less unemployment), and are more affluent than non-urban areas. They are usually characterized by a strong focus on the service economy and corresponding lifestyles. Given the higher rate of job creation in cities and the supply of labour being one of the crucial factors in migration, the population of cities in the EU is growing faster than in countries as a whole. All these factors will have an impact on future needs and expectations. Demographic and lifestyle changes are also changing forest-related investment and consumption patterns, for example, in property, products, and services. They are also leading to shifts in the value and perceived benefits of forests, with non-tangible benefits, such as "natural landscapes" and biodiversity, becoming more important, particularly in affluent societies, than wood production. **EU society as a whole is increasingly deriving higher utility from forest services and increasingly less from materials. Paradigms or concepts to adapt to changing needs and to maximize total economic value from forests to society through market frameworks are almost completely missing, and their emergence is often suppressed rather than promoted.**

Linked to globalization is the development of primary energy consumption which, in turn, influences the future climate. Increased globalization and economic growth are strongly increasing the demand for primary energy, and this is especially being driven by the development of emerging economies like China, India, and Brazil. The latest IEA energy outlook study suggests that global energy demand will increase by over 50% during the next 25 years and that dependence on fossil fuels will be around 80%. Within the same time frame respected scientists suggest that availability of conventional fossil fuels will reach its peak. This means a tight demand/supply situation with high energy prices and concerns about future energy security. This development suggests structural changes in existing energy-intensive forest industries at the global level and in the EU. Policies to increase the share of bio-energy are now being adopted at a rapid pace. However, the overall contribution to energy consumption by forests will remain low. Industries whose business models are built on renewable materials and that are working toward being self-sufficient in energy use are in an enviable position. However, given energy scarcity, raw material prices are destined to rise. **Increasing competition for raw material and energy use requires industry strategies to be reoriented from high volume–high energy to low volume–low energy production concepts and increased wood mobilization.**

Increased energy consumption will strongly contribute to increased emissions of greenhouse gases and thereby to an increased risk of triggering serious climate change. There is a need to stabilize the concentration of GHGs in the atmosphere. This means, in a business-as-usual scenario, a reduction in emissions by 2050 of 80–85%, a goal that it will take dramatic measures to reach. There will be increased demand for wood raw material in the EU and sharp competition for the use of this material for conventional forest products and energy, with possibly substantially higher prices as a result. Developments in this direction will drive substantial structural changes in the conventional forest industry, with emerging alternatives for poly-production. With climate change there are increasing risks, too, for forest production. While larger-scale damage by insects, other pests, and fire damage has not happened to date, the risk of such damage is clearly increasing.

4. State of and Trends in EU Forestry and Its Regions

According to the latest available international data on forest ownership (FAO 2006) in the EU27, around 60% of forests are in private ownership and around 40% publicly owned. These shares are very diverse among the EU 27 countries. Around a total of 8.7 million forest holdings exist in the EU27 (except Romania), practically all of which are private. There are around 70,000 public forest holdings in the EU27. The large majority of forest owners are non-industrial private forest owners. Only in a few countries does private industry hold a more substantial share of forest land, most importantly in Scandinavian countries (e.g., 9% of forests are industry-owned in Finland). The average size of public holdings in the EU27 is about 975 ha, while the average size of private holdings is 12.7 ha[11], with a median size that is considerably below that number. In the near future, an increase in the number of private holdings is expected in several Eastern European countries because of the continuing restitution or privatization process. **Fragmentation of forest ownership, more specifically small management units, without economies of scale and scope is a major obstacle to economically viable and competitive forestry in the EU. A range of incentives and measures can be applied to stop or reverse the fragmentation of forest management units, including legal and economic incentives.**

Forest cover has expanded steadily over the last half century, and with it growing stock and net annual increment. Gross forest area keeps expanding, because of land-use changes. The EFISCEN project predicts that even if fellings remain at the current level, Europe's average growing stock will rise from 137 m^3/ha in 1990 to 226 m^3/ha in 2050. According to the latest available data (MCPFE 2003) the total increment in the EU27 is 756 million m^3, compared to total (reported) fellings of 430 million m^3. Several regions have reported raw material shortages, including the Northern Atlantic Rim region and Nordic–Baltic countries. Particularly in the latter region, the Russian export duty imposed on roundwood will lead to further structural adjustments of industries. Low levels of utilization of increment in most countries could be a consequence of low or lack of profitability due to low mechanization rates and high labor costs, management objectives like biodiversity conservation or recreation areas, and ownership structures (i.e., in general, small private holdings are not intensively managed and do not profit from economies of scale). **Mobilization of forest resources is a pressing issue for the forest industry. However, it is likely that results will remain below expected levels because of structural and individual obstacles (as well as the economic**

[11] Note that the data on ownership is for "forests and other wooded land" not for forests alone (as in the rest of the report).

and technical obstacles), and that they will materialize only slowly, as impeding factors decrease over time.

Forests provide a wide range of goods and services. Commercially, however, by far the most important product from forests in the majority of EU member states is wood, mainly roundwood, and to a minor but growing extent, wood fuel. The estimated value of industrial roundwood removal in 2005 is available for 18 of the 27 EU countries and amounts to a total of US$11.1 billion or around €8.4 billion at current exchange rates. Rough estimates of the direct supply of wood energy are about 250 million m^3/year. Wood energy supply and use is much larger than wood supply direct from forests. In fact, wood energy from wood processing residues (black liquor in pulp and paper production) is a major component of wood energy supply in many countries. With ambitious goals for bio-energy adopted both at EU level and in member states, demand for wood energy would increase sharply if these policies were implemented as announced. This in turn would put considerable strain on some forest industries that currently rely on cheap raw material input. This has led to debates about the appropriate degree of involvement of governments in markets (which is traditionally strong in all types of energy).

Forests provide a variety of products other than wood. Non-wood forest products are, for example, Christmas trees, game, mushrooms, cork, berries, nuts and other products, such as medicinal plants. Non-wood goods and services are niche markets in terms of income for the EU27 region overall. The total value of non-wood forest products removal in 14 EU countries for which data is available is US$1.48 billion in 2004 according to the FAO, or roughly around 10% of the value of industrial round wood removal. However, non-wood goods often have high economic importance for forestry in particular countries, for example, cork in Portugal. Forests play a very important role as providers of other services to society, like recreation, attractive landscapes, CO_2 sequestration, erosion prevention, hydrological regulation, biodiversity preservation, recreation and tourism etc., which are often not marketed and are usually unaccounted for. Data show that, in some countries, services contribute to the total production value by the same order of magnitude of those of non-wood forest products. **Taken together, non-wood goods and services account for a substantial share of production value (although this is highly variable across regions). Nonetheless, they suffer from Cinderella syndrome in that they are not recognized appropriately, either economically or politically.**

Roundwood imports have strongly increased over the period 1990–2003, from around 32 million m^3 to 56 million m^3 in 2003, with particularly steep increases in countries with major export-oriented forest industries, such as Finland (importing around 13 million m^3 in 2003), Sweden (close to 10 million m^3), and Austria (8 million m^3). Roundwood exports from the EU27 have grown by some 50% in the period 1993–2003, with about 5.7% annual growth on average, reaching 32 million m^3 in 2003. Wood fuel imports, where data quality is less consistent and of poorer quality, grew by some 7.6% annually between 1993 and 2003 in the EU27, with particularly strong growth since 1999, reaching some 2.5 million m^3. Wood fuel exports have grown even more strongly than wood fuel import, according to UNECE/FAO data, with annual growth of close to 10% between 1993 and 2003 in the EU27, reaching around 3.1 million m^3 in 2003. With wood fuel becoming a more important and increasingly standardized commodity, trade in wood fuel is likely to grow even considerably more in the next decade.

There are large regional differences in EU forestry. Regional trends in EU27 ownership and management changes that are quite typical in terms of general developments are:

- Privatization in the countries in transition;
- Changes in state forest organization
- Changes in the demographic and lifestyle changes of forest owners (urbanization, extensions of use, decreasing shares of income, and decreased management time invested in forests);
- Establishment of plantations in Atlantic Rim countries;
- Piloting of new short-rotation forestry for bioenergy production;
- Change in management paradigms toward service- and consumption-oriented forestry in and around densely populated areas; and, in Mediterranean countries,
- Natural expansion of subsequently unmanaged (private) forests on abandoned farmland.

Significant regional differences in forests and forestry in the EU imply that there is no uniform pattern or solution; on the contrary, diversified responses according to factor endowment, asset conditions, and demand allow a more optimal (endogenous) adaptation to changing circumstances that are driven by globalization. This would, inter alia, allow for the promotion of better linkages of forestry to vertical value-added chains and further development, where a basis for doing so already exists.

5. Effects of Globalization on EU Forestry and Its Regions

Quantitative analysis reveals that the global wood supply situation will become tight in the future because of, among other things, current over-harvesting in a number of regions, increased environmental concerns, and climate change effects (such as insect outbreaks in Canada). However, the European forest sector is projected under a number of scenarios to stay a competitive region in a globalized world. The analysis also points to globalization leading to increased product prices because of rapidly increasing global demand, which may help boost current sluggish European forest sector profits. Thus, the expected cost reduction effect on the supply side due to globalization and economic integration is outweighed by the demand effect. The competitiveness of the European forest sector is robust across a large variety of different market development scenarios. However, in a globalized world scenario, Europe is not assessed as a global growth powerhouse, as Latin America and Russia are.

Only a fraction—some 60%—of the annual forest-sector growth in the EU is in the wood products market. Thus, if necessary, there is ample biological potential for making the EU less dependent on raw material supply, given the current forest resource endowment. However, the economic welfare losses of a self-sufficiency policy are potentially very large because of sharply increasing raw material costs, as the harvest would come closer to the biological potential. On the other hand there is still a large potential to increase the productivity of the existing European forests through improved silvicultural management. Moreover, there are large land resources in Europe that, through improved rural development policies, if carefully designed, could be used to increase wood supply and improve rural economies and bolster the security of supply of raw materials to the forest, biorefinery, and energy sectors.

The analysis showed that the development of the global overall energy sector, in particular, global bioenergy development, will be crucial for the development of the conventional forest industry in Europe. European land and rural development policies and climate and energy policy targets are likely to be conducive to the implementation of a substantial bioenergy sector in Europe. For the conventional forest sector this development can be both a threat as well as an opportunity. From our geographically explicit forest sector bio-energy sector modeling it can be concluded that economies of scale will turn out to be the major factor in determining competitiveness between the conventional forest sector and the bioenergy sector. The conventional forest sector has strong experience of managing large amounts of wood raw material and could thus be an important partner of the energy sector. In terms of climate policy, the forest sector has the option to play on multiple markets: sequester carbon in the forest and contribute to substitution of fossil fuel and of energy-intensive materials by wood products which could also function as temporary carbon stores. This flexibility of choosing between multiple output pathways must be recognized as a strategic opportunity for the forest sector.

Relocation of industries to emerging economies, including China, Brazil, India, or South Africa is an issue which involves a number of factors. These include: costing and security of raw material supply, transportation costs, technology and risk of losing large sink costs because of market and political uncertainties. One of the main conclusions with respect to the relocation issue is that the fate and direction of the competitiveness of the EU-based forest sector in a globalized world is determined mostly outside Europe rather than by EU internal factors. Taking on a pure engineering costing approach, raw material supply will certainly remain more competitive in regions like South America and Africa; however, these regions will also remain the most uncertain with respect to market and policy uncertainties. This means that the EU must, in the future, carefully follow the development of the global forest sector in order to set the right policies and incentives for the EU-based forest sector and its associated industries. The highest relative leverage to maintain and increase the competitiveness of the EU forest sector can be expected from innovation and technological development. The questions to be asked are:

- Up to what level can the EU become self-sufficient in raw material supply and how (given that only slightly over 60% of the annual forest growth is harvested)?
- What is necessary to make the forest-based industry carbon-neutral?
- What role can forestry play in terms of local or regional energy security/self-sufficiency?
- How can large-scale relocation of industries to emerging economies, including China, Brazil, India or South Africa be reduced or stopped? (In other words, can investment levels in the forest sector in the EU be maintained and enhanced?)
- How can employment levels and income vis-à-vis global markets be maintained or increased? (In other words, which segments of the markets will need which competitiveness strategies, depending on their exposure to global markets (products and services)?
- How and where would hypothetical EU biodiversity objectives impact on economic viability and competitiveness, and how can this be either mitigated or reversed so that it becomes an economic income generating business model/activity?
- How and where will regional climate patterns change? How will this affect economic viability and competitiveness regionally, and what countermeasures can be devised?

6. Strategic Options and Innovative Approaches in EU Forestry to Adapt to Globalization

Frame conditions in forestry are in many respects not supportive of innovations. To some extent this is due to a high fragmentation of the sector (low average size of management units), low and decreasing levels of contribution to incomes from forestry for owners, decreasing attention, time, and resources invested in forestry, and diversification of management objectives (including using forestry as a non-productive "asset" and "for private use"). Even where technical and infrastructure conditions would allow commercial exploitation of forests in principle and where forest owners would "permit" other professional management activities in their forests, such conditions in practice often fail because of the high costs involved in organizing exploitation in fragmented management units. This is despite the fact that demand for raw material is often high and prices increasing. **Raw material shortages and international competitiveness, both of which demand low- cost raw material, call for new business models and initiatives to allow economies of scale (larger forest management units), higher labor productivity (mechanization), and lower transport costs (road infrastructure investments, improved logistics). New business models comprise contractual management of small areas through large (including state) enterprises, industry, or separate companies.**

The legal and policy frameworks for forestry in the EU member states have in general focused on the development and implementation of a broad vision of SFM (see MCPFE), not on encouraging innovation and market-based adaptation. Unclear legal or policy situations create "gray areas" that impede innovation by forest owners and managers in areas that are particularly appropriate for innovation in recreational and environmental services. In the new EU member states the collapse of the former centrally planned economies and the restitution of private forest properties necessitate profound changes in administration. The resulting de facto radical "institutional innovations" often seem not to be perceived as innovations by the forest administration, as they were decided and enforced largely beyond their reach. The institutional and organizational structures of non-governmental bodies, in particular, forest-owner associations, have an important role, but are currently ill-equipped to promote innovation. Research and education and training institutions, despite their central role in innovation and knowledge development and management, seem to have had a comparatively weak record in developing and promoting more radical types of innovations in forestry. **Forest policy often hides behind the all-embracing concept of "SFM" without addressing the issue of increasingly conflicting objectives between society, which demands nature and services, and industry, which demands ever more standardized and cheap raw material. This can possibly best be solved by local and regional adaptation to local needs and conditions, rather than through national or international blueprint solutions. However, this requires a reorientation of policies from national "top-down" to flexible "bottom-up" models.**

The ongoing dynamic and accelerated changing context of forestry in the EU is widely recognized in the sector itself. Drivers of these changes are more than just the include, in particular, climate change threats, energy security issues, and societal changes. The responses of forest owners and forest company range from "wait and see" (by far the largest majority of owners in the EU) to, mainly, cost cutting and other ways of increasing productivity. Innovations in forestry mainly result from innovation push for more and cheaper wood raw material by the forest industry. Other sources of innovation are environmental standards, bio-energy demand, and, to a limited extent, societal pressure to provide services. Moreover, innovative forest owners and managers seem to be more concerned with market-related impediments than legal impediments. **Ongoing and very different changes in different local and regional contexts in forestry across the EU would require not only regional adaptation of measures but also a shifting emphasis toward more market-based incentives and instruments.**

The most visible innovations in forestry in the EU include, in particular, technological innovations such as logistics, harvesting techniques, road building, and related organizational innovations, as well as producer cooperatives and associations for more efficient production and a more-level playing field on the sales market. An increasing number of innovations concern both the organization of energy services and experimentation with diversifying into recreational services.

Policymakers and forest associations are still seeming to work toward a better understanding of the different drivers of forestry and the overall strategic relevance of an open and "innovation"-oriented governance approach for a low-tech sector such as forestry. Policymakers and forest associations risk giving in to responses that aim to defend traditional structures, which would leave forestry "locked-in" to outdated structures and "locked-out" from an increasingly interconnected competitive environment. It would also delay measures for a broader and more effective collaboration and coordination across sectoral borders. Well-designed innovation strategies and related support measures are missing in practically all EU member states, except Finland. Innovation policy approaches (or attempts in that direction) are typically characterized by traditional productivist resource- or supply-driven, technology-oriented innovation "push" measures for specific pre-identified targeted areas. Investment support measures, as one area of innovation and risk reduction support to firms, focus mainly on the traditional supply-side, technology-oriented model, supporting productivity-enhancing measures. **Consumer and market demand-driven, bottom-up emerging and people-centered innovation pull measures are a new and unexplored, yet key strategic orientation of innovation policies and measures in EU forestry.**

Opportunities for forestry arise from almost all main globalization factors. Opportunities for investments arise because of increasing demand for raw material for commodity products (standardized raw material production in plantations), wood for bio-energy (short-rotation forestry), biotechnology after breakthrough commercialization (raw material production, specialized materials and chemicals) recreation facilities around urban population centers or land property investment as part of financial risk management. At the same time there is a perceived or real threat that increasing outward FDI will mean decreasing domestic investment by forest owners and industry (probably in production capacity and products that would potentially anyway not be able to withstand competition pressure in the years or decades to come), as well as decreasing returns on investment attractiveness in forestry.

Opportunities also arise for deeper changes in economic activity by producing value added from forests through new business models for forest-related services (protection, recreation), value-added chain cooperation and forward integration of value added production throughout the chain. While there are possibly more threats to forestry employment given the dominant production paradigms (cost-competition in mass products), limited employment opportunities arise from new territorially bound services, particularly recreation, wood for bio-energy (highly standardized, comparatively low labour intensity). There are also clear threats or weaknesses: high fragmentation and resulting inexistent economies of scale result in low productivity while cost-competitiveness pressure on commodity materials is increasing, and increasingly also into value added production. There is also decreasing economic attractiveness of forestry relative to other economic sectors, decreasing employment in forestry sector and related effects on rural areas, including drain of human capital from rural areas as well as increasing competition on raw material markets from imports (including, e.g., wood pellets).

Globally competitive capacity exists at the technological leading edge in bio-technology research infrastructure and know-how in the EU (largely outside forestry and partly outside the forest sector). Given the high risks, R&D financing, and the skills and capacities needed, particularly in connecting to advanced research in bio-chemistry, physics, technology, and engineering sciences, there is the evident threat that forest industry is too weak to compete in these key fields of innovation competition. This would result in a shift in technology leadership in forest-based bio-product exploitation from forest products industries to other sectors, and a falling-behind of the industry in terms of competitiveness on the technological leading edge. While there are signs that industry has started to act on the opportunities and threats, it is not clear whether it is willing or able to organize and finance more radical and risky research and development that must necessarily go beyond short-time return-on-investment thinking horizons.

Many of the opportunities that are emerging from globalization fit, support, or are safeguarded by a policy framework (EU integration, SFM, sustainability-oriented general EU policy framework). However, there are also clear threats, including the desire of policymakers to foster "dirigistic–managerial" approaches in policies in general and, as the owners of forests, to promote incompatible regulatory regimes for different sectors (forestry, energy, climate, protection) and to succumb to short-term-oriented requests by industry to "bail" sectors out of difficult situations (e.g., by continuing to fund an overwhelmingly large part of R&D mainly through tax-payers' money).

Some potential substantive opportunities are arising from ongoing societal developments (recreation needs for urban and aging societies). However, further urbanization of lifestyles in the EU, and people's increasing mobility, without adjustments being made in financing models would be a threat, as societies are, by and large, used to demanding recreation and protection services for free. Opportunities are also arising from demand for renewable resources and resource scarcity driven by high demand for raw material, which is leading to higher prices and therefore more forestry income. At the same time the increasing scarcity of energy, as well as competition over biomass raw material, implies low levels of value added and cost. Threats, rather than direct opportunities are arising from the increasingly visible and relevant effects of climate change, including increasing risk and frequency of damage (fire, storm, drought,) and related effects (prices, quantity, resource scarcity).

The threats and opportunities of globalization are often different if viewed from the forestry rather than the forest industry perspective. In general, some globalization factors and dimensions provide opportunities both for an economically viable forestry and for the forest industry, including the fact that wood is a renewable material, which society recognizes as a very positive feature. Some opportunities are emerging for the forest industries that are, or can be seen as, threats for forestry (e.g., the globalization of natural resource sourcing) and, vice versa, (e.g., increasing raw material scarcity leading to higher prices, wood-based bio-energy, alternative non-production-oriented business models).

If forestry aims to be an economically viable sector of the economy, it must respond to globalization and its opportunities and threats in ways that are adequate for: 1) the respective local and regional context in terms of assets and asset potential; and 2) the current and likely future market demand for products and services from forests. There are four overall strategic options for forestry, three of which regard forests as an economic asset that is actively managed for income or profit:

Option 1. “Cease commercial operation” = cease active income- or profit-oriented forestry
Option 2. “Get out of the way” = diversify into alternative and niche income streams
Option 3. “Compete with the masses” = cost-competitiveness in global commodity market
Option 4. “Develop next-generation products” = technological & business model innovation

In practice, of course, individual businesses have pursued one or a mix of any two or all of the three strategic options for some or all assets, and are developing these further, either continuously or periodically, as the need or opportunities arise.

Different scenarios as specified in the scenario runs tend to shift the emphasis of options. Most main scenarios of future developments favor some options, while negatively influencing others. For instance, it is likely that more strict environmental policies and larger areas being put under partial or full biodiversity-protection-oriented management would increase the cost of management (assuming the additional costs are not covered by governmental support) and act as a impediment to cost-focused commodity-oriented production options. However, in practice, this causal relation seems not to be as grave as sometimes argued, as biodiversity-protection measures tend to be implemented in areas that are commercially less attractive. At least over the last decade, it seems, biodiversity measures have been considerably enhanced in forests in general, while many sectors of the European forest industry have been very successful on the global market. The previous chapter describes in more detail which regions are more or less likely to succeed in strategic options to respond and adapt to globalization and to the implications of the different scenarios.

The effects of strategic adaptation options on globalization factors and dimensions are difficult to foresee (not surprisingly), and they are different for different regions, the different strategic options pursued, and the scenario assumed. They are also different for each of the dimensions of globalization. For example, the option to cease traditional commercial forest management altogether is more likely in Mediterranean countries under scenarios of higher environmental restrictions: this would imply falling investment but possibly new opportunities for recreational and health services for a society in the region that is forecast (in some sub-regions) to be considerably more old-age dependent in the future compared with today. This is again discussed in more depth in Task 4.

The effects of different strategic adaptation options are different for SFM as a whole as well as for the individual dimensions (criteria and indicators). None of the main strategic options would be likely to be beneficial in all dimensions, and short-term effects are possibly different from longer-term ones. For instance, overall, ceasing commercial operation might be considered to favor biodiversity and naturalness in general, but in the longer term, this might create considerable forest health issues. In general, the (most risky and long-term) option for investing in technological innovation is the most neutral to SFM, as it changes little in current forest practices; cost-competitive mass production, however, would require a continuous push for cost-cutting mass production which rather runs counter to the perceived or real utility that societies in Europe increasingly associate with forests: recreation and nature. Societal perceptions can change, and sometimes quickly, but there would be a clear danger of conflicts over a mass-production paradigm in some regions.

Strategic adaptation options are taken by individual forest owners and managers. Whether they abandon forest management, find niches, compete on cost in commodity markets, or develop advanced products and business models, will be decisive for the character of EU land use and forest management. The millions of forest owners and managers, working with very different assets and in very different business conditions across the EU, pursue and explore a large variety of strategic adaptation options, often within small regions at the same time. Their behavior can only partly be influenced by policymakers or stakeholders. However, in the aggregate, the most frequently chosen options will make a big difference to forest industry and society as a whole.

7. Supporting Strategic Adaptation through Forest Policies

Globalization promises benefits, but its long-term benefits come with what can be substantial short-run costs. With increased competition, producers will face challenges to reduce costs if they are to remain viable. Governments can help this process by working for an open international trading system. It is extremely disruptive and costly for importers of roundwood, for example, to face sudden prohibitions in a supplying country that seeks to protect upstream manufacturers of wood products. Governments can also help with retraining and relocation of workers who are displaced from declining industries or from industries that, though not declining, are shedding labor because of technical change.

It is also possible for a government to protect its industries with subsidies, tariffs and import quotas, or prohibitions. It would even be possible for the EU to achieve self-sufficiency in this manner. Producers would not be challenged by competition, so would not have to reduce costs by increasing productivity. But the costs of such a policy would be very high indeed. By foregoing the short-run costs of adapting to globalization, the EU would also be forfeiting the long-run gains of specialization and technological change. Inevitably, trading partners would retaliate with their own subsidies and trade restrictions, increasing the costs of such a policy even more.

To sum up, it is the producers themselves who must search for effective and efficient ways to compete in a global market. Governments can aid this process by promoting open and orderly markets, at home and abroad, and by facilitating the retraining and relocation of workers who are displaced by technological change or by the creative destruction of competitive imports. We now know that gains from trade go beyond the static gains of specialization; they are dynamic as well because globalization demands technological change and high productivity from firms that enter export markets *and* from firms that hope to survive import competition.

VIIII. Summary

Most of us consider globalization to be a purely contemporary phenomenon. In a recent book, Chanda (2007) concludes that globalization is probably as old as humanity itself and just as complex and unpredictable. He states it "has worked silently for millennia without being given a name" and it moves through "a multitude of threads connecting us to far away places from an ancient time." Thus, globalization is a gradual historical process, Chanda claims, connected to the past.

The processes of globalization are continuously evolving and currently driven by the economic aspirations and desires of hundreds of millions of people around the globe. Consequently, the more people that become involved in these processes, the faster the globalization goes.

The main objective of this study is to analyze the effects of globalization on the economic viability and global competitiveness of the EU forest sector.

Globalization, as used in the study, focuses on the economic dimension and is defined as the integration of economic activities, primarily via markets. Economic globalization has, in turn, cultural, social, and political consequences, which are only partly reviewed in this study.

The geographical scope of the study is the total European Union, including the accession countries and the countries of the western Balkans; it covers a time frame from the present up to 2030.

A framework concept is used throughout the study to achieve consistency in the analysis.

The study is organized into six tasks as follows:

- Preparatory task: Detailed scoping and methodological framework;
- Main trends and factors of globalization affecting the EU forest sector and forestry;
- State and development in the EU forest sector;
- Regional effects of trends and factors of globalization;
- Threats and opportunities from globalization effects in the EU forest sector and forestry; and
- Responses and conclusions.

The study consists of a literature review and analytical work with a set of formalized models developed by IIASA.

The study has generated a large number of different results, but the report concentrates on major findings.

The study includes a literature review of globalization in general as well as a review of the main globalization factors and their related indicators.

- Globalization and forestry in general;
- Investments, globalization, and forestry;
- Economic activities, globalization, and forestry;

- Employment, globalization, and forestry;
- Trade, globalization, and forestry;
- Technology and know-how, globalization, and forestry;
- Policy and institutional changes;
- Societal and demographic shifts;
- Climate change and future energy demand; and
- Climate change, environmental change, and disturbances.

The results of this analysis are rather general for the EU forest sector and forestry, although globalization has resulted in a more diversified economic world of shifting patterns and a more differentiated model of global production. Globalization has helped to provide EU countries with access to global markets in industries that employ large numbers of people. At the same time, globalization puts the livelihoods of workers and entrepreneurs under increased pressure. Globalization also brings to the forefront a number of issues related to industrial development policies. The new imperative is to develop public policies that encourage the EU forest sector and forestry to cope with, adapt to, and shape changes rather than policies that attempt to preserve the status quo. All the globalization factors studied are likely to have an impact on the EU forest sector and forestry.

The study also carried out an analysis of the current status and development trends of the forest sector and forestry of the EU. One of its objectives was to identify commonalities and differences in the state and development of different European regions. Analyses were carried out for specific regions as defined in *Table 23.*

Table 23: Regional Types of Forestry in the EU27

Type 1: Globalized regions/ Nordic–Baltic	Globalized pulp/paper industry-oriented, raw material production oriented regions in Nordic countries, and related supply regions in the Baltic states
Type 2: Wood production oriented regions/Central Europe	Raw material production-oriented regions in Central Europe supplying sawmilling/pulp and paper industry, and related supply regions
Type 3: Plantation-oriented/ (mainly) "Atlantic Rim" Western Europe	Regions based on plantations, mainly supplying to pulp/paper forest industry, for the most part in "Atlantic Rim" Western Europe
Type 4: Broader, multifunctional forestry oriented regions/Western Europe	Broader, multifunctional forestry-oriented regions with industries mainly catering to domestic consumption in Western Europe
Type 5: Urban society service influenced regions/Northwestern Europe	Regions with forestry dominated by/oriented toward serving urbanized societies and comparatively little raw material production-oriented forestry in Northwestern Europe
Type 6: "Countries in transition" regions/Eastern Europe	Regions dominated by restitution issues, "countries in transition," weak, broken, private forestry tradition, weak infrastructure, and uncompetitive domestic forest industries in Eastern Europe
Type 7: Low forest management intensity regions/ Southern Europe	Regions dominated by low forest management intensity (if any), comparatively high importance of non-wood forest products, forest fires in southern Europe

A general observation is that this type of analysis is hampered by lack of data and especially lack of internationally comparable data within the EU27.

The overall regional globalization trends are illustrated in *Table 24.*

Table 24. Indices for overall Globalization; Economic; Social and Political Globalization. Based on KOF Index of Globalization.

Region	**Overall Globalization**		**Economic**		**Social**		**Political**	
	1994	*2004*	*1994*	*2004*	*1994*	*2004*	*1994*	*2004*
T1 Globalized region	78.9	87.4	84.1	86.6	68.8	86.2	86.7	90.2
T2 Wood production-oriented	76.6	87.2	74.2	85.0	79.1	89.0	76.4	87.5
T3 Plantation-oriented: Western Europe	78.5	86.2	86.2	90.5	72.0	82.8	77.4	85.3
T4 Multifunctional-oriented: Western Europe	77.6	85.1	71.1	78.3	73.4	83.9	93.2	96.4
T5 Urban society service	82.4	84.9	89.3	92.0	77.6	87.2	79.7	80.1
T6 Countries in transition	46.5	68.1	52.9	75.1	43.5	66.5	42.1	60.8
T7 Low forest management intensity	66.5	80.3	69.3	80.6	60.5	74.7	82.4	88.1

From the table above it can be concluded that there was substantial overall development in globalization between 1994 and 2004 in different EU regions. This overall development has been especially rapid in the regions "Countries in transition" and "Low forest management intensity." These two regions have also experienced a rapid development in economic globalization. However, they lag behind the remaining regions with respect to general globalization development . It can also be concluded that to reach a high degree of overall general globalization it is important to have, simultaneously, a strong development of economic, social, and political globalization.

With respect to the specific development trends in forest sector issues, the following can be highlighted:

- In most regions of Europe, private ownership of forest land is larger than public ownership.
- The economic activities in forestry in the form of investments and gross value added are dominated by the Nordic–Baltic regions.
- Removals of industrial roundwood are dominated by the Nordic–Baltic region followed by the Northwestern and Central Eastern regions.
- Biomass for energy production has increased over time because of increased energy prices.
- Productivity in forestry in the Nordic–Baltic region is far higher than in other regions.
- The Nordic–Baltic region is the major net importer of industrial roundwood followed by the Mediterranean and Central European regions.

It is important to keep in mind that literature reviews and statistical analysis of this kind are not very useful for identifying detailed developments with respect to globalization. The only observations that it is possible to make are necessarily of a general nature.

A commonsense assumption is that competition has become more intense in the forest sector in terms of overlap and in product and resource markets, keeping pace with the globalization of world markets. Therefore, it is of interest to see how the EU forest sector has managed to handle the recent increase in globalization. One approach is to examine the development of global export shares (based on values). This is illustrated below, based on FAO data for EU25 in *Table 25.*

Table 25. Global Export Shares (Values); expressed as a percentage for the EU25

Industrial roundwood		Sawnwood	
1985	2005	1985	2005
16.9	21.0	30.7	36.0
Wood-based panels		Pulp	
1985	2005	1985	2005
34.6	40.5	32.8	23.9
Paper and paperboard		Newsprint	
1985	2005	1985	2005
56.1	59.4	21.0	31.6
Printing and writing paper		Wrapping, packaging paper and board	
1985	2005	1985	2005
76.5	81.2	64.5	59.0

From *Table 25* above it can be concluded that during the period 1985–2005 the EU25 managed to increase its global export shares for industrial roundwood, wood-based panels, paper and paperboard, printing and writing paper, newsprint, and sawnwood rather substantially. The EU25 has lost global export shares in pulp and paper and paperboard. The decline in the global export share of pulp is a healthy development. It means that instead of merely producing and trading market pulp, the pulp produced has been used in integrated mills for higher value-added production of different paper grades. The EU25 has also lost global market shares in the grade of paper and paperboard. Even in this case it seems to be a healthy sign, as losses are in low value-added grades and the shares of high value-added grades have increased.

Thus it can be concluded that:

- *Globalization that has taken place to date has been favorable to the development of the EU forest sector.*
- *It is not only the impact factors of wood costs, energy costs, etc., that decide the competitive position in a globalized world. There are many other factors decisive to the competitiveness of the forest sector, such as know-how, quality, logistics, institutions, etc.*

The latter conclusion is further supported by the fact that most of the world's largest forest-sector companies have followed more or less the same overall development strategies over time (Lamberg *et al*., 2006). The authors studied the forest sector strategies during the timeframe 1848–2003, divided into four periods. The characteristics of these periods are illustrated in *Table 26.*

Table 26. The Development of the Global Forest Sector (modified from Lamberg *et al.*, 2006).

Time Period	Technological Development	Capitalist System	Ownership Structure	Dominant Activities
1848–1945 (Period 1)	Virgin timber as the main source, mechanization	Industrial and financial capitalism	Dominated by family companies but corporations emerging	Emerging pulp and paper industries
1946–1960 (Period 2)	Rationalization of production, integrated mechanization of production processes	Financial capitalism	Family-owned companies fading	Emerging diversification
1961–1980 (Period 3)	Atomization and computerization of production and control systems, environmental concerns, recycled fiber	Fading financial capitalism, emerging global capitalism	Heyday of large family-owned companies	Diversified structures in struggle
1981–2003 (Period 4)	Giant machines, improved productivity, converted products, integrated units, reduced energy use, environmental concerns, new raw materials	Global capitalism	International ownership	Rising globalization of production, still regional concentration in production, concentration on core business activities

Thus, Lamberg *et al*. conclude that the overall picture is that all companies have followed a similar pattern of growth strategies over the study period. The dominant strategies were adopted in a sequential order in all companies without any substantial national differences.

Forest sectors apparently have not yet faced changes that are judged to be necessary in a globalizing world for radical change and evolution of economic sectors (e.g., McGahan, 2004). Examples of these drastic changes are basic technology breakthroughs and dramatic changes in marketing.

The EU25 forest sector has, to date, been able to adapt to globalization by using overall strategies that are similar to those of their competitors. Soft characteristics such as know-how, logistics, institutions, education etc., have made it possible for the EU25 to reap gains from globalization. But will this be sufficient in the future?

To gain insight with respect to the future impacts of ongoing globalization processes, an analytical package of models (developed at IIASA) were used for scenarios analysis. These scenarios were developed based on the results of the proceeding steps of this study. Five specific scenarios were developed and used in the analysis. The flowchart of the integrated model cluster is illustrated in *Figure 35*.

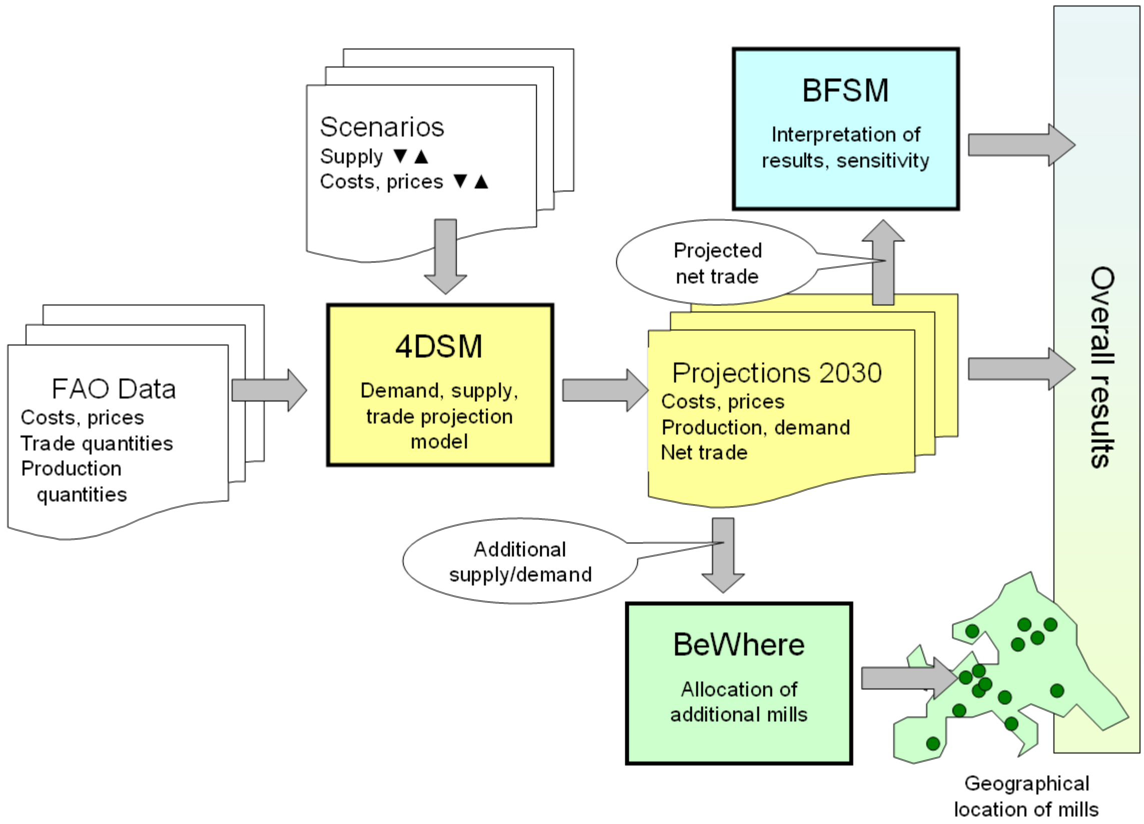

Figure 35. Integrated model cluster flow.

The expected global production of main industrial forest products in different global regions for the five scenarios and baselines are illustrated in *Figures 36, 37, 38,* and *39.*

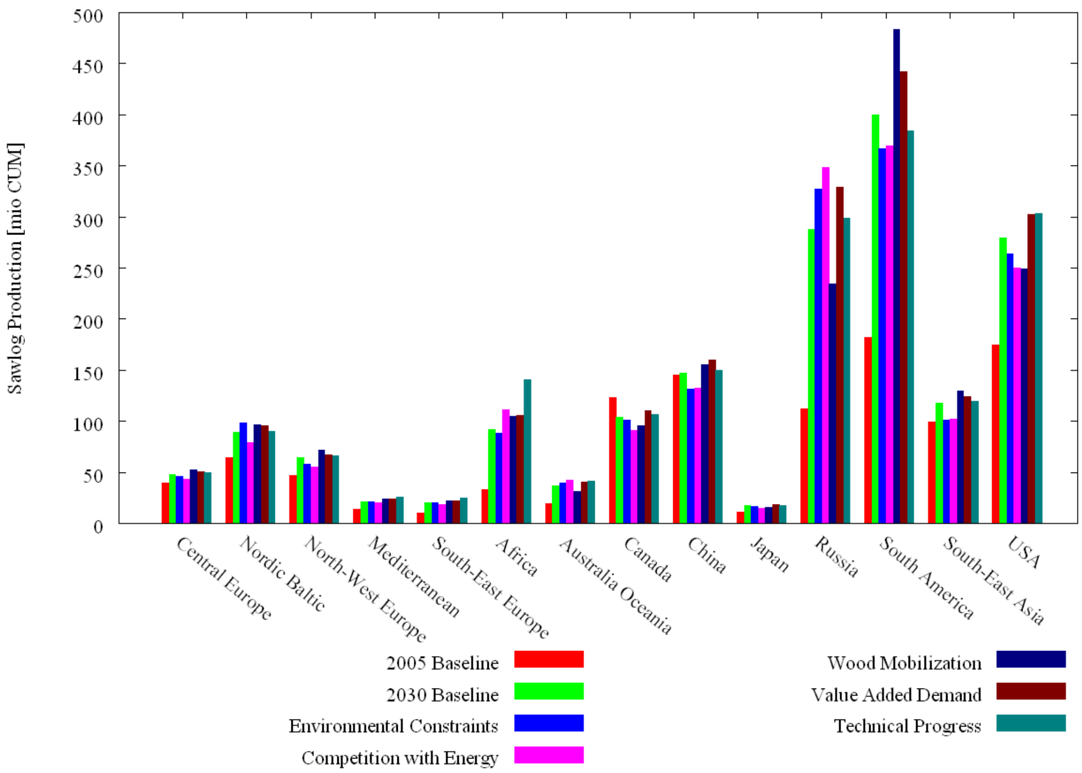

Figure 36. Expected supply/production quantity of sawlogs in world regions in 2030 in million cubic meters for different scenarios.

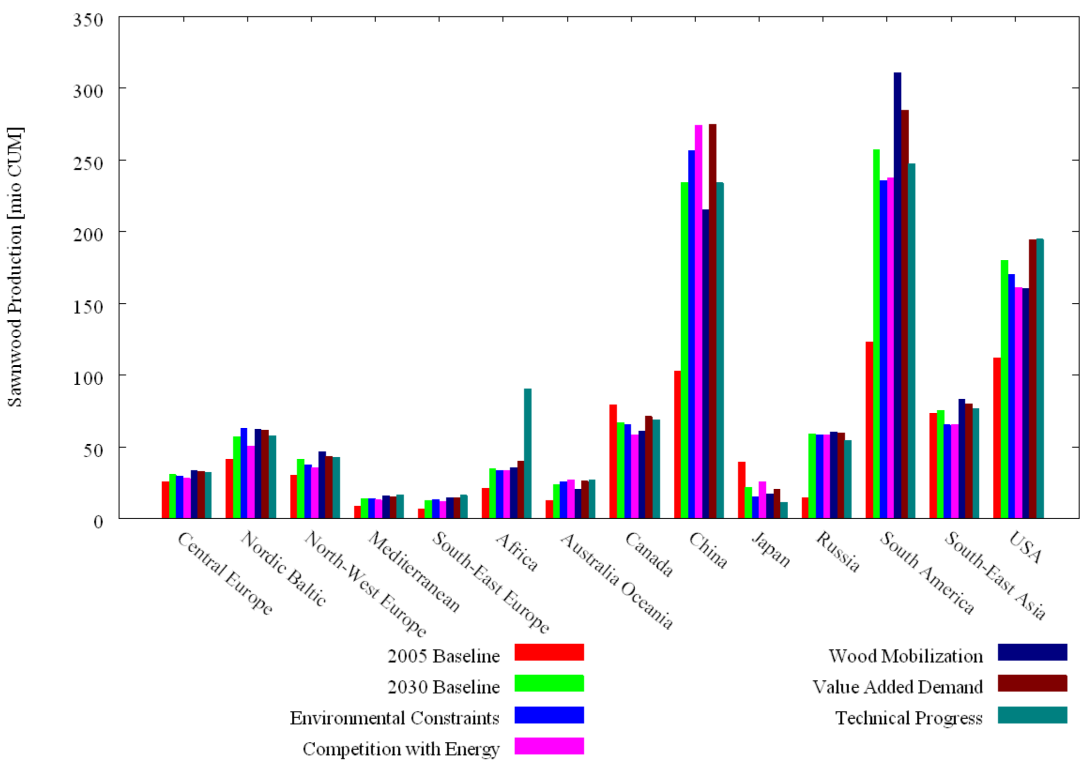

Figure 37. Expected supply/production quantity of sawnwood in world regions in 2030 in cubic meters for different scenarios.

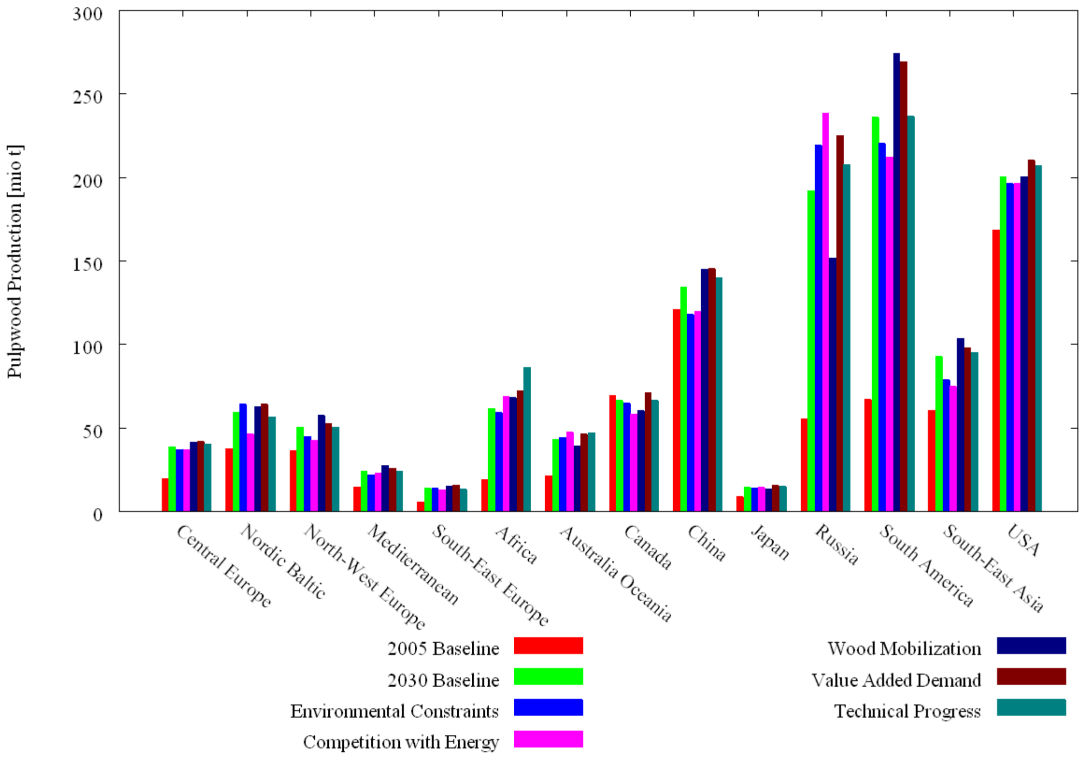

Figure 38. Expected supply/production of pulpwood in million tons by region and impact scenario.

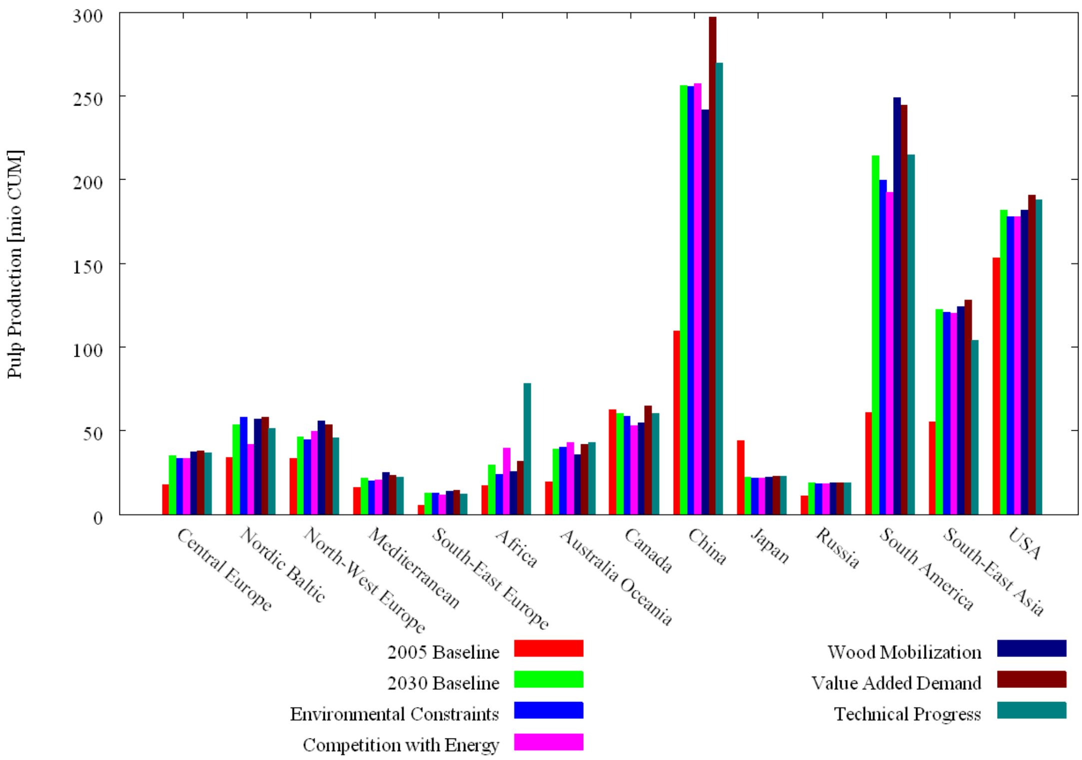

Figure 39. Expected paper and paperboard production in million tons by region and impact scenario.

The overall conclusions of the analytical analysis are presented below.

The EU Forest Sector—A Competitive Sector

A European forest sector turns out to be a competitive region in a globalized world. We assess growth in the forest sector of each European region. The analysis also points in the direction of increased product prices due to rapidly increasing global demand, which may help boost current sluggish European forest-sector profits. The competitiveness of the European forest sector is robust across a large variety of different development scenarios. However, Europe is not judged to be a global growth powerhouse like, for example, Latin America and Russia. *The fate and direction of the competitiveness of the EU-based forest sector is determined mostly outside of Europe,* where projections are more uncertain. This means that the EU must in the future carefully monitor the development of the global forest sector in order to set appropriate policies for the EU-based forest sector.

Tight Wood Supply

The global wood supply situation will become tight in the future because of current over-harvesting in a number of regions, increased environmental concerns, and climate change effects (such as insect outbreaks in Canada).

Under these conditions, analysis of the model shows that Russia and Africa will substantially increase their role as wood suppliers in order to balance global demand. Whether this will happen in reality is a crucial question. Both regions are complex from the political and institutional points of view. With respect to Russia, the overall question is if Russia will be a global partner with respect to the forest sector or if it will act based only on nationalistic self-interest. It is important for the EU to encourage Russia to become a trusted partner in the global forest sector in the future.

Africa is a difficult region and one where it is important for the EU to encourage sustainable forest management of existing resources. This is especially important in the light of current Chinese and Indian operations in that continent.

South America a High-Growth Region

South America is almost certain to become a high-growth region with its vast land resources and risky but more calculable investment conditions than countries like Russia, China, or African nations. However, this region is no stranger to political uncertainties, as illustrated by developments in Venezuela and Bolivia.

Globalization will cause increased pressure on the EU forests to meet the demands from conventional forest-industry, energy- and chemical industries, as well as increased environmental and social demands. It will be a major policy challenge for EU forestry to balance these demands.

Energy Development Crucial

Global overall energy sector development and especially global bio-energy development will be crucial for the development of the conventional forest industry in Europe. European land politics, climate policies, and energy policies are likely to be conducive to the implementation of a substantial bio-energy sector in Europe. For the conventional forest sector this development represents a possible threat as well as an opportunity. From our geographically explicit forest sector bio-energy sector modeling, we conclude that economies of scale will be the major factor determining competitiveness of the conventional forest sector relative to the bioenergy sector. The conventional forest sector has considerable experience in managing large amounts of wood raw material and could thus be an important partner of the energy sector.

Renaissance for the EU Sawmilling Industry

The EU sawmilling industry for years has suffered sluggish development and low profitability. But because of foreseen increased global demand and increased energy prices, most of the scenarios show some sort of future renaissance for the European sawmilling industry, as wood for construction purposes will be more economically and environmentally favorable than other building materials.

Substantial Growth in Paper and Paperboard Production

There is also substantial growth foreseen for the production of papers and paperboard in the EU in the future thanks to globalization. This increase in production is driven by increased production of higher value-added paper and paperboard products in the EU.

Centers of Gravity

The Nordic–Baltic and Central regions will be centers of gravity of the forest sectors of the EU in a globalized world.

Substantial Growth

The Southeastern European region is assessed to have substantial future growth in the forest sector due to increased productivity in the sector and the resulting low costs of production.

Shift in Demand

There will be a strongly upward shift in consumer demand for paper and paperboard (a shift that has already been occurring for some years).

Most growth in demand for paper and paperboard will be in China, India, Southeast Asia, and South America in the future. This is also to some extent true for sawnwood. These dramatic increases in demand crucially define the global competitiveness landscape. European forest industries, as technology and business leaders in the sector, are challenged by such growth potentials and will attract European companies to invest in new capacities in regions with growing demand.

The EU probably cannot do much to avoid such a development. The one thing the EU can do is to avoid introducing policies that diminish the existing competitiveness of the EU forest sector. Reduced competitiveness leads to the risk of a large-scale exodus of EU forest companies to the growth market regions.

Shift in Supply

With a growing demand in paper, lumber, and energy sectors, there will be a shift in supply to fast-growing plantations and remaining wood baskets like Russia and Africa. An overall concern will be “where will the raw material come from?”

Increased Prices

The analysis shows that, because of tighter wood supply, competition from the energy sector, increased demand in emerging economies, among other things, there will be a substantial increase between 2005–2030 in the demand of forest raw material and industrial forest industry products. In general it can be said that the prices will increase most in what is today regarded as low-cost regions. Prices will also become more similar across regions because of globalization. This can possibly mean increased profitability for EU forestry thanks to increased globalization.

Based on the analysis, it is difficult to obtain a clear-cut identification of the strengths and weaknesses of different regions of the EU with respect to the globalization process. Moreover, a factor regarded as a strength by one stakeholder in the sector can be regarded as a weakness by another. With this caveat, the study provides a consistent matrix on this issue for EU regions used in the quantitative work described above.

The study has also investigated the responses taken in the different regions of the EU to address and benefit from the specific effects of globalization. The findings can be summarized as follows:

5. Overall, there is little concrete response to globalization and very little innovation activity in the sector, especially in small forest holdings;
6. Large forest holdings respond mainly by cost cutting through outsourcing. This is driven by the price competition to which the forest industry is subject in globalized commodity markets. Responses to globalization are thus triggered by the forest industries and their respective demand rather than being directly to globalization;
7. Innovations are incremental and usually not new for the sector. They tend to follow existing paths ("more of the same") and traditional supply-side approaches. Customers and consumers play virtually no role as a source of improvements in products or services.
8. Institutional innovations are potentially an important response to globalization. However, insofar as they occur, they tend to be trend-follower initiatives based on perceptions of forestry as an efficient supplier of raw materials, with traditional concepts of innovation support. There is little strategic, future-oriented, and systematic response to the opportunities and threats that globalization presents to EU forestry.

It can also be concluded that the responses to globalization in the EU to date have been wood-focused, with a view to competing on price for global raw material commodities. Innovations for developing higher value-added wood products as well as products and services other than timber are very underdeveloped. In general, comprehensive innovation policies for the forestry sector that answer the challenges of globalization do not exist in the EU countries. There still seems to be a strong focus on traditions, limited emphasis on the future, and avoidance of risks in the EU forest sector.

The study also carried out a literature review of lessons learned on responses to globalization in other sectors. It is difficult to get a rich homogenous picture on this from the literature, but the following results are of interest:

- Globalization causes increased intra-industry trade rather than inter-sector trade and specialization based on comparative advantage.
- Risk-averse respondents to globalization often become anti-globalization.
- Active governance of trade by governments is necessary for markets to function, and governments need to work at getting public support for economic openness.
- It seems that globalization is driven primarily by a reduction in the costs of trade.

- Moreover, this latter development results in higher efficiency and productivity as firms face foreign competition.

There is no single explanation or easy-fix normative perspective on how the EU forest sector might remain competitive with increased globalization. There are obvious threats as well as opportunities for the EU forest sector and forestry. The study has identified these threats and opportunities, as illustrated in *Table 27.*

Table 27: Cross-matrix of opportunities and threats of globalization factors: forestry and forest industry

		Forestry	
		Opportunity	Threat
Forest industry	Opportunity	• Sustainable resource supply • Wood-based bioenergy/biomaterials—polyproduction • More efficient business relationships, including business intelligence • Productivity gains through increased technology use, including logistics • Biotechnology R&D breakthroughs • Domestic / regional outsourcing of production to enhance productivity • Increasingly stable and reliable global institutions and regulatory and operational frameworks (e.g., Kyoto) • Societal support to renewable resources, green image of wood	• Foreign direct investment outside the region (forest industry relocation) • Low import barriers industrial raw material • Import competition for raw material/globalization of natural resource sourcing • Job loss due to productivity gains • International/global outsourcing of production of components • Increasingly imperative global institutions and regulatory and operational frameworks (e.g., WTO) encouraging foreign direct investment abroad
	Threat	• Increasing raw material scarcity leading to higher prices • Wood-based bio-energy • Alternative non-production- oriented business models • Policies that restrict wood use but are viable business models for forestry (including, e.g., recreational services, some carbon sequestration) • Society demanding increasing use of forests for environmental protection and recreation, with viable business models in forestry to provide these	• Rising import competition pressure for parts, components, or finished products • Reduced export-competitiveness • Declining forest industry profitability • Policies increasingly regulating SFM, but with little scope for developing market-based solutions and experimentation • Increasing degree of urban population viewing forests as ideally untouched nature, and increasing stakeholder involvement requesting non-economically viable management without alternative income opportunities • Climate change • Continued low public and private R&D

The study has identified four possible strategic options to adapt to and benefit from globalization based on the threats and opportunities discussed above. These strategic options are:

Option 1 = Cease active income- or profit-oriented forestry
Option 2 = Diversify into alternative and niche income streams
Option 3 = Become cost-competitive in global commodity market
Option 4 = Pursue technological and business model innovation

As stated above, there is no single easy-fix strategy on how to stay competitive in the forest sector with increased globalization. In reality, a successful strategy would be a portfolio of the above options. In addition, the conditions for adapting different strategies vary for different regions of the EU. The study has made an assessment of suitable strategic options for the seven types of regions of the EU discussed earlier. This assessment is presented in *Table 28.*

Table 28: Strategic options to respond to globalization and their regional suitability (number of stars indicating suitability).

	Option 1: No commercial operation	Option 2: Niche / diversify	Option 3: Commodity-competitiveness	Option 4: Next-generation products
Type 1: Globalized regions / Nordic–Baltic		*	**	***
Type 2: Wood production-oriented regions/Central Europe		**	***	**
Type 3: Plantation-oriented/(mainly) “Atlantic Rim” Western Europe		*	***	*
Type 4: Broader, multifunctional forestry oriented regions/Western Europe		**	***	**
Type 5: Urban society service- influenced regions/Northwestern Europe	**	***		*
Type 6: “Countries in transition” regions/Eastern Europe		**	***	
Type 7: Low forest management intensity regions/ Southern Europe	**	***		**

Implementation of these strategic options will by their very nature have both positive and negative implications in the different regions of the EU. These implications are illustrated in *Table 29.*

Table 29: Effects of adaptation options on globalization factors and globalization dimensions

Globalization factors	Option 1: No commercial operation	Option 2: Niche / diversify	Option 3: Commodity competitive-ness	Option 4: Next-generation products
Investment	Considerably decreasing	Stable or decreasing	Increasing (continuous and considerable investment);	Considerably increasing (strategic and risky)
Economic activity—productivity, added value	Considerably decreasing	Stable or decreasing	Considerably increasing	Stable or increasing (short term)
Employment	Considerably decreasing	Stable or increasing	Decreasing	Stable (short term)
Trade	n.a.	Stable	Stable or increasing	Stable or increasing
Technology, know-how	Decreasing	Increasing	Increasing	Considerably increasing
Globalization dimensions				
Policy	n.a.	n.a.	n.a.	n.a.
Society	Likely neutral response	Likely neutral or positive response	Likely negative response	Likely neutral response
Environment	Likely positive except for health risks	Likely neutral or positive	Likely negative or neutral	Likely neutral (short term)
Resources (energy, raw material)	Likely negative	Likely neutral or positive	Likely positive	Likely positive

Supporting Strategic Adaptation through Forest Policies

Globalization promises benefits, but its long-term benefits come with what can be substantial short-run costs. With increased competition, producers will face challenges to reduce costs if they are to remain viable. Governments can help this process by working for an open international trading system. It is extremely disruptive and costly for importers of roundwood, for example, to face sudden prohibitions in a supplying country that seeks to protect upstream manufacturers of wood products. Governments can also help with retraining and relocation of workers who are displaced from declining industries or from industries which, though not declining, are shedding labor because of technical change.

It is also possible for a government to protect its industries with subsidies, tariffs, and import quotas or prohibitions. It would even be possible for the EU to achieve self-sufficiency in this manner. Producers would not be challenged by competition, so would not have to reduce costs by increasing productivity. But the costs of such a policy would be very high indeed. By foregoing the short-run costs of adapting to globalization, the EU would also be forfeiting the long-run gains of specialization and technological change. Inevitably, trading partners would retaliate with their own subsidies and trade restrictions, increasing the costs of such a policy even more.

To sum up, it is the producers themselves who must search for effective and efficient ways of competing in a global market. Governments can aid this process by promoting open and orderly markets at home and abroad, by facilitating the retraining and relocation of workers who are displaced by technological change, or by the creative destruction of competitive imports. We now know that gains from trade go beyond the static gains of specialization; they are dynamic as well because globalization demands technological change and high productivity from firms that enter export markets *and* from firms that hope to survive import competition.

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