

Land appropriation of the forest sector

1 Introduction

Globally, the dominant trends for forest products are an increasing demand for wood (resulting from increased populations and incomes) from a diminishing, or more restricted, forest supply base. As forests are cleared, degraded, or withdrawn from production for conservation purposes or other reasons, the burden placed on the remaining production forest increases commensurately.

2 Forest sector description and forestry databases

Several key economic activities rely on timber resources. Besides forestry, logging and related activities to produce timber, other economic sectors rely on timber as prime input. They include sawmilling and the manufacture of wood to produce sawn wood, panels, veneer sheets, plywood and others as well as the manufacture of pulp, paper and paperboard. While trade in the primary sector, i.e. transport of logs is relatively small, trade of processed timber commodities (wood and paper products) may be significant.

The aim is to estimate the area claimed to produce timber required for the three economic sectors represented in Input Output tables. Except for furniture¹ these three sectors comprise all important commodities of an economy that require timber and therefore rely on area to produce roundwood.

FAOSTAT database

For the compilation of data for the forestry sector two different data sources are used. Firstly, the time series production and trade data were compiled from the FAOSTAT online database of the forestry sector. It covers all countries of the world and includes several items relevant to describe forest products commodities and differentiate into the three economic sectors. Table xx summarizes those items including their definition used for the land appropriation. Generally for each item domestic production (in m³) and trade data, namely imports and export quantity (in m³) and value (in \$) are reported. FAOSTAT forest commodities include both, the raw timber materials, as well as numerous forest products.

¹ In I-O tables furniture is included in sector 24 'Manufacturing nec; recycling. FAOSTAT does not report any data on furniture production and trade.

Table xx. Definition of items reported in the FAOSTAT forest products database and used for the land appropriation of the forest sector.

(In brackets commodity numbers used in the FAOSTAT database)

Roundwood (1861)	Wood in its natural state as removed from forests and from trees outside forests; wood in the rough. - Wood in its natural state as felled, with or without bark. It may be round, split, roughly squared or in other forms.
Industrial roundwood (1865)	Roundwood that is used for industrial purposes, either in its round form (e.g. as transmission poles or piling) or as raw material to be processed into industrial products such as sawn wood, panel products or pulp. - The commodities included in this category are sawlogs or veneer logs, pulpwood and other industrial roundwood. In the case of trade, chips and particles and wood residues are also included.
Wood fuel (1864)	Wood that will be used "in the rough" as fuel for purposes such as cooking, heating or power generation; and wood that will be used for charcoal production.
Charcoal (1630)	Wood carbonized by partial combustion or application of heat from an external source. It is used as a fuel or for other uses.
Sawn wood (1872)	Wood (including sleepers) sawn lengthwise or produced by a profile-chipping process, and planed wood. – Sawn products produced from logs. A log refers to any section of the bole, or of the thicker branches, of a felled tree after limbing and bucking.
Wood-based panels (1873)	An aggregate term including the following commodities: veneer sheets, plywood, particle board and fibreboard. Particle board includes varieties such as oriented strand board (OSB) and flakeboard. Fibreboard includes hardboard, medium-density fibreboard (MDF) and insulation fibreboard.
Wood pulp (1875)	Wood pulp is the most common material used to make paper. It generally comes from softwood trees such as spruce, pine, fir, larch and hemlock, but also some hardwoods such as eucalyptus and birch. Wood pulp comprises all wood based pulp, including mechanical, semi-chemical, chemical and dissolving wood pulp.
Wood residues* (1620)	Miscellaneous wood residues. Wood residues which have not been reduced to small pieces. They consist principally of industrial residues, e.g. sawmill rejects, slabs, edgings and trimmings, veneer log cores, veneer rejects, sawdust, bark (excluding briquettes), residues from carpentry and joinery production, etc.
Chips and Particles* (1619)	Wood chips and particles. Wood that has been deliberately reduced to small pieces from wood in the rough or from industrial residues, suitable for pulping, for particle board and fibreboard production, for fuelwood or for other purposes.
Paper and paperboard (1876)	The following commodities are included in this aggregate: newsprint, printing and writing paper, other paper and paperboard. (It excludes manufactured paper products such as boxes, cartons, books and magazines.)
Recovered paper (1669)	Used paper and paperboard or residues from paper conversion that are collected for reuse as a raw material for the manufacture of paper, paperboard or other products.

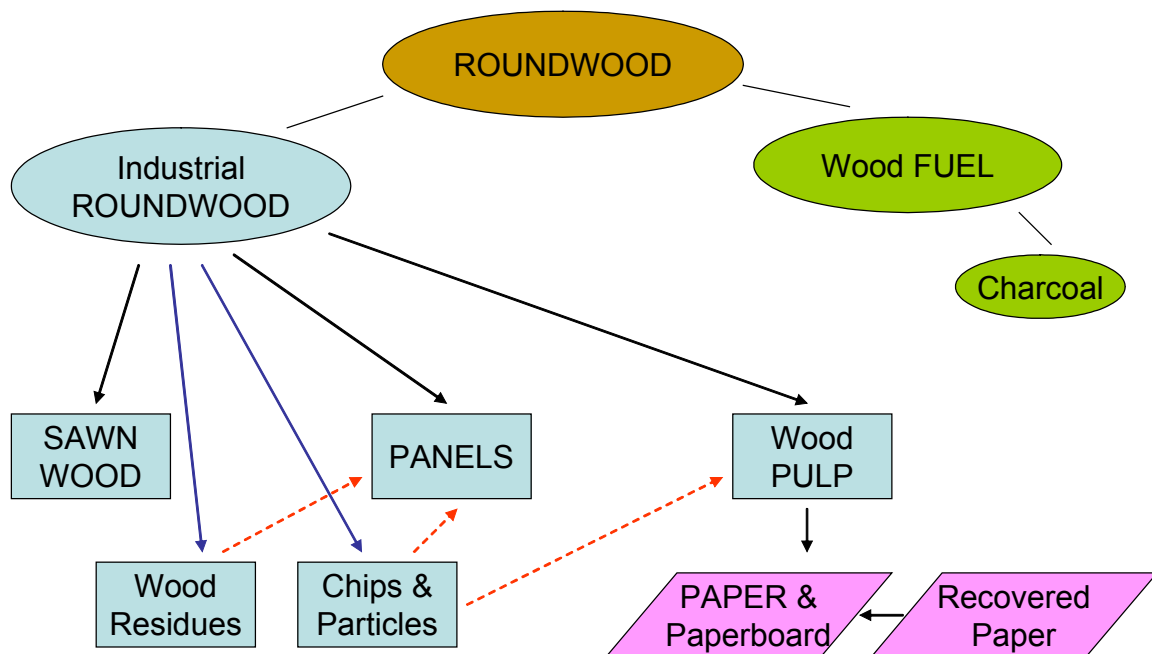
* Until 1998 chips and particles and wood residues are only included in trade data.

Source: *FAO Yearbook of Forest Products (2000)*

Figure xx shows the commodities used in this study and their interrelations. *Roundwood* refers to all wood in its natural state obtained from removals. It comprises wood fuel and industrial roundwood. Charcoal is a subcategory of wood fuel. However in the trade data charcoal is reported separately and is excluded from the traded wood fuels.

Industrial roundwood commodities include sawlogs or veneer logs, pulpwood, and other industrial roundwood. 'Chips and particles' and 'wood residues' are reported in roundwood equivalents and are included in the domestic industrial roundwood production (as of 1998). In contrast in the trade data these two commodities are reported separately next to the import and export of industrial roundwood. Industrial roundwood commodities are the raw material to produce sawn wood, wood based panels and wood pulp with the latter being the base material for paper production.

Figure xx. Commodity structure of FAOSTAT forest products database.



TBFRA-2000 database

The second data source is the TBFRA-2000 report on “Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand (industrialized temperate/boreal countries” (UN-ECE/FAO, 2000). It is primarily used to estimate forest productivity and to judge calculated productive forest area against actual forest lands available for wood supply. As inferred by the title in contrast to the FAOSTAT database TBFRA-2000 data are not available for all countries of the world.

The following TBFRA-2000 items are most relevant for the present study:

- *Forest land*: Forest is defined as “land with tree crown cover of more than 10 percent and area more than 0.5 ha.” Trees on the site are considered to be higher than 5 m.
- *Forest available for wood supply (FAWS)*: This is “forest where any legal, economic, or specific environmental restrictions do not have a significant impact on the supply of wood.” This category also comprises areas where harvesting is not taking place, although there are no such restrictions.
- *Forest not available for wood supply*: This refers to “forest where legal, economic or specific environmental restrictions prevent any significant supply of wood.”

TBFRA-2000 information on the productivity of forests includes:

- *Net annual increment*, defined as the average annual volume over the given reference period of gross increment less that of natural losses on all trees.
- *Annual fellings*, referring to the volume of all trees “that are felled during the given reference period, including the volume of trees or parts of trees that are not removed” (ibid, p.33).
- *Annual removals*, representing the “average annual volume of those fellings that are removed” (ibid, p. 33) from the felling sites. Annual removals thus also comprise the removals of trees felled at an earlier period than the reference period as well as natural losses.

3 Forest productivity

Whereas roundwood production and forest products data in m³ are being reported, the actual forestry area needed to produce this output is lacking. How much area is behind the production of roundwood depends on forest productivity, i.e. the equivalent of yields in the case of crops. More specifically, increments in FAWS are required.

$$Y_j = \text{Incr}_j / \text{FAWS}_j$$

j	Country
Y	Average annual forest productivity on FAWS (Yield) [m3/ha]
FAWS	Forest available for wood supply [ha]
Incr	Net annual increment on FAWS [m3]

Inventory information on increment is generally measured only for forests under regular management and has in consequence been obtained mainly for the developed countries (FAO, 1995). For developing countries, even forest volume and biomass data were not widely available (FAO, 2001). Net annual increment per hectare is dependent on climatic and biophysical growing conditions but also on management policies and objectives, in particular on the intensity of management. For these reasons it varies greatly among regions and countries.

In natural, unmanaged and mature or over-mature stands, such as exist over large parts of the former USSR and Canada, natural mortality may more or less equal gross increment, leaving a negligible volume of net increment. This explains the low net annual increment figures for those two countries, 1.7 and 1.9 m³ o.b./ha/year respectively, compared with an average estimated at 2.6 for the developed countries as a whole, 4.3 for Europe and 3.9 for the United States (FAO, 1995).

TBFRA2000 reports FAWS and increments as well as total annual fellings and total annual removals. By definition this study aims to identify the corresponding productive forestry area of annual fellings and not of annual removals. However, FAOSTAT roundwood production data refer to annual removals and not to annual fellings. To correct for this potential underestimation of the productive forest land, the resulting area from the forest productivity applied to the production data is increased by the share of annual removals over annual fellings.

$$\text{Share}_j = \text{Annual Removals}_j / \text{Annual Fellings}_j$$

$$\text{ProdForArea}_{ji} = \text{Prod}_{ji} / (Y_j * \text{Share}_j)$$

i	year
Annual Fellings	Annual fellings over bark on FAWS [m3]
Annual Removals	Annual removals over bark on FAWS[m3]
Prod	Roundwood production [m3]
ProdForArea	Productive forest area in a country [ha]

This study assumes forest productivity data and the share of annual removals over annual fellings to remain constant throughout the time period considered. Table 10 summarizes results for those items including the underlying data.

For those countries not included in the TBFRA-2000 report forest productivity estimates are more difficult and uncertain. The GFSM Report (FAO, 1998) includes estimates for Gross Annual Increments (GAI) on all forest land as well as on commercial forest land. For many European countries GAI compares relatively well with TBFRA-2000 net annual increments. However, for Canada and Russia GAI is higher than TBFRA-2000 increments. For those countries not mentioned in TBFRA-2000, the GAI estimates are generally quite low, especially on the commercial forests, often below 2 or 1 m³/ha. GFSM only considers natural forests.

Productivity in forest plantations may generally be much higher. However, we currently do not know what share of roundwood production in a country stems from plantations or natural forests. The reasons for the high net annual increments of 18 m³/ha for New Zealand are certainly related to the fact that all roundwood stems from plantations.

Forest plantations

In the tropical and subtropical zones the species with the highest yields include for example Eucalyptus cultivated in Latin America with mean annual increments (MAE) of 16-25 m³/ha. In the temperate and boreal zone highest yields are found with Pinus species grown in New Zealand (18-24 m³/ha MAE) or Picea and Abies species grown in Ireland (12-18 m³/ha MAE) (Brown, 2000). However, yields for plantation forests can usually only be indicative since yields are highly dependent on the quality of management of planting sites.

While forest plantations account for only a very small proportion of global forest area, in some countries they contribute an important share in industrial roundwood production. Recent estimates from 1995 state the global area of forest plantations to be some 123 million hectares or 3.6 percent of global forest area (Brown, 2000, Pandey, 1997, UN, 2000). Brown (2000) estimates that in 1995 industrial forest plantations could have accounted for about 331 million cubic metres of industrial roundwood production or about 22 percent of total global industrial roundwood production with large regional variations.

Uncertainty, however, exists about the reliability of the statistics regarding the reported areas of forest plantations and there is even less certainty concerning the volume of wood produced from them. Some confusion also exists about the definition of plantation (Pandey et.al, 1998). Reliable data on the production of industrial wood from plantations, as distinct from natural forests, are not available from most countries.

Some countries, such as South Africa and New Zealand, produce almost 100 percent of their industrial wood from forest plantations. Other countries with a high proportion of industrial wood coming from plantations include: Chile, 95 percent; Spain, 81 percent; Brazil, 60

percent; Argentina, 60 percent; and Japan, 55 percent (Pandey, 1998). Brown (2000) presents somewhat different data and states that industrial forest plantations appear to have the greatest importance in Oceania (Australia and New Zealand), where up to 80 percent of industrial roundwood may be coming from industrial forest plantations. They may also contribute up to 35 percent of industrial roundwood supply in South Africa, 27 percent in South America (Chile and Brazil) and 23 percent in Asia (China and Japan).

Despite trustworthy data on current forest plantation resources are scarce, there seems to be a general agreement that in the future forest plantations will be an increasingly important source of industrial fibre (World Forestry Congress, 1997, Pandey, 1998, Brown, 2000).

For the purpose of land attribution, productivities estimates are crucial. In view of the present lack of reliable information on almost every aspect of forest plantations, in developed and developing countries and regions alike, productivity figures should be considered as indicative rather than definitive. Some of the countries with substantial forest plantation areas are among the worlds' largest roundwood producers and are important roundwood or forest products exporter. They include Brazil, Chile, South Africa, Indonesia, Malaysia and China.

In 2000 Brazil produced 103 mio.cubic meter industrial roundwood, after USA, Canada and Russia the third largest producer off this commodity. Brazil Plantation forests cover 4.9 million hectares, mainly comprising of Eucalyptus (2.9 mio. Ha) and Pinus (1.8 mio.ha) species.

In this study plantation forests are considered to contribute significantly to industrial roundwood production in Brazil, Chile and South Africa. Since it is assumed that management is relatively well established here, annual productivity rates in these countries are estimated to be relatively high amounting to 10 m³/ha/year.

With the countries included in TBFRA 2000 on the one hand and Brazil, Chile and South Africa on the other hand, except for Malaysia and China all major roundwood and forestry products producers and exporters countries are covered and productivity estimates are thus available.

Malaysia was in 2000 after Russia and the United States the third important roundwood exporting country. It contributed also 9% of world exports of wood-based panels. In a country report on Malaysia (FAO 1997), FAO states that Malaysia can supply logs at sustainable levels of around 18 mio m³ per year from 11 million hectares of forests designated as production forests. This calculates an annual logging yield of 1.6 m³/ha. In 2000 Malaysia produced 15 million cubic meters of industrial roundwood and in 2003 15 million cubic meters. Thus it has already reached the stipulated sustainable production level.

According to FAOSTAT in 2000 China produced 96 million hectares of industrial roundwood making it after USA, Canada, the Russian Federation and Brazil the fourth largest producer. China reports 45 million hectares of plantation forests, the largest worldwide. Brown (2000) estimated for China 17 million hectares of industrial forest plantations and a potential to produce from those some 54 million cubic meters of industrial roundwood plus 13 million

cubic meters of wood fuel by the year 2000. This would mean productivity rates of 3.8 m³/ha/year or 3.1 m³/ha/year only for industrial roundwood.

Forest productivity data used in this study

Bearing all this in mind and due to the lack of productivity data, this study assumes for countries not mentioned in TBFRA 2000 relatively low 2 m³/ha/year productivity rates on FAWS. The exception is the above mentioned three countries, Brazil, Chile and South Africa with strong evidence of successfully implemented forest plantation schemes. Despite of limited information on successfully implemented forest plantations with high yields, we also assumed for India and China 5 m³/ha/year. This is because these countries report to produce large amounts of roundwood and we would exceed FAWS area, in particular in the case of India. Table xx summarizes for all countries included in this study forest land areas including FAWS and forest plantations as well as forest productivity data reported as annual increases in cum roundwood per hectare.

Forest productivity data are used to calculate area required to produce roundwood reported in FAOSTAT statistics. Regarding reliability of forest productivity data, we considering the TBFRA 2000 data source as the most recent and reliable currently published. Some 72% of the year 2000 global industrial roundwood production occurs in countries included in the TBFRA 2000 study. Another 16% stem from Brazil, Chile, India, China and South Africa, countries for which we assumed forest plantations to contribute with some success to roundwood supply.

Table 1 Forest area statistics and forest productivity on FAWS

Country	FOREST Area [1000 ha]	Forest available For Wood Supply (FAWS) [1000 ha]	Plantation Forests [1000 ha]	Forest Productivity [cum/ha] *
Austria	3840	3352	0	7.1
Bel-Lux	732	725	0	8.7
Germany	10740	10142	0	7.0
Denmark	445	440	341	7.3
Spain	13509	10479	1904	2.7
Finland	21883	20675	0	3.2
France	15156	14470	961	5.0
Great Britain	2469	2108	1928	6.0
Greece	3359	3094	120	1.1
Ireland	591	580	590	5.9
Italy	9857	6013	133	3.0
Netherlands	339	314	100	6.0
Portugal	3383	1897	834	6.7
Sweden	27264	21236	569	3.7
Cyprus	117	43	27	1.0
Czech Rep	2630	2559	0	6.4
Estonia	2016	1932	305	3.7
Hungary	1811	1702	136	5.1
Lithuania	1978	1686	284	4.3
Latvia	2884	2413	143	3.8
Malta (*)			0	2.0 (*)
Poland	8942	8300	39	3.9
Slovenia	1099	1035	1	5.9
Slovakia	2016	1706	15	5.5
Iceland			12	2.6
Norway	8710	6609	300	3.1
Switzerland	1173	1060	4	6.6
Bulgaria	3590	3124	969	2.6
Romania (*)	6301	5617	91	5.0 (*)
Turkey	9954	8635	1854	3.5
Ukraine	9458	5999	4425	3.6
Russian Fed	816538	525191	17340	1.4
South Africa (*)	7204	3000 (*)	1614	8.0 (*)
Canada	244571	125863	0	1.8
USA	217333	198123	16238	3.0
Argentina (*)	33000	10000	0	2.0 (*)
Brazil (*)	546000	68000	0	5.0 (*)
Chile (*)	13443	3900	2153	8.0 (*)
Mexico (*)	55476	18000	63	2.0 (*)
Peru (*)	67400	17300	0	2.0 (*)
China (*)	99452	65160	39876	5.0 (*)
Indonesia (*)	120600	74166	0	2.0 (*)
India (*)	50385	21935	0	5.0 (*)
Japan	24064	23276	10682	2.6
Korea Rep (*)	4200	2200	0	2.0 (*)
Malaysia (*)	16325	11255	91	2.0 (*)
Philippines (*)	5798	2202	0	2.0 (*)
Singapore (*)			0	2.0 (*)
Thailand	11101	7000	0	2.0
Australia	156877	16438	1043	2.1
New Zealand	7940	1851	1542	12.8
OPEC(ex.Indo) (*)	57371	29641		2.0 (*)
Rest of World (*)	933285	466643 (*)		2.0 (*)

Source: TBFRA-2000 (UN, 2002) except for countries marked with (*); For countries marked with (*) FAWS from GFSM (1998) and own yield estimates (see text); Forest plantation areas from FRA2000, Table 6

4 Methodology for land appropriation

Overview

Using the above described commodities reported in FAOSTAT on an annual basis and the forest productivity estimates we can allocate land area required for their production. By definition the economic model GINFORS to which we will link the land area estimates requires a separation of forest products into three sectors. A primary sector and two sectors of manufactured forest products, namely:

- Sector 1 (S1): Agriculture, hunting, forestry and fishing
- Sector 5 (S5): Wood and products of wood and cork
- Sector 6 (S6): Pulp, paper, paper products, printing and publishing

Roundwood quantities for each sector and trade element (domestic production, import, export) and required areas to produce these are calculated for the period 1980 to 2002 for a total of 52 countries and two country aggregates (Box xx). The latter include OPEC countries and an aggregate covering all remaining countries. The rest of the world aggregate is essential to balance global trade. The selection of countries has been determined by GINFORS and includes all major economies.

Box xx. Countries included in the analysis (and abbreviations used henceforth)

EU25: Austria (at), Bel-Lux (be), Denmark (de), Finland (fi), France (fr), Germany (ge), Greece (gr), Ireland (ie), Italy (it), Netherlands (nl), Portugal (pt), Spain (es), Sweden (se), Great Britain (gb), Czech Republic (cz), Hungary (hu), Poland (pl), Slovak Republic (sk), Cyprus (cy), Estonia (ee), Latvia (lv), Lithuania (lt), Malta (mt), Slovenia (si)

Other Europe: Iceland (ic), Norway (no), Switzerland (ch), Bulgaria (bg), Romania (ro)

Other Eurasia: Turkey (tr), Ukraine (ua), Russia (ru), China (cn), Japan (jp), South Korea (kr), Indonesia (id), India (in), Malaysia (my), Philippines (ph), Singapore (sg), Thailand (th)

America: Canada (ca), United States (us), Mexico (mx), Peru (pe), Argentina (ar), Brazil (br), Chile (cl)

Africa: South Africa (za)

Oceania: Australia (au), New Zealand (nz)

Aggregates: OPEC excl. Indonesia (op), Rest of the World (row)

Land required for producing commodities domestically as well as land behind trade are estimated for each sector. In general forest productivities (yields) of the individual countries are applied to the different forest commodities as described in FAOSTAT. In this way land area requirements can be estimated for domestic production, imports and exports for all forest derived commodities.

For exported commodities simply forest productivities of the exporting country's domestic roundwood production is used. A potential shortcoming of the methodology therefore is that possible different yields behind commodities that were first imported into the country and then

re-exported are replaced by domestic yields. However, neither export statistics nor the complexity of the forest sector would allow differentiating between the origins of production. For example exported paper may be have been manufactured from wood pulp produced from domestic roundwood or imported roundwood or imported wood pulp.

In the case of imported roundwood or derived commodities an average world yield is applied calculated as weighted average using roundwood export quantities as weights. This was xxxcum/ha in the year 2002. *****.

In consequence it is necessary to separate as good as possible FAOSTAT commodities into the three economic sectors. Sector 1 quantity and area estimates are straightforward, since the commodity roundwood includes all primary harvested timber. It forms the raw material for all further manufactured forest products. More complex is a separation on this forest products level in commodities related to sector 5 (wood products) or sector 6 (paper). For traded quantities and land we separate relevant commodities into sector 5 and 6 and add their import and export quantities. In the case of domestic production the approach is to first estimate the amount of roundwood equivalents required for the paper sector 6. As shown in Figure 6.1 industrial roundwood comprises all roundwood used for the production of industrial products. Thus industrial roundwood minus the (wood based) paper production represents all commodities manufactures in sector 5. Thus sector 5 is calculated by subtracting the roundwood estimated for sector 6 from the total net industrial roundwood. The latter corresponds to domestic consumption and is calculated as domestic production plus imports minus exports.

Sector 1 (Primary)

Sector 1 covers all primary harvested timber. As described above charcoal is not included in roundwood trade data. Charcoal is reported in Mt. According to FAOSTAT a factor of 6 converts charcoal metric tons into roundwood equivalents. Following the above description the specifications for the calculation of areas behind domestic production (PROD), imports (IMP) and exports (EXP) are as follows:

$$AS1_c^{PROD} = RWD_c^{Prod} * Yield_c \text{ [ha]}$$

$$AS1_{ci}^{IMP} = (RWD_{ci}^{IMP} + 6 * Charcoal_{ci}^{IMP}) * Yield_{wi}$$

$$AS1_{ce}^{EXP} = (RWD_{ce}^{EXP} + 6 * Charcoal_{ce}^{EXP}) * Yield_{ce}$$

$AS1_c^{PROD}$	Area required to domestically produce roundwood for sector 1 [ha]
$AS1_{ci}^{IMP}$	Area behind imported sector 1 commodities of importing country ci[ha]
$AS1_{ce}^{EXP}$	Area required in exporting sector 1 commodities of exporting country ce [ha]
<i>Yield</i>	Annual forest productivity [cum/ha]
<i>RWD</i>	Roundwood [cum]
<i>Charcoal</i>	Charcoal [Mt]
c	country
ci	importing country
ce	exporting country
wi	World average import yield

Sector 6 (Paper)

The raw material to produce paper and paperboard is wood pulp, derived via different processing from wood. It is reported in Mt as a subcategory of industrial roundwood. However, depending on the country, substantial amounts of the paper production may as well rely on recovered fiber derived from collected wastepaper. Paper recovery rates have steadily increased during the past two decades and are now in the order of 50% for many industrial countries. Since we assume that no area is required to produce recovered paper, the recycled paper has to be subtracted from the total paper production. Paper, wood pulp and recovered paper are traded extensively.

Domestic production of sector 6 thus calculates as the sum of domestic paper production plus wood pulp exports minus the amount of net recovered paper. For exported sector 6 commodities (i.e. paper and wood pulp) we assume the same share of recycled paper in total paper production as in domestic production (see below RWF0E). In the case of imports a world average share of recycled paper in exported paper is assumed by weighting this share with export paper quantities (see below RWF0I)

A regression analysis over all countries conversion factors calculates conversion factors to convert wood pulp and recovered paper into paper quantities in Mt. These are 0.971 for wood pulp and 0.923 for recovered paper.

According to the EFSOS (UNECE, 2005) study the conversion of one metric ton of diverse paper and paperboard products into volume of roundwood in m3 varies between 3.2 and 4 for European countries. In this study we generally use a conversion factor of 3.5.

$\alpha\beta\epsilon\theta$

$$S6^{Prod} = (Paper^{Prod} + WPulp^{Exp} * \alpha - Recycle^{NET} * \beta) * 3.5$$

$$Recycle^{NET} = Recycle^{Prod} + Recycle^{Imp} + Recycle^{Exp}$$

$$S6^{Imp} = Paper^{Imp} * 3.5 * (1 - RWF0I) + WPulp^{Imp} * \alpha * 3.5$$

$$S6^{Exp} = Paper^{Exp} * 3.5 * (1 - RWF0E) + WPulp^{Exp} * \alpha * 3.5$$

$$RWF0I = \frac{\sum_{CNT} Paper^{EXP} * Re cycle^{NET} * \beta}{\sum_{CNT} Paper^{EXP}}$$

$$RWF0E = \frac{NET Re cycle * \beta}{Paper^{PROD}}$$

RWF0I World average share of recycled paper in exported paper,
Applied as recycling share to imported paper quantities

RWF0E Share of recycled paper in domestic paper production,
Applied to exported paper quantities

Paper Paper & paperboard [Mt]

Recycle Recovered paper [Mt]

WPulp Wood pulp [Mt]

NET Trade net balance (domestic production + imports – exports)

$\alpha = 0.971$ Conversion factor for wood pulp into paper quantity

$\beta = 0.923$ Conversion factor for recovered paper into paper quantity

Sector 5 (Wood products)

As shown in figure xx, except for wood pulp and paper products the other subcategories of industrial roundwood are used for sector 5 commodities. Thus industrial roundwood minus the roundwood calculated for the paper sector 6 represents the roundwood (and area behind) required for sector 5. Taking into account trade and the fact that chips and particles, wood residues and wood pulp are not included in industrial roundwood trade (see above section 6.1), computations are as shown below. In theory chips and particles should be partitioned into those feeding sector 6 (wood pulp) and those feeding sector 5 (see figure xx). Such a partitioning is not possible with the current database. However, the implied potential

error is considered to be small. Moreover some of the wood pulp is used to produce fiber board (a subcategory of panels) and should thus be included in sector 5 rather than sector 6.

$$S5^{Prod} = IndRWD^{NET} + Chips\&Partic^{IMP} + WoodResid^{IMP} + WPulp^{IMP} * \alpha * 3.5 - S6^{Prod}$$

$$IndRWD^{NET} = IndRWD^{Prod} + IndRWD^{Imp} + IndRWD^{Exp}$$

$$S5^{Imp} = SawnWood^{IMP} + Panels^{IMP} + Chips\&Partic^{IMP} + WoodResid^{IMP}$$

$$S5^{EXP} = SawnWood^{EXP} + Panels^{EXP} + Chips\&Partic^{EXP} + WoodResid^{EXP}$$

$S5^{Prod}$	Roundwood quantity (or area behind) for the domestic production of commodities consumed in sector 5 (wood products) [cum]
$S5^{Imp}$	Roundwood quantity (or area behind) for imported sector 5 products
$S5^{Exp}$	Roundwood quantity (or area behind) for exported sector 5 products

IndRWD	Industrial roundwood [cum]
Chips&Partic	Chips and particles [cum]
WoodResid	Wood residues [cum]
SawnWood	Sawn wood [cum]
Panels	Panels [cum]

Total country roundwood balances over all sectors

Overall area balances show a country's need for area to produce forest products and highlight whether a country is a net importer or exporter of forest land area. Net area is defined as the sum of a country's area required for domestic roundwood production plus all area used outside the country for the production of the imported commodities for the sectors 1, 5 and 6 minus all the area behind the exports of the three sectors. It represents domestic consumption of forest land area required by a country's economy and is specified as follows:

$$ANET_c = AS1_c^{PROD} + AS1_c^{IMP} + AS5_c^{IMP} + AS6_c^{IMP} - AS1_c^{EXP} - AS5_c^{EXP} - AS6_c^{EXP}$$

In this way a relatively complete accounting is available for the forest land area required to produce roundwood based commodities for a country's economy. The limitation refers to the consumption and trade of those commodities which can currently not be traced because data are not available. These are derived products from material produced in sector 5 and 6, most notably furniture and manufactured paper products such as boxes, cartoons and books².

² Graphic papers, such as paper used for printing newspapers and most office papers are included.

Export land resource coefficients

Export quantities and values of roundwood are reported in the FAOSTAT data. Using the country specific forest productivity data and the share of annual removals over annual fellings the area behind a \$ of exported roundwood can be estimated as follows:

$$LRC_{ji} = \text{ExportQty}_{ji} / (\text{ExportVal}_{ji} * Y_j * \text{Share}_j)$$

LRC	Land resource coefficient of exported forest products [m3/1000\$]
ExportQty	Exports Quantity [m3]
ExportVal	Exports Value [1000\$]

5 RESULTS

Country area balances were calculated for three economic sectors, which rely on roundwood and area to grow and harvest roundwood. A primary sector and two sectors of manufactured forest products, namely:

- Sector 1 (S1): Agriculture, hunting, forestry and fishing
- Sector 5 (S5): Wood and products of wood and cork
- Sector 6 (S6): Pulp, paper, paper products, printing and publishing

Results include for each sector domestic production and trade for both roundwood quantity (in cum) and area required to produce roundwood (in hectare). Additionally some derived variables were calculated. They include countries net trade (domestic production + imports – exports), i.e. domestic consumption. In order to make a cross-country comparison per capita data are useful, in particular for domestic consumption. Table xx presents a comprehensive summary for roundwood quantities and table xx for area. Area data were compared with the forests available for wood supply (FAWS).

Results are available on an annual basis for the period 1980 to 2002. Production and trade change over the years. The trend is an increase in overall production levels in most countries and increasing trade in commodities.

5.1 Total country area balances

When a country imports commodities it also imports resources behind these commodities and vice versa in the case of exports. The most important natural resources include energy, material uses, and water and land area. Depending on the commodity and biophysical environment of the country of origin the production of commodities entails the consumption of

a certain amount of these natural resources. Trade results in cross-country flows of natural resources. In the case of water these were termed 'virtual' water (xxx).

The focus of this study is land area and relevant commodities are all agricultural and forestry products. Henceforth we refer to land in trade as 'traded' or 'virtual' land. From a sustainability or environmental point of view *****

Overall area balances show a country's required area to produce forest products and highlight whether a country is a net importer or exporter of forest land area. Net area represents domestic consumption of forest land area required by a country's economy. Net area is defined as the sum of a country's domestic roundwood production (DP-S1) plus all area imports required to produce commodities for the sectors 1, 5 and 6 (IMP-S1 + IMP-S5 + IMP-S6) minus all the area behind the exports of the three sectors:

$$\text{NETArea} = \text{DP-S1} + \text{IMP-S1} + \text{IMP-S5} + \text{IMP-S6} - \text{EXP-S1} - \text{EXP-S5} - \text{EXP-S6}$$

In this way a relatively complete accounting is given for the forest land area required to produce roundwood based commodities for a country's economy. The limitation refers to the consumption and trade of those commodities which can currently not be traced because data are not available. These are derived products from material produced in sector 5 and 6, most notably furniture and manufactured paper products such as boxes, cartoons and books³.

Roundwood domestic production (DP-S1) includes wood fuel, which is of major significance for developing countries. Trade data comprise for sector 5 sawnwood, panels, chips and particles and wood residues and for sector 6 paper as well as traded wood pulp used for paper production. As described above area estimates are based on roundwood quantities in cubic meters for all individual variables and forest productivity (yield) data for each country. For exported commodities the exporting country's yield is applied. In the case of imported commodities we use a calculated world average yield over all countries, weighted by export quantity. For the year 2000 this was xxx cum/ha⁴. The combined effect of roundwood quantity and yield determines the areas required for production.

Results are generally available on an annual basis. The following data refer to current situation, which is here defined as the average of the three years 2000 to 2002. Table xx presents area balances for all countries and compares them with a country's forest available for wood supply (FAWS) area. Figure XX presents for selected European country's net area data and compares them with FAWS and roundwood produced domestically. Figure xx shows

³ Graphic papers, such as paper used for printing newspapers and most office papers are included.

⁴ Forest productivity data are only available for one time point, but export quantity shares may change over time.

the same data for the EU15, EU25 and compares Europe with other major players in roundwood production and consumption as well as rest of the world.

In general there are only a few forest area exporting countries, while most are area net importing countries. In Europe only Finland and Sweden are net exporting countries, each some 11 million hectares used for the production of 40 and 33 million cubic meters roundwood respectively. Exports are dominated by sector 6 exports, namely paper and wood pulp.

Outside Europe the major exporters are Canada and Russia with net exports of 118 and 54 mio.cum of roundwood, which means an export of 80 and 52 mio.hectares forest land area. Russia exports primarily primary roundwood (sector 1) and accounted for 28% of the world's roundwood exports. In contrast Canada's net exports are in the paper and wood products sectors. It was even a small net importer of primary roundwood. Other net area exporting countries, but to a much smaller extent are Indonesia (8 mio.ha), Malaysia (5.2 mio.ha) and Australia (5.8 mio.ha).

Most countries are net importers of forest area. The largest ones in Europe are Germany, Great Britain and Italy, each with net imports of some 15 million hectares. Largest trade volumes are in the paper sector 6. Great Britain and Italy import major parts of the roundwood required for their domestic consumption of sector 5 and 6 and have very low export quantities. Since Germany imports even more roundwood, but also exports a significant amount, their net area imports are as big as those from Great Britain or Italy, despite their roundwood net imports of over 30 mio.cum are much larger than those of Germany (14 mio.cum).

Outside Europe the largest net importers are the United States (50 mio.cum), China (63 mio.cum) and Japan (67 mio.cum). The US has also significant export levels (63 mio.cum), primarily of sector 6 products. This is higher than Russia's exports.

Figure xx shows net areas and compares them with a country's area used for domestic roundwood production and its forest available for wood supply (FAWS). In this way we can derive some indication of potential forest resource availabilities or constraints.

In theory domestic roundwood production should always be below FAWS area. However, results show that this is not the case for a few countries.

The exporting countries also highlight the sensitivity of yield assumptions. TBFRA-2000 reports for Sweden a slightly higher yield of 3.7 cum/ha compared to Finland's 3.2 cum/ha. Canada's yield rates are 1.8 cum/ha and Russia's 1.4 cum/ha.

EU25 is a net importer of forest area. Overall

Figure 6.x

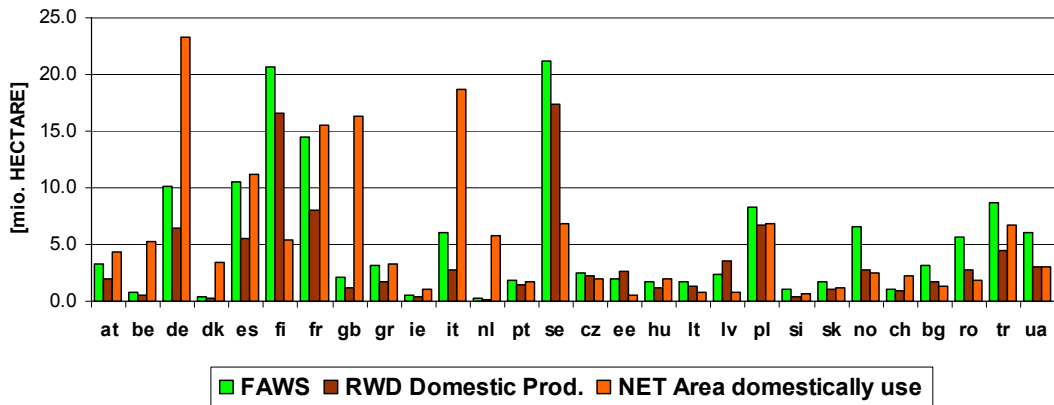
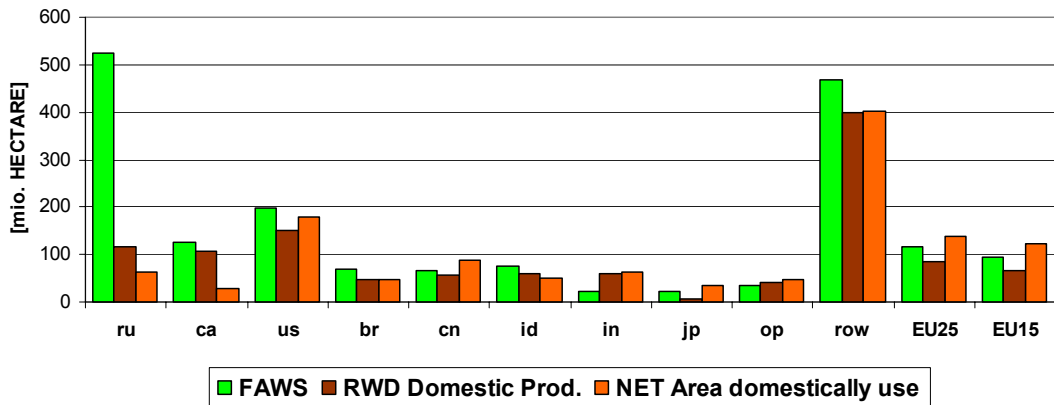


Figure 6.x



Box xx. Country grouping regarding land area trade balance and resource availability

A) Net Area EXPORTING countries

EXParea > IMParea; NETArea > RWDDom.Prod.
 Finland, Sweden;
 Russia, Canada; Indonesia, Malaysia, Australia

B) Net Area IMPORTING countries

NETArea < RWDDom.Prod.

B1) Country is not self-sufficient in FAWS. Imported area is essential to satisfy the nation's roundwood demand for the three economic sectors.

NETArea > FAWS

Germany, Italy, Great Britain, Netherlands, Austria, Switzerland
 China, Japan

B2) Country would be self-sufficient in FAWS, but import is the preferred option.

NETArea < FAWS

Poland; United States, Indonesia

Table 6.1. Forest land area statistics for European countries (in 1000 ha)

country	cc	Domestic Production			IMPORTS				EXPORTS				Area	
		DP-S1	DP-S5	DP-S6	S1	S5	S6	SUM	S1	S5	S6	TOTAL	NET	FAWS
Austria	at	1953	5099	2609	3451	1274	2492	7216	139	2564	2163	4866	4303	3352
Bel-Lux	be	556	1802	1584	1197	2111	4413	7720	111	1245	1718	3073	5203	725
Germany	de	6456	6937	9324	1978	4986	17891	24855	743	2422	4874	8039	23272	10142
Denmark	dk	274	587	102	323	1971	1300	3593	100	220	70	390	3478	440
Spain	es	5591	5303	4078	1690	2068	4786	8544	207	622	2142	2970	11165	10479
Finland	fi	16613	10635	15599	4940	683	663	6287	140	3391	13960	17491	5408	20675
France	fr	8074	7052	7520	1007	2540	10468	14016	1100	1628	3856	6584	15506	14470
Great Britain	gb	1244	1472	3487	389	5230	10464	16084	50	123	840	1013	16316	2108
Greece	gr	1743	604	198	346	499	832	1677	17	68	29	114	3306	3094
Ireland	ie	439	634	40	58	493	491	1042	13	346	54	412	1070	580
Italy	it	2771	3485	6756	2680	5028	10671	18379	8	635	1793	2435	18715	6013
Netherlands	nl	152	487	2267	283	2481	5448	8211	62	375	2091	2529	5835	314
Portugal	pt	1419	816	1481	570	301	905	1775	109	207	1140	1456	1738	1897
Sweden	se	17396	9813	15827	4582	1036	1301	6919	414	3466	13622	17502	6814	21236
Czech Rep.	cz	2258	1472	1305	426	478	911	1815	369	736	1024	2129	1945	2559
Estonia	ee	2668	1641	316	225	177	82	484	1042	1272	281	2594	557	1932
Hungary	hu	1147	634	322	150	664	828	1642	336	349	168	853	1936	1702
Lithuania	lt	1342	1111	0	38	189	97	324	308	539	0	847	819	1686
Latvia	lv	3562	3169	0	106	83	96	285	1158	1954	0	3112	735	2413
Malta	mt	0	2	0	3	28	31	62	0	0	0	0	62	0
Poland	pl	6682	4580	2870	376	639	1962	2977	255	1263	1268	2786	6873	8300
Slovenia	si	384	367	504	195	213	503	910	56	162	408	625	669	1035
Slovak Rep.	sk	1075	513	784	326	338	455	1119	324	312	398	1034	1160	1706
Norway	no	2775	1923	3075	1534	823	690	3047	175	395	2809	3379	2442	6609
Switzerland	ch	983	618	1050	264	624	1914	2802	452	274	771	1497	2288	1060
Bulgaria	bg	1745	605	306	42	52	174	268	205	302	227	734	1279	3124
Romania	ro	2715	1457	954	19	184	187	390	90	722	452	1265	1840	5617
Turkey	tr	4514	2968	1109	561	287	1556	2404	2	124	93	219	6699	8635
Ukraine	ua	2966	1557	194	38	190	479	707	358	304	40	703	2970	5999

Table 6.2. Forest land area statistics for non-European countries and selected country aggregates (in 1000 ha)

country	cc	Domestic Production			IMPORTS				EXPORTS				Area	
		DP-S1	DP-S5	DP-S6	S1	S5	S6	SUM	S1	S5	S6	TOTAL	NET	FAWS
Russia	ru	116143	25378	35174	200	277	601	1078	24467	8541	20559	53567	63654	525191
South Africa	za	3827	775	2068	34	222	346	603	92	455	1020	1567	2863	3000
Canada	ca	107853	88151	66686	3118	2150	4089	9357	2273	29831	57220	89324	27886	125863
United States	us	151518	50522	96134	1255	22932	28967	53155	3948	4635	17700	26282	178391	198123
Argentina	ar	4764	1445	1606	2	82	740	823	301	252	467	1019	4568	10000
Brasil	br	47286	4868	1826	113	153	1350	1617	169	744	576	1490	47413	68000
Chile	cl	4674	2032	1911	0	12	369	381	71	766	1607	2444	2611	3900
Mexico	mx	22692	2159	2446	45	1043	3027	4116	276	177	205	658	26150	18000
Peru	pe	4349	292	0	12	32	262	306	0	46	0	46	4609	17300
China	cn	57103	19956	19850	8912	6270	20551	35733	375	2340	2087	4801	88035	65160
Indonesia	id	58373	7624	8952	73	96	1856	2025	1436	3886	4918	10240	50159	74166
India	in	60846	1859	1268	958	58	987	2003	16	4	37	58	62791	21935
Japan	jp	6313	12403	17715	6717	15784	6940	29440	12	18	858	888	34865	23276
Korea	kr	2015	5276	5109	3585	2266	4962	10814	2	72	1298	1372	11457	2200
Malaysia	my	9838	5513	293	353	367	1264	1984	3225	3888	51	7165	4658	11255
Philippines	ph	17405	773	833	221	290	650	1161	170	71	110	351	18215	2202
Singapore	sg	1	6	117	123	321	922	1366	174	41	262	477	890	0
Thailand	th	13727	1143	849	318	622	1107	2047	27	888	281	1197	14577	7000
Australia	au	14740	10748	6622	5	501	1933	2439	555	6352	1360	8267	8912	16438
New Zealand	nz	1629	539	597	2	24	366	392	548	257	461	1266	756	1851
OPEC	op	41634	1324	563	348	1862	2689	4899	146	33	160	339	46195	34000
Rest of World	row	398288	12865	1616	831	4730	7495	13055	6995	3078	199	10271	401072	466643
Europe	EUR	92035	72832	82359	27287	35329	80148	142764	7983	25589	56159	89730	145069	133325
EU25	EU25	83818	68228	76973	25423	33600	77155	136178	7060	23896	51900	82856	137141	116901
EU15	EU15	64682	54727	70873	23493	30702	72125	126320	3213	17309	48351	68873	122129	95525
WORLD	ww	1244534	333007	355898	55109	95901	173660	324670	53622	92393	167728	313743	1255461	1843462
	ind	355150	226746	269670	40594	76496	123401	240491	11603	60041	132259	203903	391738	474539
	ww-ind	889384	106261	86228	14515	19405	50259	84179	42018	32352	35469	109840	863723	1368923

5.2 RESULTS – PAPER sector

Pulp, paper and paper products are included in the economic sector 6. Pulp is the basic ingredient for the manufacture of paper. It is produced from fresh wood and woodchips on the one hand and recovered fiber on the other. We consider full statistics of recovered paper (recycled paper). No forest land area is necessary to produce recycled paper. Thus in the area estimates for the paper sector, the amount of recovered paper is subtracted from total paper production and only for the remaining paper quantities the area is calculated.

No data are available for certain manufactured paper products, primarily boxes, cartoons and books⁵. The raw material for these products is pulp or paper. Since both are included in the area estimates, estimates for countries with little trade in these manufactured products are fairly complete. However, if trade is significant, in the case of an exporting country we overestimate land area required for domestic consumption in the paper sector and vice versa for importing countries. We may assume that for the industrialized countries the per capita domestic paper consumption (in quantity terms) should be fairly similar. Therefore countries with a higher per capita consumption (see Table xx) point towards being a net exporting country for these not accounted for manufactured paper products. In Europe these include Sweden, Austria, Finland and Netherlands.

The area required to produce commodities in the paper sector is determined by the following factors. The first two relate as in all forest area estimates to the paper consumption level per capita and the assumed yield to produce the roundwood quantities for pulp and paper production. An additional factor here is the amount of recycled paper collected and consumed in the pulp and paper industry.

Table 6.1 and 6.2 summarize country statistics for quantities (in cum roundwood or roundwood equivalent) of individual items considered in sector 6. If not stated otherwise data refer to the current situation, which is defined as the average of the three years 2000 to 2002. Domestic production of paper (Paper-DP) comprises two different elements. One is the paper directly derived from roundwood (Rwd-based), the other is the paper produced from collected and recycled papers. The latter refers to the recycled paper domestically consumed (NET-Recycle), i.e. domestic production plus imports minus exports. For the paper domestically consumed (Paper-DC, NET) also per capita levels are shown. In the case of recycled paper, domestic production per capita is shown for two time periods, the average of 2000 to 2002 and 1985 to 1987. Paper recycling is possible only a few times. Recycle share in domestic consumption is the ratio of domestic production of recycled paper and paper domestic consumption.

⁵ Graphic papers, such as paper used for printing newspapers and most office papers are included.

The data reveal the major importance of trade in many countries. Paper, pulp, as well as recovered paper is traded extensively. However, often trade is dominated by individual countries. Currently major paper exporting countries are Canada (24% of world exports), the United States (11%), Finland (12%), and Sweden (10%), while on the import side the United States (17% of world imports), China (12%) and Germany (10%) control the market. The pattern of countries primarily participating in trade was relatively stable since the 1980s. The exception is Canada who reduced its high world share in paper exports from 31% down to 24% and China who substantially increased its paper imports. The trend is a participation of more countries in world trade.

Per capita paper consumption is highly related to GDP. In industrialized countries per capita paper consumption is around 0.8 cum roundwood equivalent compared to a world average of 0.2. In Eastern Europe per capita paper consumption is quite low, mostly between 0.1 and 0.2. These levels are similar to many countries in Asia and South America (e.g. China, Indonesia, Brasil).

Recovered paper

Paper recovery is the practice of collecting paper to produce recycled paper or some other product, such as cellulose insulation. Paper recovery is accomplished in many ways. The most visible method is residential curbside recycling programs, which collects a variety of paper types generated by households. However, the majority of recovered paper originates from the business and industrial sectors.

The use of recycled fiber has been growing steadily in the past two decades (Table 6.xx). For both the world and the EU15 recycled paper production more than doubled in the past 15 years. Globally the amount of traded recycled paper increased from 27 million cum roundwood equivalent to over 80 million. Thus today some 20% of recycled paper is traded. The dominant exporting country for recycled paper is the United States with a share of 41% of world exports, while China is the major importer with 24% of world imports.

The ratio of produced recovered paper in total domestic paper consumption has also increased and is currently at 39% for the EU25, only slightly higher than the world average of 37%.

Table x2. Recycled paper statistics for selected countries

	EU25	EU15	Germany	World	USA	Japan	S.Korea	China
Average 2000-2002								
Dom. production	131	125	37	447	136	48	17	52
Per capita	0.29	0.33	0.45	0.07	0.48	0.38	0.37	0.04
Dom. consumption	125	118	30	460**	105	44	23	73
Recycle ratio*	39	40	50	37	41	48	44	31
Average 1985-1987								
Dom. production		56	18	201	64	34	3	12
Per capita		0.16	0.23	0.04	0.26	0.28	0.08	0.01
Dom. consumption		57	17	202	51	35	6	15
Recycle ratio*		27	32	27	25	41	26	22

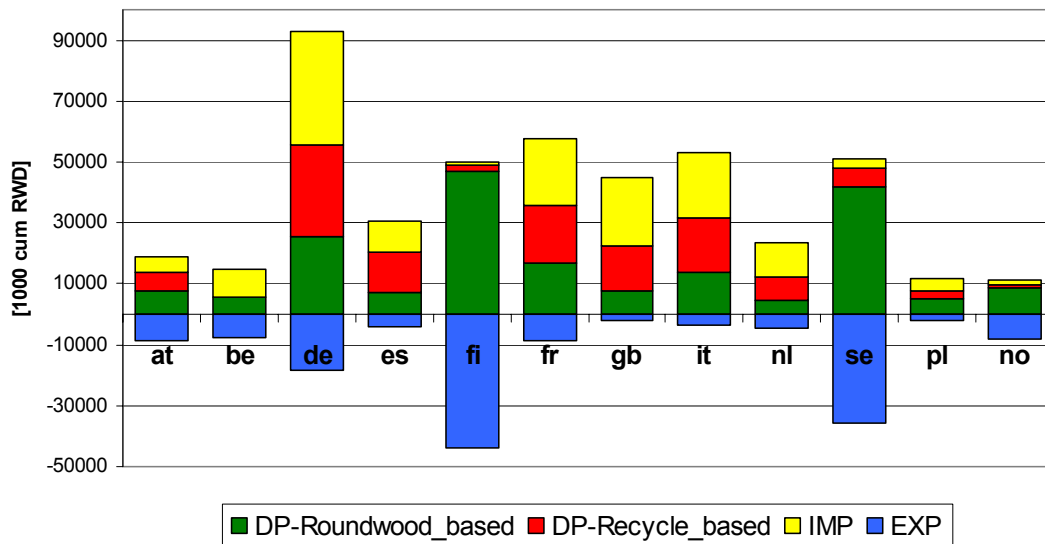
*Share of domestic production of recycled paper in domestic paper consumption ($\text{Recycle_DP} * 100 / (\text{PaperDP} + \text{PaperIMP} - \text{PaperEXP})$)

Paper production and trade

The composition of a countries paper sector varies widely. Figure xx shows selected European countries. In general the main producers of roundwood based paper (Finland, Sweden in Europe; Unites States and Canada) are at the same time the main paper exporting countries. Countries that rely to a significant extent on imports for their domestic paper supply tend to have high rates of paper produced from recovered fiber.

The latest data for the EU25 (average 2000 to 2002) indicate the EU being practically self-sufficient in the paper sector. A total of 95 million tons of paper (323 million cum roundwood equivalent) was produced, of which 61% rely on roundwood and 39% on recovered fiber.

Figure 6.x. Paper trade balances and sources of domestic paper production for selected European countries



Land area in the paper sector

With respect to forest land area required to produce commodities in the paper sector only the roundwood based paper production is considered. As a result of this combined with differences in paper consumption levels, globally relatively few countries require forest land for their paper sector.

Currently the world requires 356 million hectare to produce roundwood for the paper sector up from 267 million hectare in the mid 1980s. Nearly half of this area (48%) is traded compared to 41% in the 1980s. The EU25 is a small net importer of forest area required for the paper sector (Table 6.x). Per capita area varies widely between industrialized countries and less developed ones. Countries on the high end include the United States with 0.8 ha per capita. The EU25 consumes 0.46 ha per capita compared to a world average of 0.12 ha per capita (Table 6.x).

Today 15% of the world's population (group of industrialized countries as shown in Table 6.x) requires more than two third (72%) of the 356 million hectare forest land area currently used for the paper sector. However, these industrialized countries do not rely on forest land outside their territory. The main reason for this is the three roundwood exporting countries Canada, Sweden and Finland. They even were a very small net exporter of forest land area, which however is solely due to the forest resources of Canada, Sweden and Finland. As described above (Table 6.x) the paper production in this group of industrialized countries relies to a third (35%) on fibers derived from recovered paper.*****

Table 6.x. Forest land area required for the production of commodities in the paper sector – Selected countries and aggregates

AVG 2000-2002 [mio. ha]	Share [%]					
	Domestic Production (DP)	Domestic Consumption (DC)	DC per capita	POP	DP	DC
EU25	77	102	0.46	7.4	22	28
USA	96	107	0.80	4.7	27	29
China	20	38	0.07	21	6	11
Industr.*	270	260	0.59	15	76	72
Non Indust.	86	101	0.04	85	24	28
World	356	362** (170 in trade)	0.12	100	100	100

* Group of industrialized countries including EU15, Czech Rep., Slovenia, Norway, Switzerland, Canada, USA, Australia, New Zealand;

** The difference in world domestic production and consumption reflects the error in the underlying trade statistics in the original data source.

Figure 6.x. Forest land area required for the production of commodities in the paper sector. Domestically used area and trade statistics for European countries

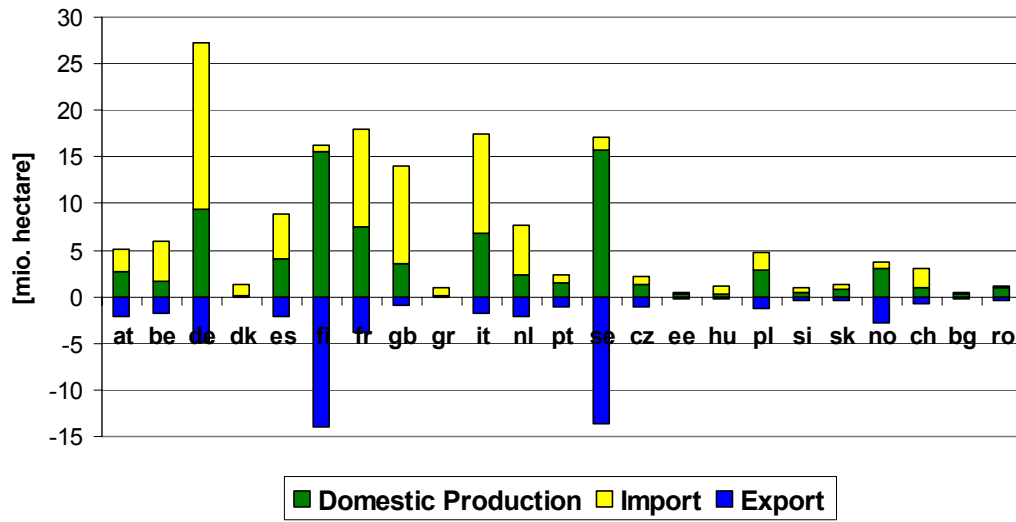


Table 6.x. Paper quantity statistics for European countries (in cum roundwood equivalent)

country	cc	Paper-DP (dom.prod.)		PAPER			Paper-DC (dom.cons.)		RECYCLED Paper			DP per Capita		Recycle Share	
		Rwd-based	NET-Recyc.	total DP	IMP	EXP	NET	per Capita	IMP	EXP	DP	00-02	85-87	00-02	85-87
Austria	at	7419	6196	13615	5125	8449	10290	1.27	2871	669	3994	0.49	0.18	39	21
Bel-Lux	be	5375	0	5375	9410	7678	7108	0.69	782	3302	2520	0.25	0.17	35	26
Germany	de	25754	30057	55810	36835	18516	74130	0.90	5120	12275	37211	0.45	0.23	50	32
Denmark	dk	937	0	937	2865	798	3003	0.56	379	1398	1019	0.19	0.21	34	30
Spain	es	7012	13409	20421	10149	4042	26528	0.66	2489	313	11234	0.28	0.12	42	34
Finland	fi	46730	2001	48732	1364	44102	5993	1.16	122	367	2246	0.43	0.22	37	19
France	fr	16748	18991	35739	21674	8696	48717	0.80	3931	3301	18361	0.30	0.14	38	27
Great Britain	gb	7702	14858	22560	22116	1982	42694	0.73	290	2764	17332	0.30	0.14	41	24
Greece	gr	355	48	403	1781	189	1995	0.18	26	145	168	0.02	0.05	8	22
Ireland	ie	107	74	181	1075	147	1110	0.29	6	317	385	0.10	0.04	35	18
Italy	it	13763	17883	31646	21400	3768	49279	0.85	2250	963	16596	0.29	0.08	34	17
Netherlands	nl	4588	7725	12314	11383	4591	19105	1.20	5845	5836	7717	0.48	0.28	40	34
Portugal	pt	6649	774	7423	1927	5723	3627	0.35	85	474	1163	0.11	0.08	32	35
Sweden	se	41660	6477	48137	2655	35765	15027	1.69	2325	565	4717	0.53	0.30	31	27
Cyprus	cy	0	0	0	141	2	139	0.18	0	36	36	0.05	0.00	26	0
Czech Rep.	cz	2965	1056	4021	1935	2313	3644	0.35	164	332	1224	0.12	nd	34	nd
Estonia	ee	224	8	232	183	200	215	0.16	5	52	55	0.04	nd	26	nd
Hungary	hu	666	1108	1775	1721	350	3146	0.31	177	120	1051	0.10	0.09	33	31
Lithuania	lt	0	250	250	213	15	448	0.13	116	6	139	0.04	nd	31	nd
Latvia	lv	38	47	86	215	25	276	0.12	3	90	135	0.06	nd	49	nd
Malta	mt	0	0	0	69	0	69	0.18	0	0	0	0.00	0.00	0	0
Poland	pl	4972	2560	7532	4158	2196	9494	0.25	35	132	2657	0.07	0.04	28	28
Slovenia	si	1406	713	2118	1000	1087	2032	1.02	600	97	210	0.11	nd	10	nd
Slovak Rep.	sk	2592	774	3366	957	1297	3025	0.56	347	93	520	0.10	nd	17	nd
Norway	no	8637	940	9577	1450	8065	2961	0.66	243	647	1344	0.30	0.10	45	17
Switzerland	ch	2009	3621	5630	3935	2150	7415	1.03	807	936	3751	0.52	0.25	51	31
Bulgaria	bg	441	320	761	380	273	867	0.11	69	8	258	0.03	0.03	30	11
Romania	ro	908	479	1387	413	426	1374	0.06	25	2	455	0.02	0.01	33	11
Turkey	tr	2179	3333	5511	3225	181	8555	0.13	401	5	2938	0.04	0.01	34	28
Ukraine	ua	372	1288	1660	1025	79	2606	0.05	250	6	1045	0.02	nd	40	nd

Table 6.x. Paper quantity statistics for Non-European countries and selected country aggregates (in cum roundwood equivalent)

country	cc	Paper-DP (dom.prod.)		PAPER			Paper-DC (dom.cons.)		RECYCLED Paper			DP per Capita		Recycle Share	
		Rwd-based	NET-Recyc.	total DP	IMP	EXP	NET	per Capita	IMP	EXP	DP	00-02	85-87	00-02	85-87
Russia	ru	20501	5256	25757	1313	12066	15004	0.10	22	96	5330	0.04	nd	36	nd
South Africa	za	8024	1889	9914	726	3942	6697	0.15	12	28	1906	0.04	0.04	28	24
Canada	ca	100208	10911	111119	8936	84633	35423	1.15	7838	1701	4775	0.16	0.13	13	16
United States	us	205507	104789	310297	59766	38551	331511	1.18	997	32082	135874	0.48	0.26	41	25
Argentina	ar	2377	3068	5445	1582	937	6090	0.16	78	4	2995	0.08	0.03	49	29
Brasil	br	26360	8478	34838	2738	11440	26136	0.15	54	13	8438	0.05	0.03	32	29
Chile	cl	10179	388	10567	808	8082	3293	0.22	0	51	439	0.03	0.03	13	32
Mexico	mx	6031	7040	13072	6305	405	18972	0.19	4429	361	2972	0.03	0.04	16	30
Peru	pe	0	283	283	565	0	848	0.03	57	6	233	0.01	0.01	27	24
China	cn	56331	73645	129975	42035	5791	166219	0.13	22105	665	52205	0.04	0.01	31	22
Indonesia	id	17043	11360	28403	3490	10613	21281	0.10	7667	64	3757	0.02	0.01	18	36
India	in	7319	6311	13630	2062	216	15477	0.02	3565	0	2746	0.00	0.00	18	13
Japan	jp	45899	44585	90484	13401	2976	100910	0.80	685	4044	47944	0.38	0.28	48	41
Korea	kr	10164	22669	32834	9354	2672	39516	0.84	5244	78	17503	0.37	0.08	44	26
Malaysia	my	856	1078	1935	2784	321	4397	0.19	773	24	330	0.01	0.01	7	12
Philippines	ph	1500	2256	3756	1413	202	4968	0.07	1197	2	1061	0.01	0.00	21	8
Singapore	sg	0	87	87	2011	869	1229	0.31	234	1368	1221	0.30	0.24	99	49
Thailand	th	3019	6268	9287	2167	1560	9894	0.16	3667	0	2602	0.04	0.01	26	29
Australia	au	5068	4451	9518	4077	1020	12576	0.65	193	922	5180	0.27	0.12	41	23
New Zealand	nz	5224	409	5633	811	4094	2350	0.62	0	216	626	0.17	0.10	27	16
OPEC	op	806	1692	2498	5789	227	8060	0.03	636	357	1413	0.00	0.01	18	20
Rest of World	row	11322	8392	19713	16107	2434	33386	0.02	2211	572	6753	0.00	0.00	20	21
Europe	EUR	209658	130379	340037	166591	162843	343785	0.69	29112	35257	136524	0.27	0.13	40	nd
EU25	EU25	197663	125011	322674	160349	151929	331095	0.73	27966	33644	130688	0.29	0.13	39	nd
EU15	EU15	184799	118493	303293	149759	144445	308607	0.82	26520	32687	124661	0.33	0.16	40	27
WORLD	ww	755946	460308	1216254	359082	356156	1219180	0.19	91424	77922	446806	0.07	0.04	37	27

6 CONCLUSIONS

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