Recent trends and developments in global markets for pulp and paper[1]

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ABSTRACT

This paper is based on the results of recent and ongoing outlook studies carried-out by FAO. It presents an overview of some of the main driving forces currently affecting the global markets for pulp and paper and describes how they have affected production and consumption patterns. It then discusses the implications of these trends for the pulp and paper sector in India.

Over the last few decades, global forest products markets have been driven by trends in the forest resource, technology, markets and government policies. In terms of the resource, a major trend has been towards greater availability and use of wood from forest plantations. This has shifted supply away from traditional suppliers in the Northern Hemisphere towards countries in the South. In addition to this, the use of recycled fibre has also increased considerably, driven by urbanisation and environmental policies that reflect concerns about waste disposal.

On the demand side, the pattern of demand for products has been driven by changes in consumer tastes and, in particular, the increased use of computers. On the one hand, the increased use of computers has led to high growth in the use of printing and writing paper. In contrast, the more recent advent of the internet has reinforced the gradual decline in the importance of newsprint within the paper sector. These forces are reflected in the high rates of growth in demand for printing and writing paper in recent years and much more subdued growth (and even a decline) in the demand other types of paper. The rapid increase in globalisation has also been a major force. A significant proportion of forest products has always been traded internationally, but this proportion has increased dramatically over the last decade. This has, in part, been driven by rapid economic growth in the major industrialising nations (e.g. Brazil, Russia, India and China).

There are two major conclusions that can be drawn from recent trends in forest products markets. The first is that the forces driving the development of the forestry sector have changed somewhat. Traditionally, forest industries developed in countries with significant forest resources and international trade was driven by the geographical mis-match between countries with vast resources and countries with high levels of consumer demand. In recent years, these natural advantages have become less important and development of the forest industry has been driven more by economic advantage (e.g. factors such as: labour costs; levels of research and technology; and access to capital). The second conclusion is that government policies continue to play a major role in shaping developments. Many of the changes described above have been influenced by policies on industrial development, trade, land use, technology and the environment.

The challenge for the pulp and paper industry in India will be to identify and deal with the opportunities and threats posed by this changing environment, so that they will continue to meet the demands of their consumers in the future. In particular, some emerging issues might include the following: the increased dependence on forest plantations and trees outside forests for fibre supply; the comparative advantage of using domestic fibre compared with importing wood fibre and pulp; and the potential impact of water scarcity on the sector.

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[1] Paper presented to: *"Paperex'2005 – International Technical Conference on Pulp and Paper Industry"*, 3-5 December 2005, New Delhi, India.

[2] The views expressed here are those of the author and do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

INTRODUCTION

This paper is based on the results of recent and ongoing outlook studies carried-out by FAO (Bull *et al*, 1998; FAO, 1998; Zhu *et al*, 1998; Ljungman *et al*, 1999; Brown, 2000; and UN, 2005a). It is divided into four sections, covering: trends in wood and fibre supply; market developments; developments in processing capacity; and some comments about the implications of global trends for the pulp and paper sector in India. In particular, each of the sections attempts to describe some of the main driving forces behind recent developments in the pulp and paper sector and present some conclusions about the future.

WOOD AND FIBRE SUPPLY

Unlike other parts of the wood processing sector, the pulp and paper industry obtains wood and fibre supplies from a wide variety of different sources. These include: pulpwood (from forests, other wooded land and trees outside forests); wood residues (from the sawmilling and plywood industry and recovered wood products); non-wood fibre sources (such as grasses and bagasse); and recovered paper. In addition, international trade in wood pulp is significant and paper producers in a number of countries rely heavily on imported wood pulp as a source of fibre supply (UN, 2005a).

Over the last few decades, the regional distribution of industrial roundwood production has shifted somewhat, with a decline in the relative importance of traditional producers in the Northern Hemisphere and rapid growth in production in countries in the South. At the same time, there has also been a global trend towards greater use of wood and fibre from non-forest sources. The driving forces behind these trends are explained below, followed by a more detailed description of some of the most important trends.

Main driving forces

Over the last few decades, trends in wood and fibre supply have been driven largely by changes in technology and government policies. These changes have altered the location, amount and type of fibre resources available to the industry and the ability of the industry to utilise different types of wood and fibre.

For example, forest plantation management has improved in many countries, largely due to the wider application of existing knowledge about best practices in areas such as: species selection; ground preparation; planting techniques; and protection. In addition, more recent research into tree growth and fibre properties has started to lead to increases in fibre quality and yield (Fenning and Gershenzon, 2002; Vichnevetskaia, 1997). These developments have resulted in greater success in forest plantation establishment and an increase in the economic viability of tree planting, especially in the tropics and subtropics.

Technological advances in processing techniques have been quite gradual, but they have developed in parallel to enable the industry to adapt to these changes in wood and fibre supply. For example, techniques have been developed to overcome some of the problems associated with the shorter and weaker fibres present in hardwood species. In addition, de-inking techniques (such as floatation and washing cells with adjunction of chemicals to maintain ink particle separation) have increased ink removal and improved the quality of pulp and paper manufactured from recovered fibre (Lahaussois, 2000).

In the area of forestry policy, a general trend has been the gradual imposition of restrictions on commercial access to forest resources (especially natural forests) for social and environmental reasons (Bull *et al*, 1998; and Durst *et al*, 2001). However, many governments have also supported the development of new and alternative sources of fibre supply. In particular, subsidies and other enabling measures have been used to encourage the establishment of forest plantations in a large number of

countries (Brown, 2000; and Enters *et al*, 2004). This has had a major impact on current and future wood supply that is especially relevant to the pulp and paper industry.

There is also evidence that the control and ownership of forest resources is gradually changing, with a decrease in the proportion of forest area that is owned and managed by the public sector (FAO, in prep). With an expansion in the area of privately-owned forest, it can be expected that wood production from these forests will be determined more by market forces and might increase in the future.

Environmental policies have also had a major effect on fibre supply. For example, subsidies have been used in some countries to encourage wastepaper collection and recycling and the development of a recycling industry. A number of countries have also introduced measures (such as landfill taxes) to ensure that businesses pay the full cost of waste disposal. Recently, this has led to significant increases in the recycling of solid wood products in countries such as Germany and the UK (UN, 2005a). Environmental concern amongst the wider public has also led to some buyers (including governments) demanding a minimum recycled fibre content in the paper that they purchase.

At the same time that these environmental policies have been introduced, the gradual urbanisation of many countries has also tended to reduce the cost of wastepaper recovery and recycling. Thus, these policies and demographic changes have combined to result in a huge increase in the availability of recovered paper (especially in developed countries) over the last 10 to 15 years.

Trends in the forest resource

Table 1 shows the trends in the total forest area over the last 15 years reported in the forthcoming Global Forest Resource Assessment (FRA). At the global level, the forest area has declined by about 2.5 percent over the period or an average of just under 0.2 percent per year. However, the variation between regions is significant. For example, the forest area in Europe has increased since 1990, while the area in the Asia-Pacific region declined in the 1990s but has since increased slightly. In contrast, there has been a significant loss of forest cover in Africa and South America throughout the period.

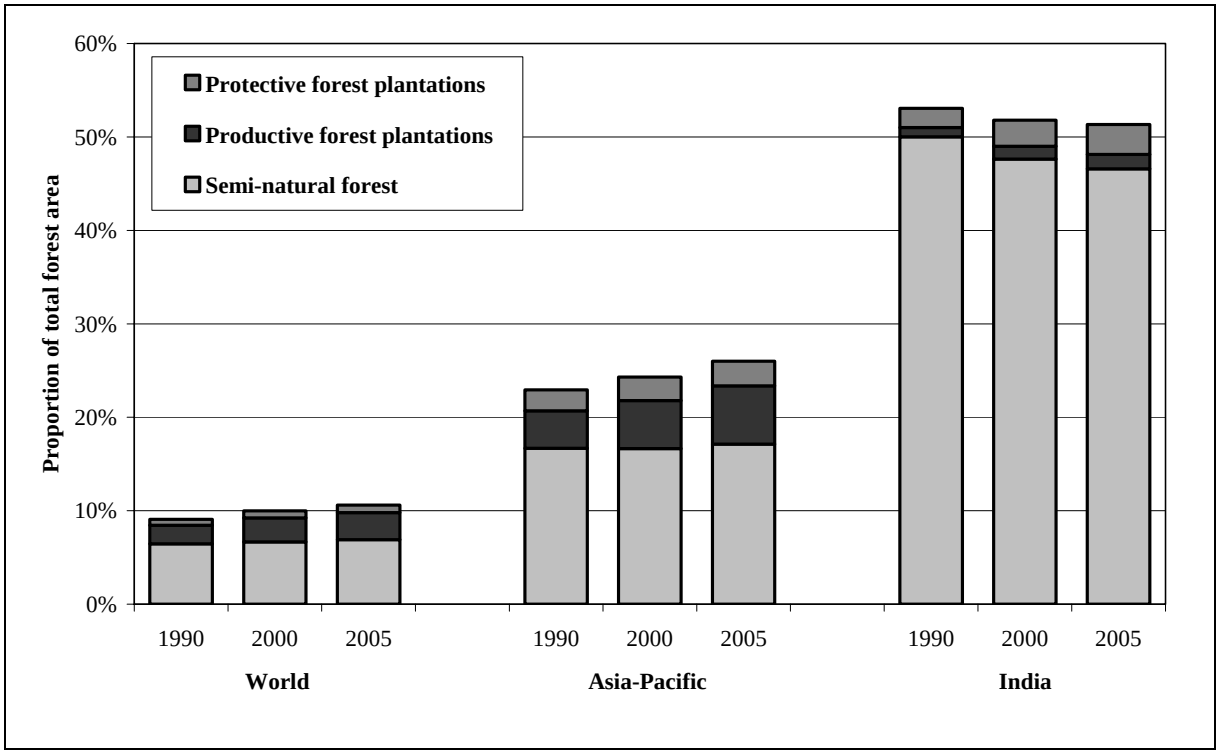
Table 1 Trends in the total forest area from 1990 to 2005

Region	Total forest area (in million ha)			Annual change (in %)	
	1990	2000	2005	1990-00	2000-05
Africa	686	642	623	-0.65	-0.62
Asia-Pacific	786	774	777	-0.16	+0.08
India	*64*	*68*	*68*	*+0.55*	*+0.04*
Europe (including Russia)	989	998	1,001	+0.09	+0.07
North and Central America	711	708	706	-0.05	-0.05
South America	970	943	929	-0.28	-0.29
World	**4,141**	**4,065**	**4,036**	**-0.19**	**-0.14**

Source: FAO (in prep).

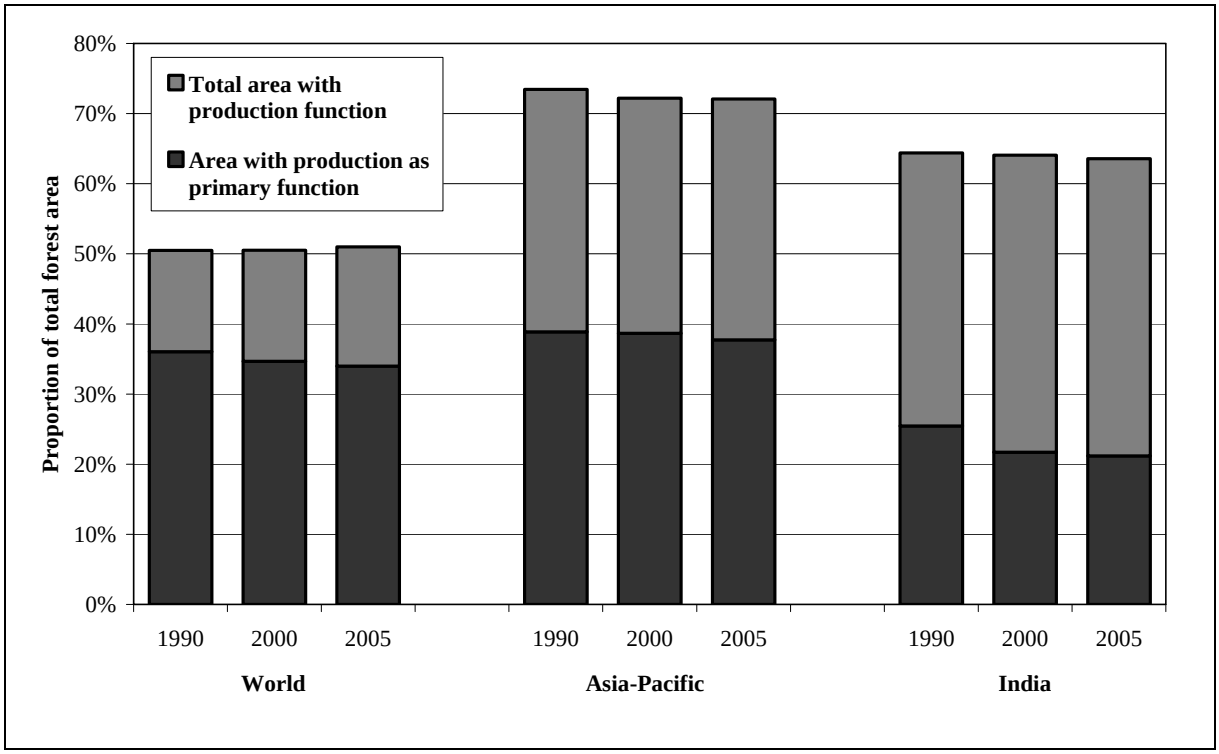
From the perspective of wood and fibre supply, the total forest area is not a particularly useful indicator of supply potential as there is little correlation between historical levels of wood production and total forest area. Indeed, the status of the forest resource is just one of a number of variables that affect wood supply (including, for example, harvesting costs and government policies within and outside the forestry sector). However, when examining the relationship between the forest resource and wood supply, there are likely to be some more subtle factors that could be quite important, such as the characteristics of the forest (i.e. intensity of management), the area available or designated for production and the structure of forest ownership.

Figure 1 Trends in the characteristics of the forest resource from 1990 to 2005



Source: FAO (in prep). Note that the figures for the World and Asia-Pacific region are based on the sample of countries that provided this information to FAO for all three years.

Figure 2 Trends in the forest area designated for production from 1990 to 2005



Source: derived from FAO (in prep). Note that the figures for the World and Asia-Pacific region are based on the sample of countries that provided this information to FAO for all three years.

Figure 1 shows the trends in the characteristics of the forest resource from 1990 to 2005 reported in the FRA. For the purpose of this assessment, forest characteristics were divided into five forest types that broadly reflect the intensity of management and the naturalness of the resource. These include "*primary forest*" and "*modified natural forest*", where the latter represents areas of natural forest that have been disturbed by human intervention (e.g. wood harvesting), but left to regenerate naturally with little or no assistance. At the other end of the scale, "*productive forest plantations*" and "*protective forest plantations*" have been defined (as in previous assessments) as areas that are planted with introduced species (often on a relatively short rotation) and are primarily managed for a single purpose. Between these extremes, "*semi-natural forest*" is forest of native species established through assisted natural regeneration, seeding or planting (FAO, in prep).

The figure shows that forest plantations and semi-natural forest have increased as a proportion of the total forest area over the last 15 years at the global level and in the Asia-Pacific region. It shows that these three types of forest account for a particularly high proportion of the total forest area in the Asia-Pacific region (and even more so in India). Most importantly, it also shows a significant increase in forest plantations over the last 15 years at the global level, in India and in the Asia-Pacific region as a whole.

Figure 2 shows the trends in the forest area designated for production from 1990 to 2005. This information has been collected and presented in the FRA in two ways: the area of forest where production is the primary function or purpose of management and the total area of forest where production is a function (either the primary function or one of a number of different functions).

Based on the sample of countries that provided this information to the FRA, the proportion of forest used for production is about 50 percent at the global level, just over 70 percent in the Asia-Pacific region and about 65 percent in India. Furthermore, these proportions have not changed very much over the last 15 years. However, the proportion of the forest area where production is the primary function is much lower, at about 35 percent at the global level, just under 40 percent in the Asia-Pacific region and slightly more than 20 percent in India. In addition, these proportions have all fallen over the last 15 years. This suggests that a greater proportion of the forest area used for production is now managed for several different functions. It could also mean that future roundwood production might become more complicated (and possibly more costly) in some locations.

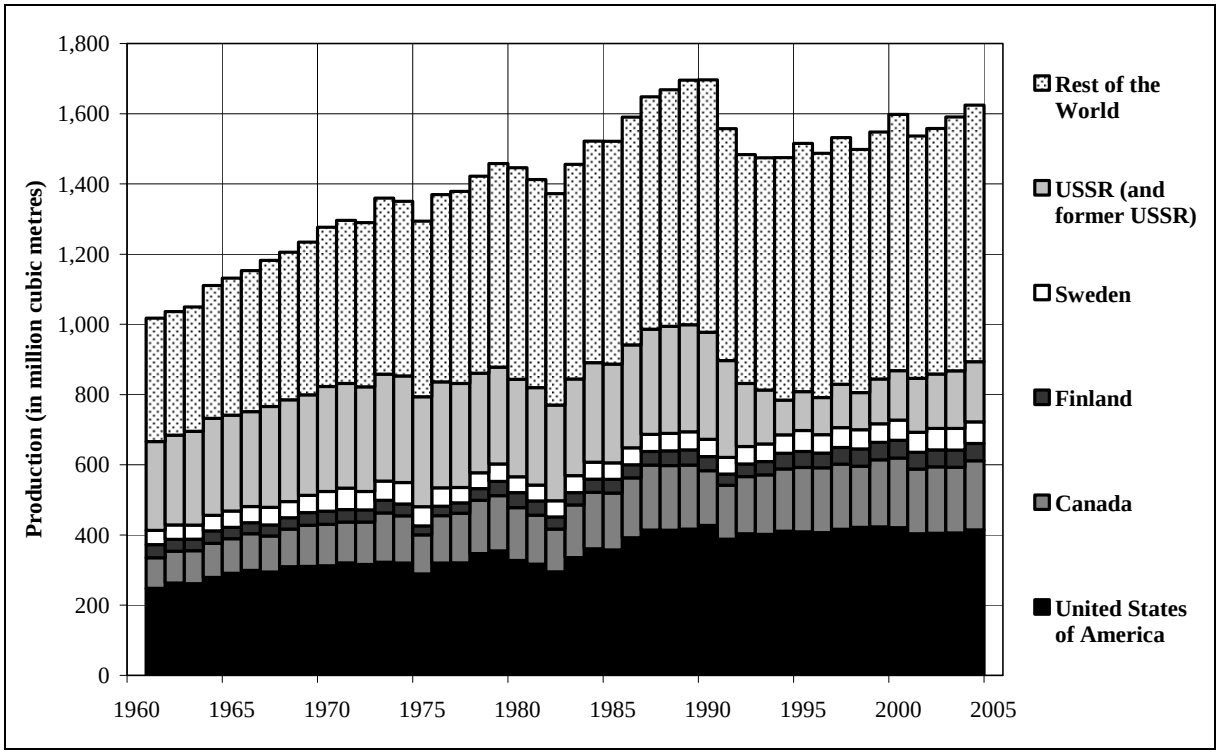
Trends in industrial roundwood production

Over the last four decades, global industrial roundwood production has increased by about 60 percent, to a current level of around 1.6 billion cubic metres (see Figure 3). However, the current level of production is somewhat less than the peak in production experienced in the early 1990s. This decline in production since 1990 is largely due to the disintegration of the USSR, although there are now signs that production is increasing again quite rapidly in many of the countries of the former USSR.

Examination of the long-term trend in global industrial roundwood production also reveals that there has been a shift in the regional distribution of production (see Figure 4). Until the mid-1970s, five countries in the Northern Hemisphere (USA, Canada, Sweden, Finland and USSR) accounted for about 65 percent of global production and almost all of the growth in production. Over the next 30 years, their share of global production fell to the current level of 55 percent, due to the decline in production in the (former) USSR and a much lower level of growth in production in the USA.

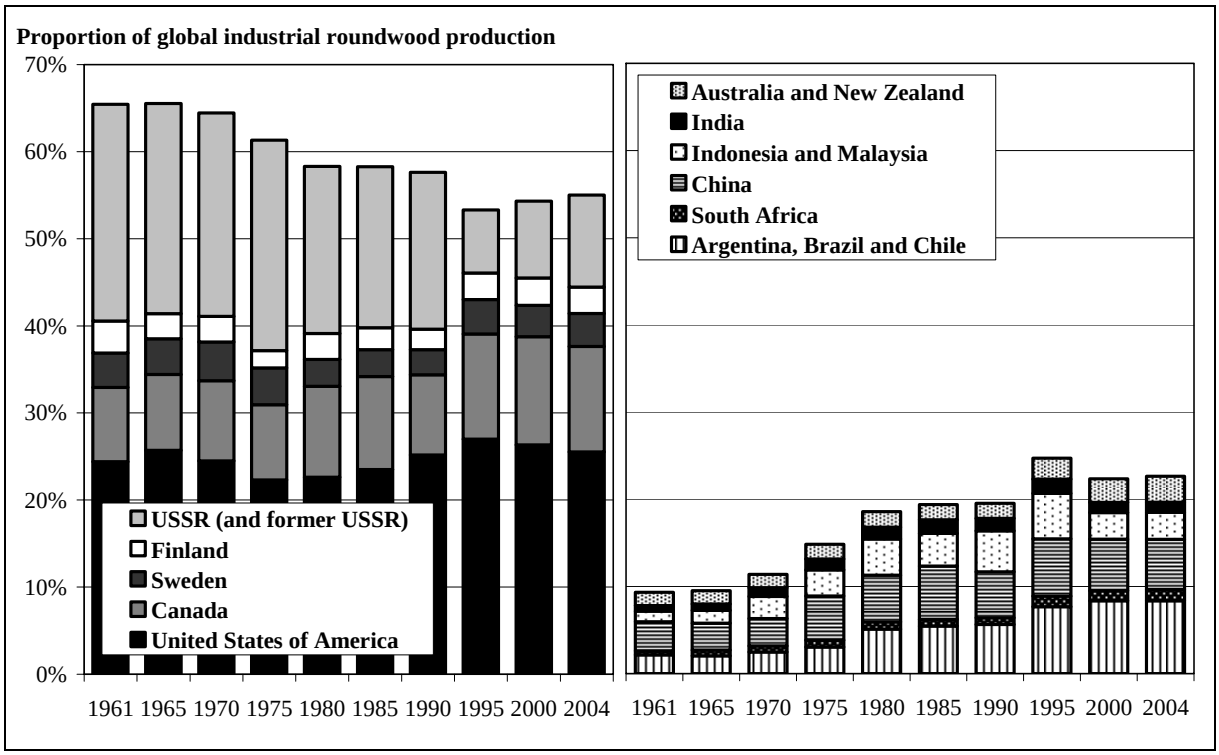
In contrast, production in a number of countries in the South increased significantly over the same period. Their share of global production increased from under 10 percent in 1961 to around 22 percent in 2004. During the 1970s and 1980s, this increase was largely the result of industrialisation in the sector, based on industrial roundwood supplied from the natural forest. However, in more recent years, many of these countries have started to make the transition from harvesting in the natural forest to obtaining industrial roundwood supplies from forest plantations.

Figure 3 Trends in global industrial roundwood production from 1961 to 2004



Source: FAO (2005).

Figure 4 Changes in the location of industrial roundwood production from 1961 to 2004



Source: FAO (2005).

Due to a number of factors, the future outlook for industrial roundwood production is quite uncertain at the moment. One major uncertainty is the outlook for production in Russia. If the forest industry in Russia starts to grow at a similar rate to that experienced until 1990 (and there is evidence to suggest that it might), then global industrial roundwood production could revert to the growth rate experienced during this period (about 1.8 percent per year). However, if the Russian forestry sector does not recover quickly, then the longer-term historical growth rate in production (about 1.1 percent per year over the whole of the period 1961 to 2004) might be a better indication of future growth.

The other major uncertainty in the outlook for industrial roundwood production is the effect of forest plantation developments on future wood supply. Based on information about forest plantation developments collected in the previous FRA (Pandey, 1995 and 1997), this was examined by FAO in 2000 (Brown, 2000). This analysis examined the following three future scenarios for forest plantation development:

1. no new forest plantation establishment, but replanting of all existing areas after harvesting;

2. new planting at a fixed annual rate equal to one percent of the forest plantation area in 1995 (plus replanting of all existing areas after harvesting); and

3. new planting for 10 years at the rate of new planting estimated in 1995, with this rate reduced by 20 percentage points at 10 yearly intervals (plus replanting of all existing areas after harvesting).

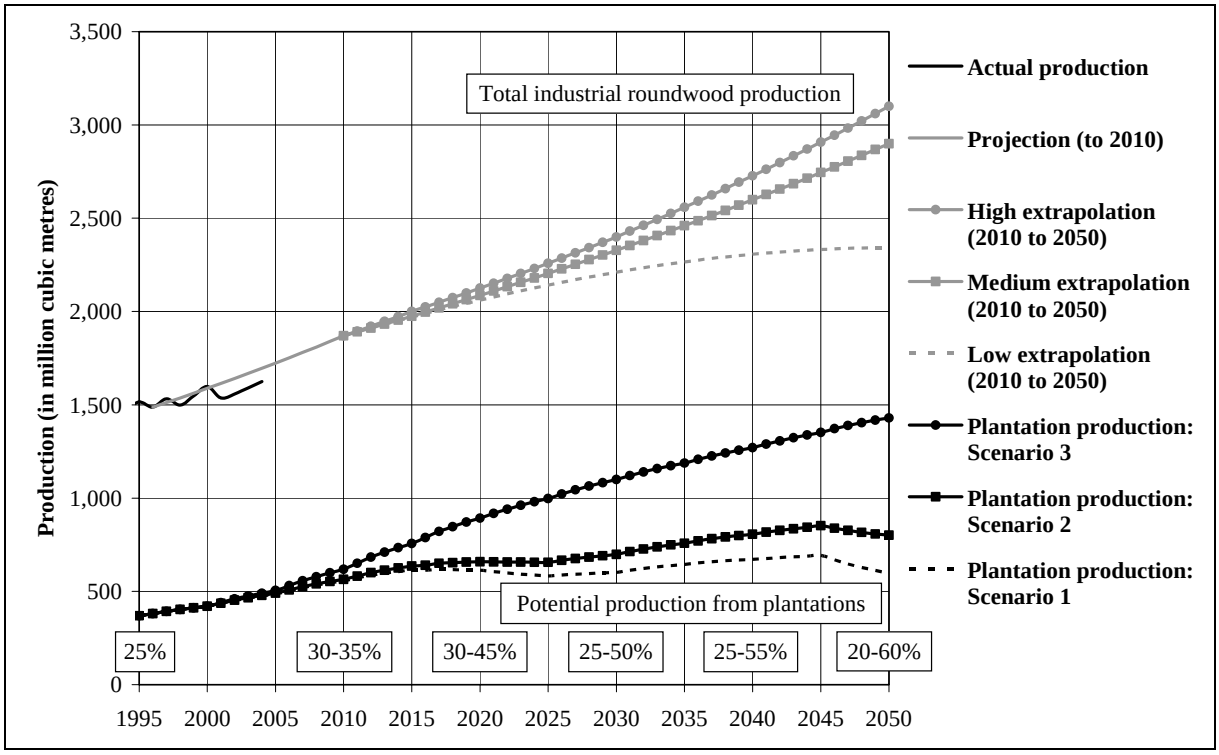
A model of forest plantation yields was then used to produce projections of future potential production from forest plantations under each of these scenarios. This was compared to FAO's projections of global industrial roundwood production (1995 to 2010) and three simple long-term extrapolations of future production (high, medium and low) for the period 2010 to 2050.

The results of this analysis are shown in Figure 5. Forest plantations were estimated to account for up to 25 percent of global industrial roundwood production in 1995 (although they only accounted for about 3.5 percent of the global forest area estimated in 1995). By 2010, it was projected that they would account for 30-35 percent of global production. After this point, the impact of forest plantations on future wood supply would depend upon current and future rates of plantation establishment and the long-term outlook for total industrial roundwood production. With no new planting, production would reach and maintain a level of around 600 million cubic metres (equal to 20-25 percent of total future production). With the highest assumed level of new planting (scenario 3), production would rise to 1,400 million cubic metres (or about 45-60 percent of total future production).

Given the uncertainties surrounding future industrial roundwood production and plantation establishment, it was concluded that forest plantations will account for at least 30 percent of future industrial roundwood supply (at minimum). A more likely scenario is that production from forest plantations will expand somewhat in the future, to reach a level of around 50 percent of total production. Furthermore, it is also likely that this increase will account for almost all future growth in total production (i.e. there will be little increase in production from natural forests).

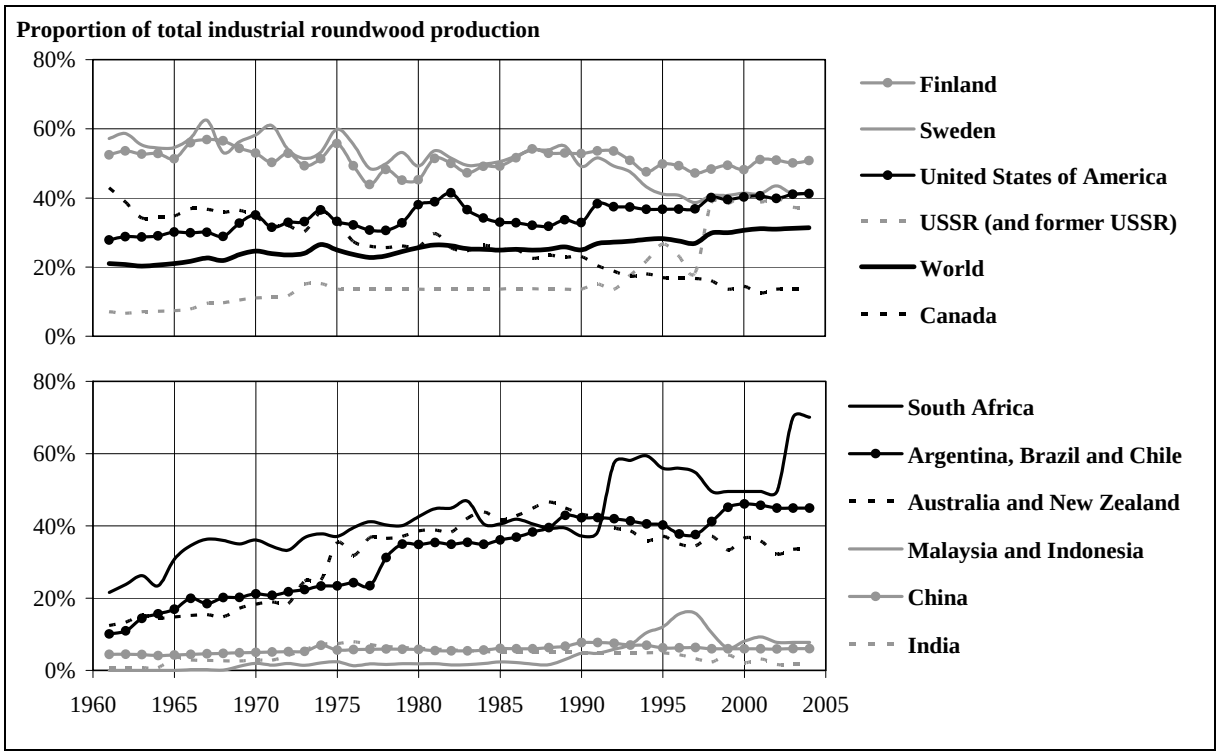
If the production from "*semi-natural forest*" (in the new FRA definitions) were to be added to these figures, it seems likely that all planted forests probably already account for more than half of all industrial roundwood supply and that their share of total production will increase considerably in the future. This conclusion is confirmed by others that have examined the outlook for forest plantation supply using a broader definition of forest plantations (ABARE, 1999).

Figure 5 Potential production of industrial roundwood from plantations from 1995 to 2050



Source: Brown (2000).

Figure 6 Changes in the structure of industrial roundwood production from 1961 to 2004



Source: derived from FAO (2005).

One additional point worth noting about wood supply is the changes in the structure of industrial roundwood production that have occurred over the last few decades. Figure 6 shows the proportion of pulpwood production in total industrial roundwood production since 1961 and compares the trends in some important countries.

In a number of northern countries (Finland, Sweden and, especially, Canada), the proportion of pulpwood production in total industrial roundwood production has fallen over recent decades. At the same time, the average size of trees harvested in these countries has probably not changed by very much (and may have even fallen). This trend can most likely be explained by improvements in sawmilling technology that now allow sawmills to produce sawnwood from smaller tree sizes (that would have previously been considered as pulpwood rather than sawlogs), as well as lesser known species.

Another impact of this development has been an increase in the production of wood chips from sawmill residues. Nowadays, it is quite common for the sawmilling industry in developed countries to consider almost all roundwood as a potential sawlog, which can be processed in an integrated "*chip and saw*" operation. This increases sawnwood recovery and the wood chips produced as a by-product can then be sold to producers of reconstituted wood panels or wood pulp. Thus, it is also likely that the type of wood used for pulp and paper production has gradually shifted away from pulpwood towards wood chips and residues.

For the countries in the South, it is noticeable that the opposite trend appears, with the share of pulpwood in total industrial roundwood production increasing in many countries over the last few decades. To some extent, this probably reflects increasing demand for pulpwood in these countries. However, it is also likely to reflect developments in the forest plantation sector. In particular, the area of forest plantations grown on short-rotations specifically for pulpwood production has increased in recent years in countries such as Brazil, China and, more recently, Indonesia. A significant proportion of forest plantations in the southern USA are also managed specifically for pulpwood production, which probably explains why the USA shows a similar upward trend in the share of pulpwood in total production.

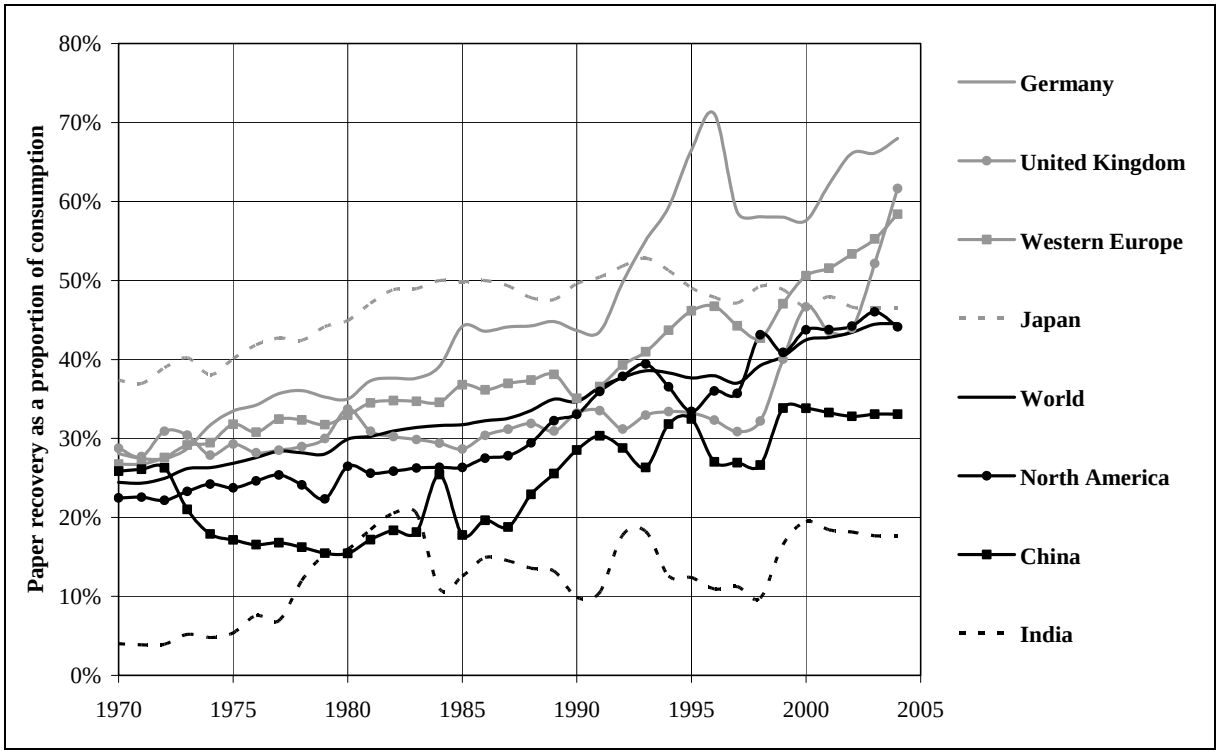
Trends in wastepaper recovery and use

Figure 7 shows the trends in paper recovery since 1970 at the global level and in some major countries and regions. For the purpose of this chart, paper recovery is defined as the total weight of paper recovered as a proportion of the total weight of paper and paperboard consumption. In addition to the effect of government policies on this activity, wastepaper recovery is mostly affected by the degree of urbanisation in a country and the mixture of different types of paper and paperboard consumed. For example, newsprint, printing and writing paper and some types of packaging paper are generally recovered more easily than other types of paper (such as household and sanitary paper).

The figure shows that global paper recovery has increased from around 25 percent in 1970 to 45 percent in 2004. The impact of government policies on this activity is most clearly shown in the trend for Western Europe, where paper recovery has increased from 35 percent in 1990 to nearly 60 percent in 2004. This is largely due to the impact of the European Union (EU) Council Directive on packaging and packaging waste issued in 1994 (EC, 1994) and subsequent legislation, which have set targets for the recovery (or incineration) of packaging waste (of glass, metal, paper, plastic and wood).

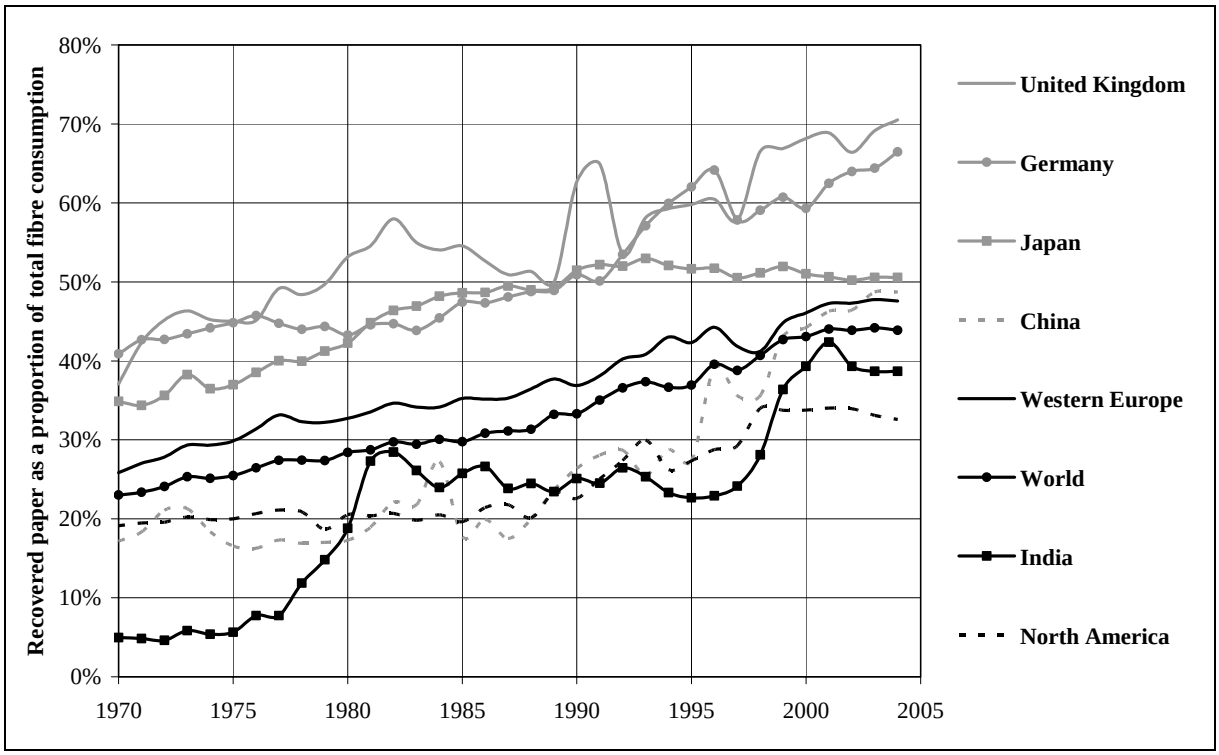
Paper recovery in most developing countries is generally lower and has not increased by as much, although paper recovery in China is currently around 33 percent. However, the experiences from developed countries demonstrate that it is possible to achieve much higher levels of paper recovery before this activity becomes limited by the structure of paper consumption.

Figure 7 Trends in paper recovery from 1970 to 2004



Source: derived from FAO (2005).

Figure 8 Trends in recovered paper utilisation from 1970 to 2004



Source: derived from FAO (2005).

Figure 8 shows the trends in recovered paper utilisation since 1970 at the global level and in some major countries and regions. This is defined as the total weight of recovered paper as a proportion of the total weight of fibre furnish used in the paper and paperboard industry. These trends are driven by the availability of recovered paper and the demand for paper and paperboard with a specific recycled fibre content. They are also limited by a technical constraint, which is the proportion of recycled fibre that can be used to manufacture certain types and grades of paper and paperboard.

At the global level, the trend is almost the same as that shown for paper recovery (as, by definition, global paper consumption equals global production, so the trend in the paper recovery rate must be the same as the trend in the utilisation rate). However, at the level of individual regions and countries, the trends and levels of recovered paper utilisation can be quite different to recovery rates.

In Western Europe and North America, the levels of recovered paper utilisation show a gradual upward trend, but are much lower than paper recovery rates. This is because these two regions are large net exporters of paper and paperboard and, hence, not all of their production can be recovered within the same region. It is also because these two regions still use significant amounts of wood fibre for paper and paperboard production (around 52 percent of the fibre furnish in Western Europe and 67 percent in North America). In particular, the recovered paper utilisation rate in North America is very low, because wood fibre is by far the most significant fibre input used in paper and paperboard production in Canada.

Recovered paper utilisation in developing countries is very varied and depends on the availability of different fibre sources and the size of the domestic paper and paperboard industry. However, it has also increased, particularly in China and, more recently, India. In both of these countries, recovered paper utilisation is higher than paper recovery rates, suggesting that there could be significant benefits to the industry from increasing paper recovery.

Trends in the prices of wood and fibre

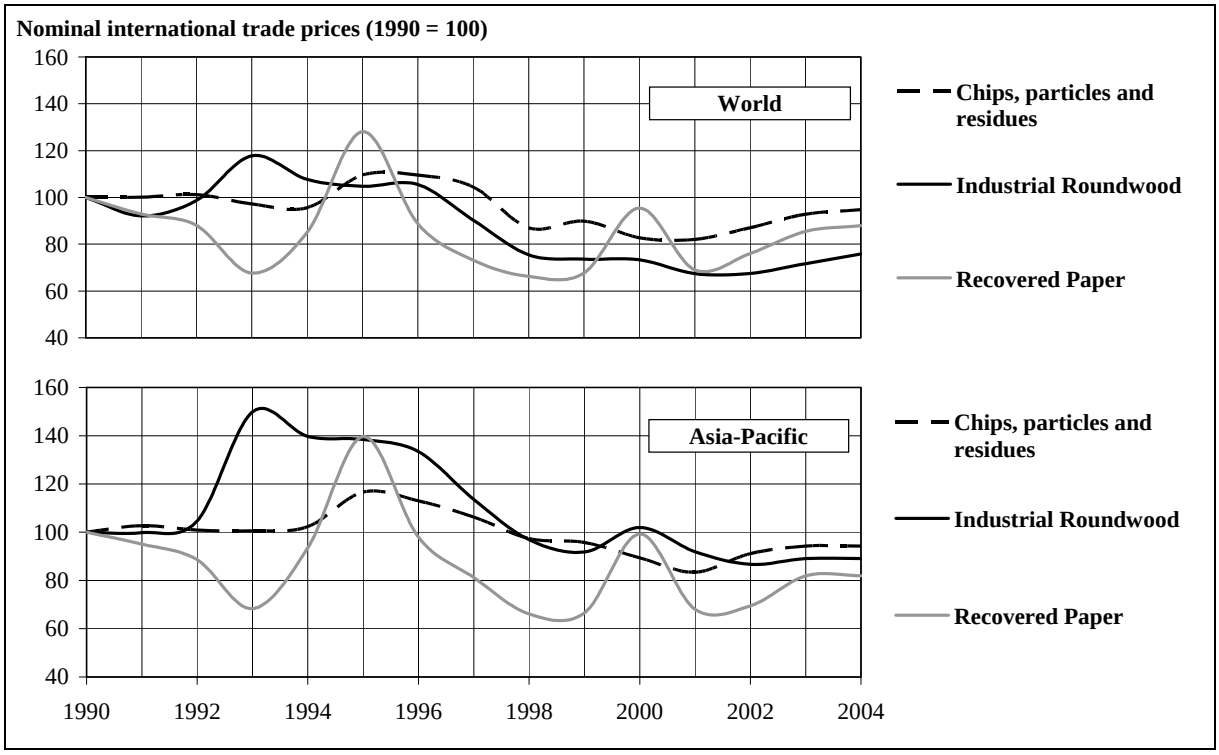
For most developed countries, the price of wood and fibre is the most significant operating cost in the pulp and paper industry, accounting for up to 50 percent of total operating costs (Industry Canada, 2002). Domestic wood and fibre price statistics are not collected at the international level, but average trade prices can be derived from the international trade statistics (volumes and values) collected by FAO each year (FAOSTAT, 2005). Although international trade in wood and fibre represents only a small proportion of total production and consumption (around 10 percent), these statistics give some indication of price trends in the sector.

Figure 9 shows the trends in international trade prices for wood and fibre from 1990 to 2004 at the global level and in the Asia-Pacific region. These figures are index numbers (with the prices set to 100 in 1990) and are not adjusted for inflation. It should also be noted that the price trends for industrial roundwood are for all types of industrial roundwood (i.e. sawlogs and veneer logs, pulpwood and other industrial roundwood).

The figure shows that, at the global level, the prices of all three types of wood and fibre have declined since 1990, by between 5 percent (for wood chips, particles and residues) and 25 percent (for industrial roundwood). Furthermore, if inflation over the period were to be taken into account, prices have probably fallen in real terms by 30 percent more than indicated here. In the Asia-Pacific region, prices have also declined in nominal terms, although by somewhat less (5-20 percent).

The figure indicates a slight downward trend over the period, but given the fluctuation in these figures it is not possible to say whether this is an indication of a longer-term trend. Instead, in the near-term, it looks likely that prices will continue to fluctuate around the current level.

Figure 9 Trends in prices for wood and fibre from 1990 to 2004



Source: derived from FAO (2005).

Conclusions about wood and fibre supply

Based on the analysis of the trends described above, some conclusions about wood and fibre supply are presented below.

Supply and demand dynamics. The trends in forest resources and industrial roundwood production show that the supply of industrial roundwood has been more than adequate to meet demand in recent decades. Indeed, the recent decline in prices suggests that the availability of industrial roundwood has exceeded demand over the last decade, leading to downward pressure on prices.

It also appears likely that wood supply will expand to meet demand in the foreseeable future. Currently, in temperate and boreal regions (especially Western Europe and Russia), the forest area is stable or expanding and industrial roundwood production is much lower than the increment of the forest resource (UN, 2005a). In the rest of the World, the potential supply of industrial roundwood from forest plantations is expected to increase significantly and should meet foreseeable increases in demand.

However, there are two major uncertainties about future supply and demand for wood and fibre. The first is the outlook for industrial roundwood production in Russia and the second is the outlook for demand in China and India (and, to a lesser extent, Brazil).

Russia is a major wood producer and exports of industrial roundwood from Russia have increased significantly over the last decade. The outlook for industrial roundwood exports from Russia is uncertain and will depend upon the level of future investment in the sector (in roundwood production and processing) and on the government's policies towards international trade.

In contrast, demand in China and India is currently growing rapidly and is likely to increase significantly in the future. In both of these countries, it is uncertain how much of this growth in

demand will be satisfied by increased domestic production or increased imports of wood and fibre or processed products.

The uncertainties described above are not so much about whether supplies will expand to meet demand, but rather whether international trade will be able to balance supply and demand at the regional level and the types of forest products that will be traded in the future (i.e. raw materials or processed products). Current trends suggest that significant increases in international trade of forest products will continue in the future, so much will depend upon government policies in this area.

Production technology. Trends in forest management and the processing sector indicate that the forestry sector is slowly changing to an "*agricultural*" production and processing model. Harvesting in the natural forest and a reliance on natural regeneration is gradually declining and is being replaced by more tree planting and more intensive management of planted and natural forest stands. These developments are gradually shifting the comparative advantage in wood production away from countries with large forest resources (mostly in the Northern Hemisphere) towards countries where trees grow fast (especially in the tropics and subtropics).

As techniques and technology improve and are more widely adopted, it is expected that this will continue to place downward pressure on wood and fibre prices. At the same time, with more intensive management and the adoption of new technologies, it is quite likely that the quality of wood and fibre from forest plantations might also increase.

These trends suggest a very positive outlook for wood and fibre supply for the pulp and paper sector. However, the outlook will partly depend on the future availability of land for forest plantation expansion and the social and environmental impacts of such developments (Cossalter and Pye-Smith, 2003). These issues will need to be addressed by governments and the industry, if the full potential of the sector is to be realised.

Diversity of supply sources. The analysis above also suggests that the supply of wood and fibre to the pulp and paper industry will continue to diversify in the future. This diversification will occur both in terms of the sources and types of wood fibre that the industry uses and the mixture of wood and recovered fibre that is used.

With respect to pulpwood supply, the broad trends in the forest resource suggest that more wood will come from forests managed for a variety of purposes and from forests managed by a variety of different owners (e.g. farmers and small private forest owners). Thus, environmental and social considerations will become increasingly important in some locations. However, the gradual increase in private forest ownership and the development of mechanisms such as "*outgrower schemes*" may also imply the opposite (i.e. that economic forces may become more important in some areas).

The overall impact of these different developments is difficult to predict, but it seems likely that forest management may become more specialised (by location) in the future. Pulpwood supply from natural forests will probably decline in importance, as these forests are likely to remain the property of the state and be managed for a variety of purposes. Where pulpwood supply is likely to expand in the future is from the increasing number of small private forest owners, who mostly own planted forests and will be seeking a return on their investment.

With respect to other types of fibre, it seems likely that the trend towards increased use of wood residues, recovered paper and recovered wood products will also continue. In most developed countries, the recovery and utilisation of wood residues and recovered paper is probably close to technical limits. Therefore, increases in the proportion of wood residues and paper that are recovered and used will be modest. However, in absolute amounts, these sources will expand significantly (in line with growth in production and consumption). In addition, some further growth in the utilisation of recovered wood products might be expected, along with greater use of non-wood fibre.

In developing countries, there is still considerable scope for expansion in these sources of fibre supply. Urbanisation and increasing environmental awareness and concern are likely to combine to lower recycling costs and increase the potential supply of recycled materials. In addition, there may be scope to increase the collection and use of wood residues from the sawmilling industry. Perhaps the greatest scope for expansion is in the countries where the rate of recovered paper utilisation is already high (e.g. China and India). High utilisation rates in these countries suggest that the industry already has the technology to utilise recovered fibre and that the demand for such material exists.

As the trends for recovered paper have shown, the outlook for recovered fibre supply is strongly influenced by government policies. For example, environmental policies in the area of waste disposal have been a major driving force behind the recent expansion of supply in many developing countries. However, more recent government policies in the area of renewable energy have started to increase competition for wood and fibre between energy producers and the forest processing industry. This is currently a major concern for the forest processing industry in Europe. The likely impact of these new policies is currently unknown, but they represent the most important new development that could put upward pressure on wood and fibre prices and restrict future supplies to the pulp and paper industry.

PULP AND PAPER DEMAND

In almost all parts of the World, the demand for pulp and paper has been the most rapidly expanding component of forest product demand for a long time. Paper tends to be relatively expensive, so the demand for paper only expands rapidly when countries reach a certain level of economic development. The demand for paper is also affected by the structure of national economies and is strongly tied to the development of service activities that rely on information and communication.

Pulp is an intermediate product that is manufactured from wood and other fibres and is then used as an input to the paper making process. As such, the demand for pulp is a "*derived demand*" that is tied to the growth in the paper and paperboard industry. Pulp is used in different mixtures and combinations to manufacture different types and grades of paper, so the demand for pulp is affected by the composition of paper and paperboard production as well as changes in manufacturing technology.

This section describes some of the main driving forces that affect the demand for pulp and paper and then presents the trends in these two sectors by product type and region. It finishes by presenting some overall conclusions about demand.

Main driving forces

At the most basic level, the demand for forest products is driven population growth and income. As countries expand and become wealthier, demand for everything increases due to the increased purchasing power of larger numbers of citizens. Thus, the total size of the national economy (Gross Domestic Product or GDP) is often identified as the most significant variable in economic studies of forest products demand.

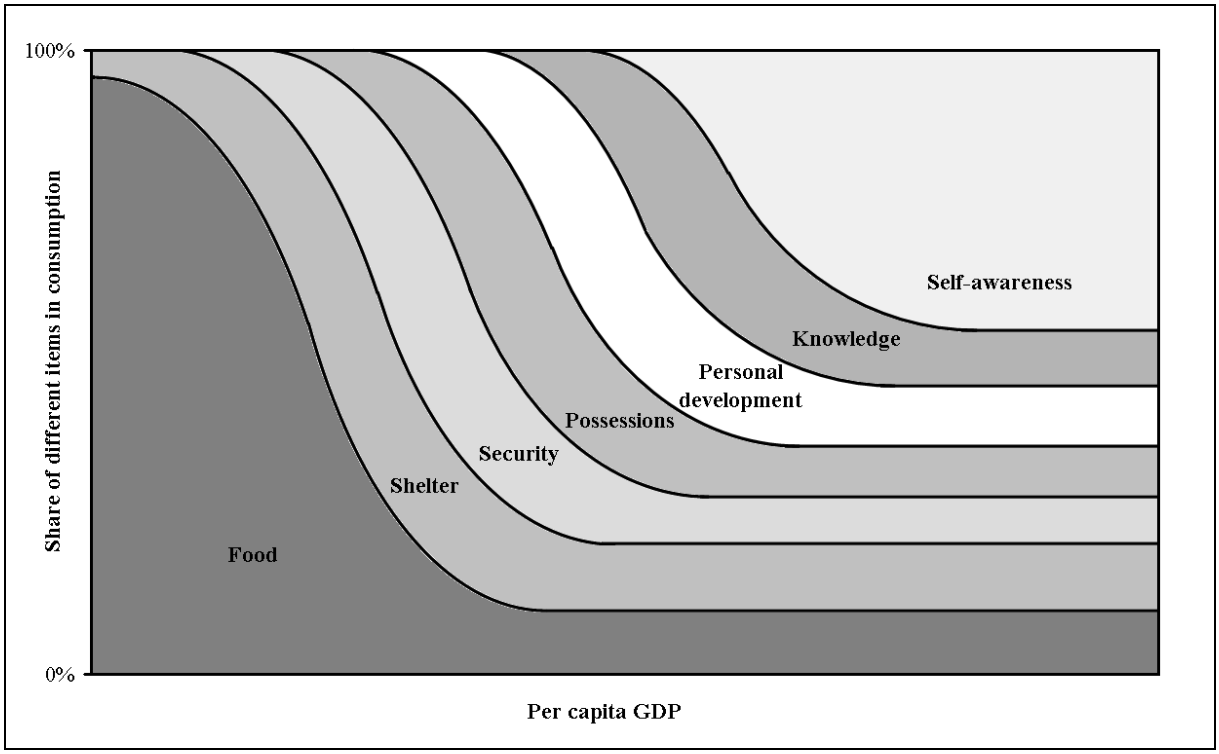
However, in addition to the size of the economy, the distribution of income is also an important (but often neglected) variable. Of particular importance to many developing countries is the development and expansion of the urban middle-class. This section of society is often the main driving force behind growth in domestic demand and the creation of demand for new types of product.

It has also been noted that the effect of income on demand (or the "*income elasticity of demand*") changes as countries become richer. At low levels of income, demand for some products expands very rapidly as income increases, then this relationship declines (or even reverses) at higher levels of income. For other products, the income elasticity of demand increases at higher levels of income and then declines thereafter, or stabilises at a high level.

These more subtle relationships between growth in demand and income are due to the different human needs that are served by different types of product. These needs can be arranged into a hierarchy (Ernst, 1978), starting with basic needs such as food, shelter and security, followed by other activities that are less of a "need" and more of a personal pleasure. The latter include the accumulation of material possessions and personal development, followed by the acquisition of knowledge and self-awareness.

As personal incomes increase, individuals tends to spend a higher proportion of their income on activities that are higher up in this hierarchy and less on satisfying their basic needs (see Figure 10). Thus, for example, in most developed countries only a small proportion of personal income is currently spent on food, while in developing countries this can account for a significant proportion (if not the majority) of personal expenditure.

Figure 10 The relationship between human needs and the level of personal income



Source: Rennel (1984).

In terms of the demand for paper and paperboard, the transition through this hierarchy can be described as follows. At very low levels of income, there is very little demand for paper and paperboard, except for packaging paper (for food and shelter materials) and maybe a little newsprint (providing information that contributes to security). At middle-income levels, demand for almost all types of paper increases rapidly as the demand for possessions increases (requiring more packaging paper) and personal development creates demand for more books, magazines and newspapers. At higher levels of income, consumers start to focus more on quality than quantity, so the demand for lower grades of paper (e.g. newsprint) becomes relatively less important, demand shifts towards higher grades of packaging paper and demand for printing and writing paper (e.g. for books and magazines) continues to expand. At this later stage of development, advertising also become more important as manufacturers compete to stress the quality and uniqueness of their products.

Currently, most developed economies are at the upper end of the personal income scale, so demand is very heavily concentrated on printing and writing paper and the higher grades of wrapping and packaging paper. In contrast, many countries in Eastern Europe, Asia and South America are in the

transitional stage from low to middle income levels. Consequently, they are currently experiencing rapid growth in paper and paperboard demand for all types and grades of product.

The other major driving force that affects demand for all products is the price, quality and availability of substitutes. For the paper and paperboard sector, the main competing products are other types of packaging materials and alternative forms of information communication and storage.

There has been little analytical work on global competition in the packaging sector, but a few studies have shown that considerable substitution of plastic for paper packaging materials occurred during the 1980s. Since then, growth in plastic packaging has suffered somewhat from concerns about oil prices (a major cost of plastic production) and the environmental impact of plastic packaging waste. In addition, paper packaging manufacturers have fought back by developing better products, including composite products that draw on the strengths of both materials (Renaud, 1994). Consequently, it seems unlikely that there will be further significant material substitution in this sector in the foreseeable future.

In the area of information communication and storage, concerns were expressed in the 1980s that the development of computers and emergence of the "*paperless office*" might result in a significant decline in the demand for paper. A comprehensive review of these developments was produced in the mid-1980s (Rennel, 1984) and arrived at the following two main conclusions:

1. growth in office automation and the use of computers would stimulate the demand for paper (especially printing and writing paper) and, rather than leading to substitution, growth in demand in both sectors would be complementary; and

2. substitution of electronic media for traditional forms of information storage and mass communication (e.g. newspapers, magazines and books) would be limited, due to consumer preferences and the limited access to information technology outside the workplace.

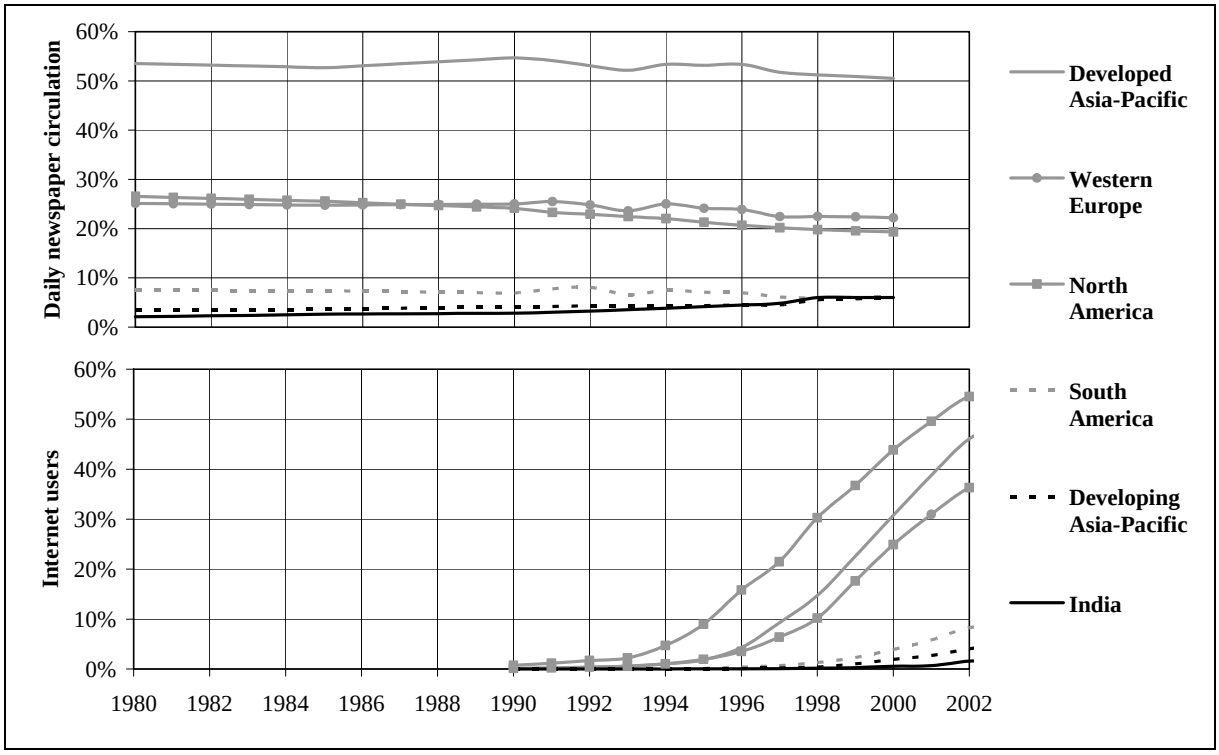
To a large extent, developments in the demand for paper over the last two decades have shown that both of these conclusions were broadly correct. However, over the last decade, the validity of the second conclusion has been challenged by the expansion of home computing and the internet.

For example, Figure 11 shows the trends in daily newspaper circulation and internet use in some major regions since 1980. During the 1980s, daily newspaper circulation remained stable in most regions as a proportion of total population. The one exception was North America, where circulation declined in the face of continuing and increased competition (for readers and advertisers) from other forms of media (e.g. radio and television). In addition, it is also worth noting that the average size of newspapers (e.g. number of pages) increased in many countries over the same period. Consequently, the demand for newsprint remained stable or increased slightly.

Since 1990, newspaper circulation has decreased by about five percentage points in all of the main developed regions. This has been a significant decline, especially in North America and Western Europe. At the same time, internet access and use increased dramatically and it seems very likely that these two trends are related.

In the developing regions, daily newspaper circulation has declined very slightly in South America (relative to the population level), but doubled in the Asia-Pacific region since 1980. Expansion of internet use in these regions has been much less during the 1990s, suggesting that it has had little impact so far on the ways that most people communicate and access information. However, with the ability of these countries to adopt modern technology without going through the earlier stages of development, there is the possibility of rapid change in paper demand in the future.

Figure 11 Trends in daily newspaper circulation and internet use since 1980



Source: UN (2005b). Note: both measures are expressed as the daily newspaper circulation and number of internet users divided by total population.

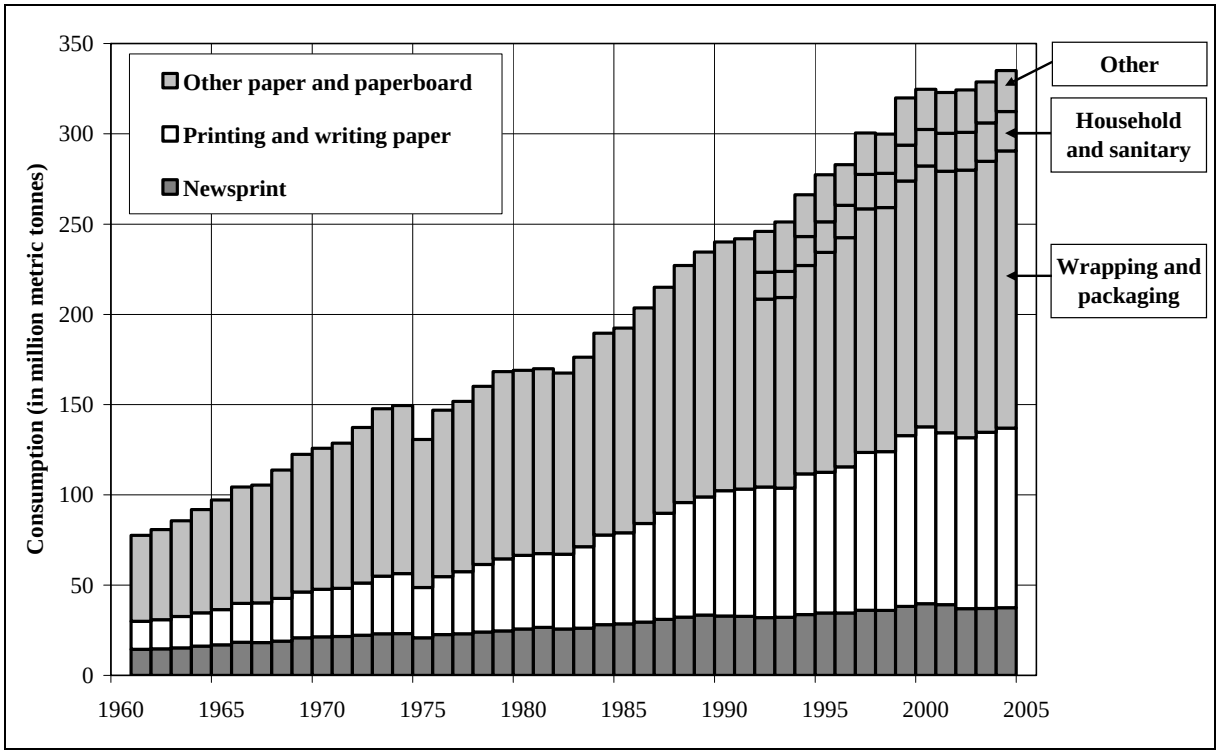
Trends in paper and paperboard consumption

Trends in global paper and paperboard consumption (by type of paper) over the last four decades are shown in Figure 12 and Figure 13. Total consumption has increased four-fold over the period, from 78 million metric tonnes in 1961 to 335 million metric tonnes in 2004. The share of other paper and paperboard in total consumption has remained about the same over the period, at about 60 percent of total consumption. Furthermore, more detailed statistics collected in recent years have shown that wrapping and packaging paper accounts for the majority of other paper and paperboard consumption. In contrast, the share of newsprint in global consumption has almost halved over the period, while the share of printing and writing paper has increased from 20 percent of consumption in 1961 to 30 percent in 2004.

Historical trends in global and regional newsprint consumption since 1961 are shown in Figure 14 and Figure 15. Global consumption has grown by around 2.2 percent per year (on average) over the last four decades and has more than doubled from 14 million metric tonnes in 1961 to 38 million metric tonnes in 2004. However, there have been significant regional variations in the growth in consumption.

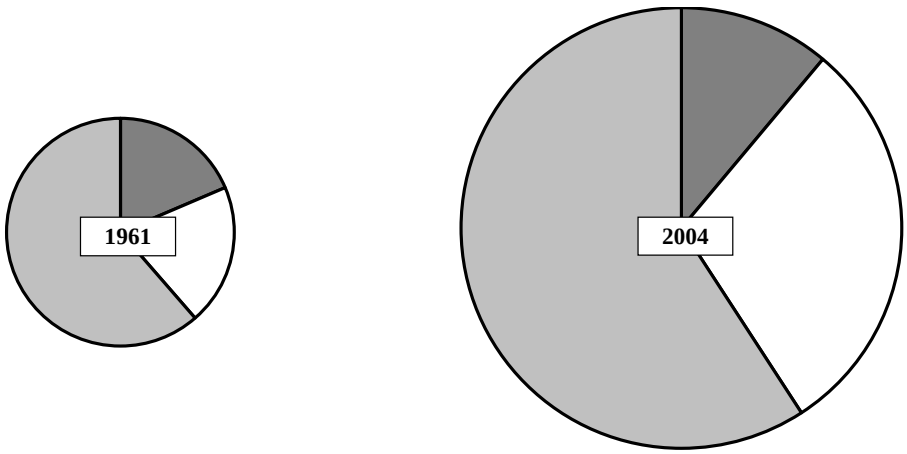
Until the 1990s, growth in consumption was quite evenly distributed across the main regions and the three developed regions remained the dominant consumers of newsprint (accounting for about 80 percent of global consumption). But since 1990, consumption in the developed regions as a whole has not increased (due to a decline in consumption in North America and very modest growth in the other two regions). In contrast, growth in newsprint consumption in the developing Asia-Pacific region actually increased during the 1990s (to 6.5 percent per annum), probably due to increased rates of literacy and higher incomes. This region is now the main centre of growth in the newsprint sector, with a level of consumption that is currently close to that of Western Europe or North America.

Figure 12 Trends in global paper and paperboard consumption from 1961 to 2004



Source: FAO (2005).

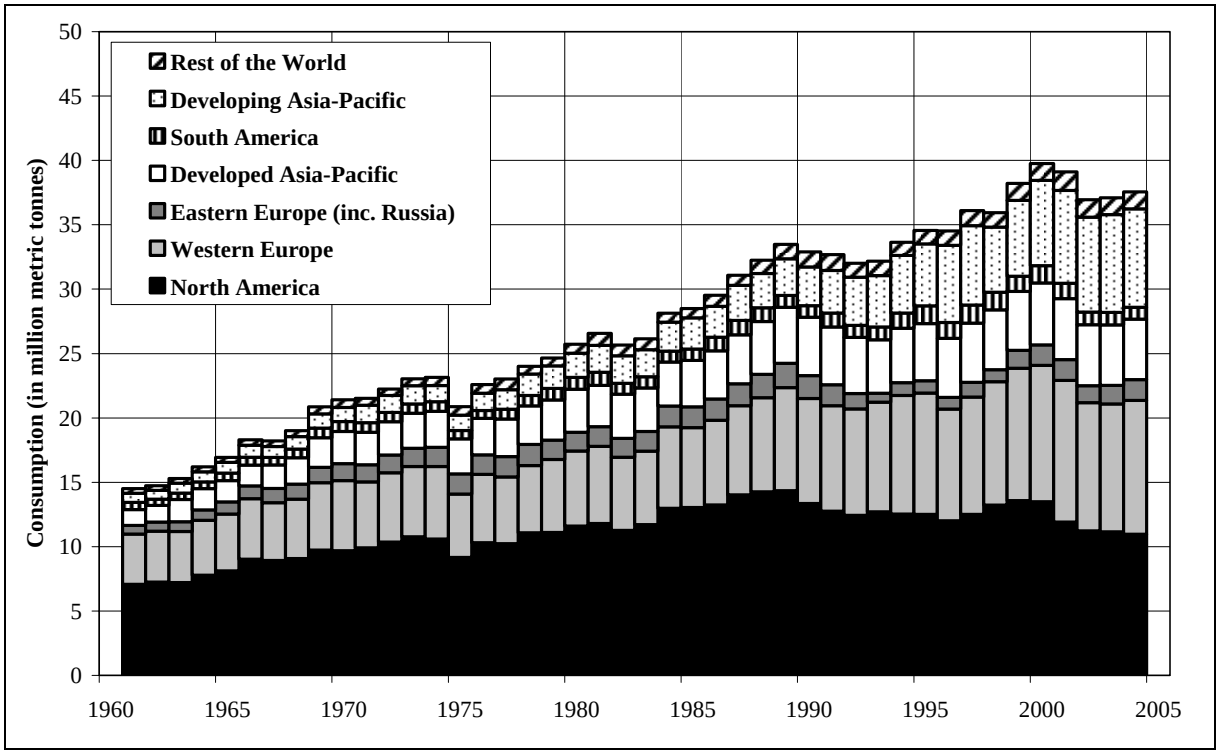
Figure 13 Comparison of global paper and paperboard consumption in 1961 and 2004



Global consumption (in million metric tonnes)	1961	2004	Average growth rate
Newsprint	14 (19%)	38 (11%)	2.2% per year
Printing and writing paper	15 (20%)	99 (30%)	4.4% per year
Other paper and paperboard	48 (61%)	198 (59%)	3.4% per year
Total	**78 (100%)**	**335 (100%)**	**3.5% per year**

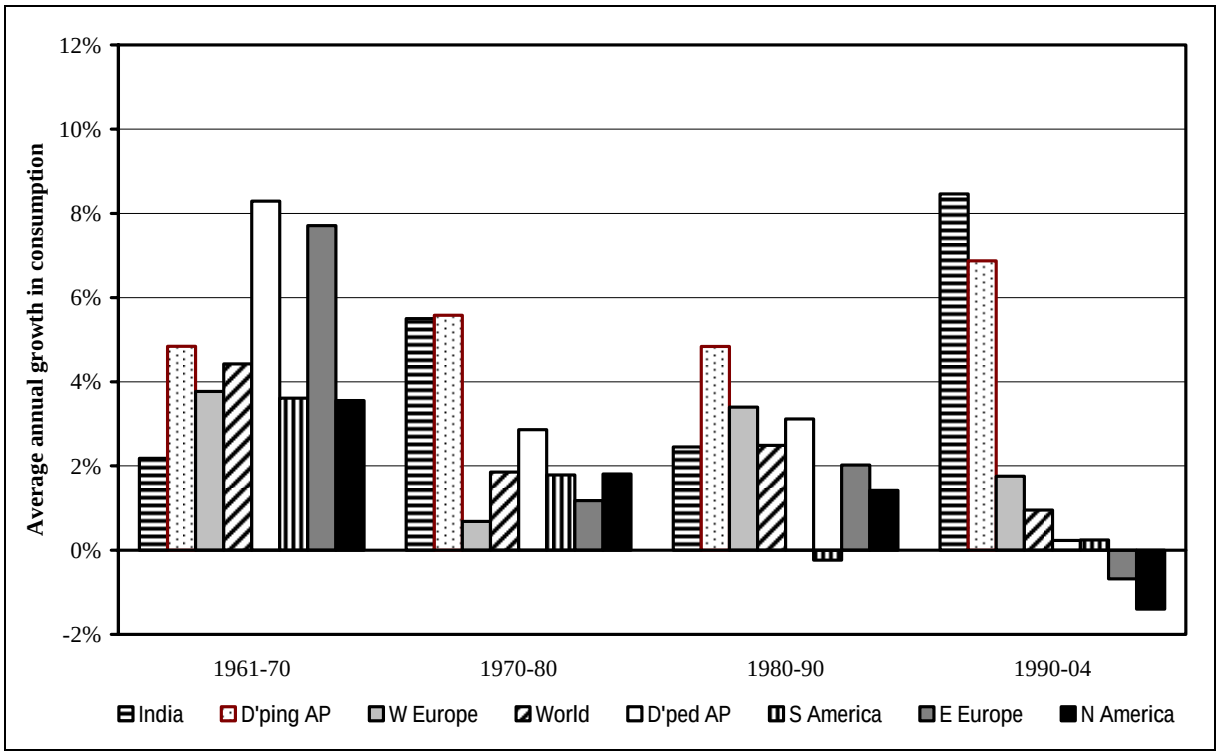
Source: FAO (2005).

Figure 14 Trends in newsprint consumption by region from 1961 to 2004



Source: FAO (2005).

Figure 15 Growth in newsprint consumption by region since 1961



Source: FAO (2005).

The global and regional trends in printing and writing paper consumption since 1961 are shown in Figure 16 and Figure 17. At the global level, consumption has grown by around 4.4 percent per year (or twice the average for newsprint) and has increased six-fold from 15 million metric tonnes in 1961 to 99 million metric tonnes in 2004. Again, there have been significant regional variations in the growth in consumption and changes over the last four decades.

At the global level, consumption grew by between 4 percent and 6 percent per annum until the 1990s, but declined to 2 percent per annum during the 1990s. Although this decline in growth is not as significant as that experienced in the newsprint sector, it does suggest that the period of rapid expansion in the markets for printing and writing paper has come to an end, perhaps due to increased competition from electronic media.

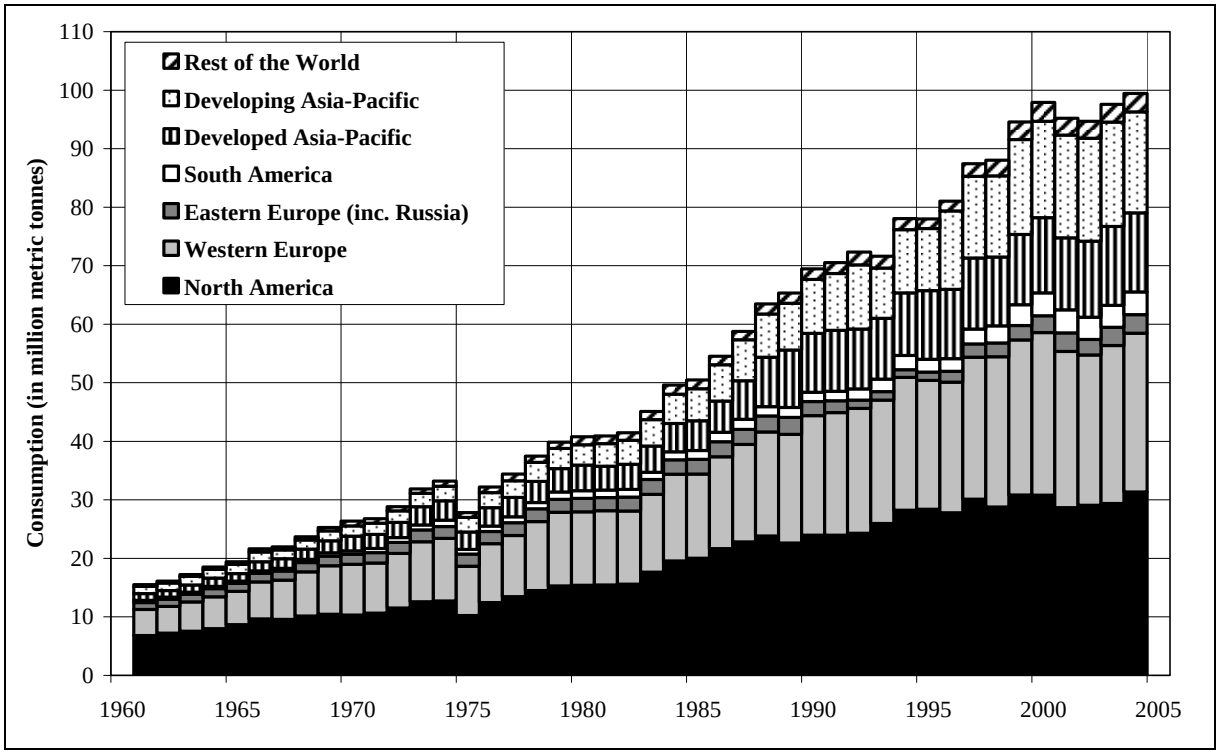
At the regional level, the trends display a similar pattern to that experienced in the markets for newsprint. Growth in all regions was distributed fairly evenly until 1990, with the three developed regions accounting for about 80 percent of global consumption. During the 1990s, growth in all three developed regions declined to around 2 percent, while growth in the developing Asia-Pacific region and South America remained high (at 4.6 percent and 6.7 percent per annum respectively). Consequently, the global consumption share of the three developed regions has declined slightly to 75 percent.

Trends in other paper and paperboard consumption since 1961 are shown in Figure 18 and Figure 19. At the global level, consumption has grown by around 3.4 percent per year and has increased four-fold from 48 million metric tonnes in 1961 to 198 million metric tonnes in 2004.

At the global level, consumption increased by slightly less than 6 percent per annum in the 1960s, but has increased by around half this rate thereafter. However, growth in consumption has stabilised at this level and has shown little variation over the last three decades.

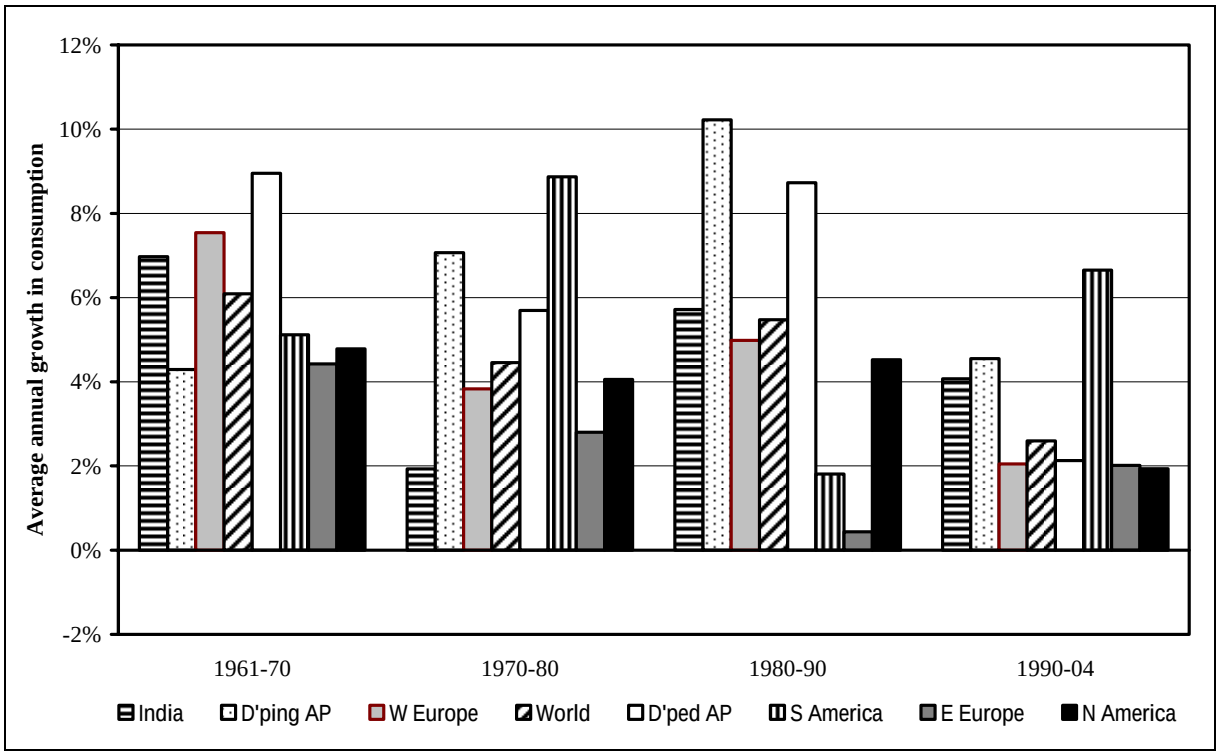
At the regional level, the growth in consumption in developing regions has generally been higher than the growth in consumption in developed regions. This is likely to be due to the demand for packaging materials from manufacturing industries and the rapid expansion of manufacturing that has occurred as many of these countries have industrialised. For example, during the 1990s, other paper and paperboard consumption increased by 6.7 per annum in the developing Asia-Pacific region and 4.0 percent per annum in South America. In addition, consumption in the developing Asia-Pacific region surpassed that in Western Europe in 1994 and is currently approaching the level of consumption in North America.

Figure 16 Trends in printing and writing paper consumption by region from 1961 to 2004



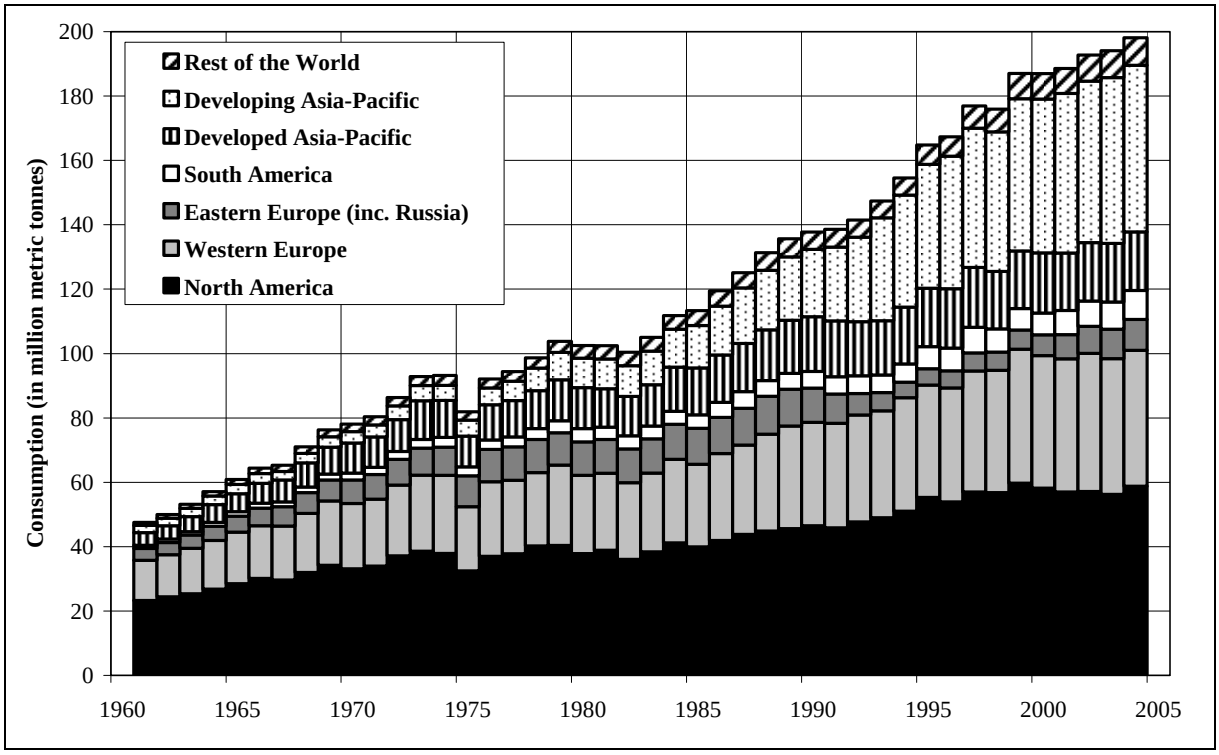
Source: FAO (2005).

Figure 17 Growth in printing and writing paper consumption by region since 1961



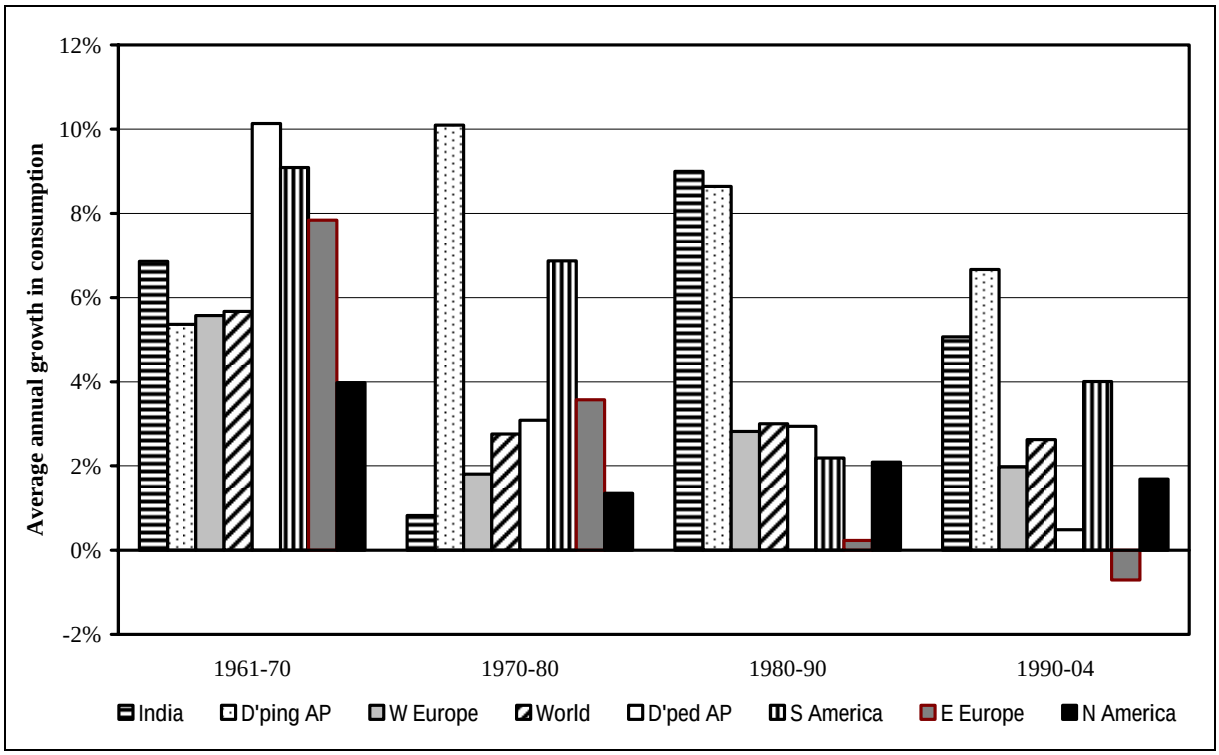
Source: FAO (2005).

Figure 18 Trends in other paper and paperboard consumption by region from 1961 to 2004



Source: FAO (2005).

Figure 19 Growth in other paper and paperboard consumption by region since 1961



Source: FAO (2005).

Trends in consumption of pulp for paper

Industrial roundwood is used to manufacture four main types of wood pulp: dissolving wood pulp; mechanical wood pulp; semi-chemical wood pulp and chemical wood pulp. Dissolving wood pulp is used to manufacture a range of products outside the forestry sector (and is relatively insignificant), while the latter three types of wood pulp are used to manufacture paper. In addition, pulp made from other fibres (e.g. straw and bagasse) is also used to manufacture paper, along with recovered paper.

The global trend in the consumption of pulp for paper is shown in Figure 20 and Figure 21. As recovered paper is also a significant input to the papermaking process (and is a major competing source of fibre), the trend in recovered paper consumption since 1970 (the start of this data series) is also shown in Figure 20.

Total consumption of pulp for paper has increased by 2.6 percent per year (or roughly trebled) over the last four decades, from a level of 62 million metric tonnes in 1961 to 191 million metric tonnes in 2004. This rate of increase is much lower than the increase in paper and paperboard production over the same period because of the increased utilisation of recovered paper. Since 1970, recovered paper consumption has increased five-fold, at an average rate of 4.7 percent per year. The impact of this can be seen in the figures for 2004, where the additional fibre supplied by recovered paper consumption was equal to almost 80 percent of total pulp consumption (by weight).

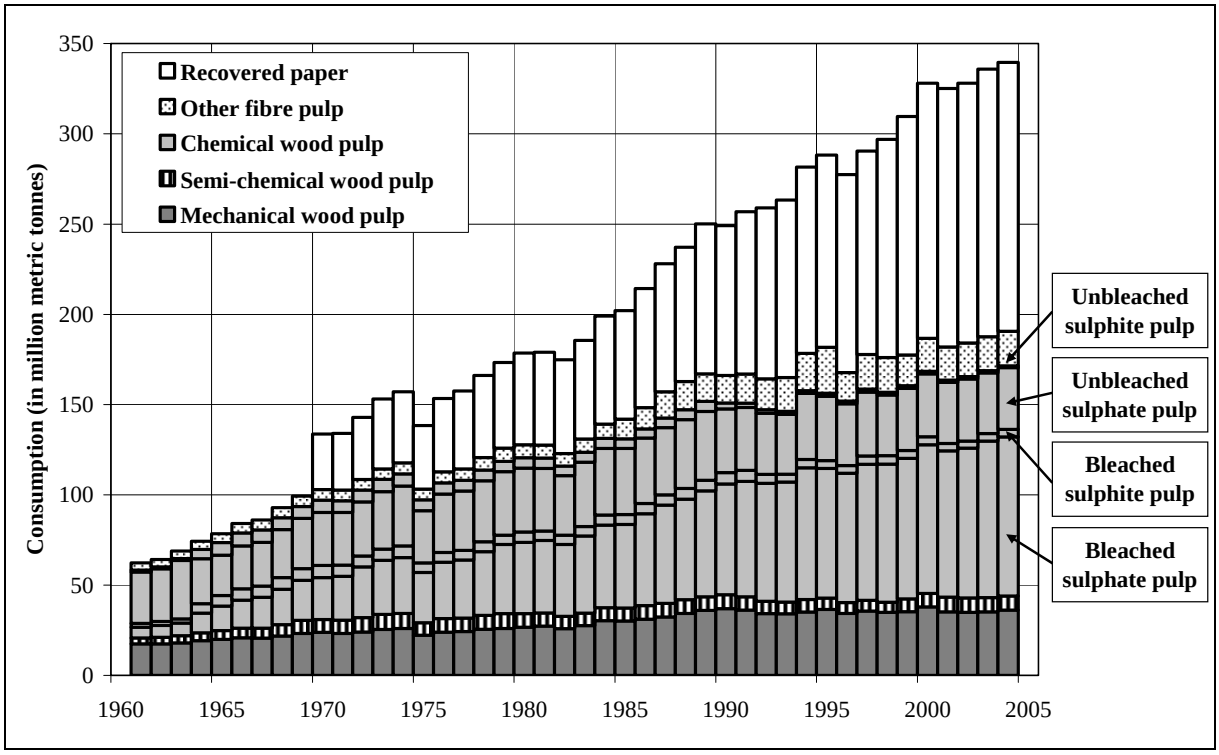
In terms of the different types of pulp used to manufacture paper and paperboard, the figures show that chemical wood pulp has remained the most important type of pulp, with a 60 percent share of total pulp consumption in 1960, increasing to a 67 percent share in 2004. Furthermore, almost all of the growth in consumption of pulp for paper has been growth in the consumption of chemical wood pulp, which increased from 38 million metric tonnes in 1961 to 127 million metric tonnes in 2004 (an increase of 235 percent over the period, equal to growth of 2.9 percent per year).

Chemical wood pulp is further subdivided into bleached or unbleached sulphate or sulphite wood pulp. Consumption of sulphite wood pulp has always been relatively insignificant, but has declined since 1961 to only 5 million metric tonnes (or 4 percent of all chemical wood pulp consumption) in 2004. Consumption of unbleached sulphate pulp has remained almost unchanged over the last four decades, while consumption of bleached sulphate pulp has expanded dramatically. Indeed, all of the growth in chemical wood pulp consumption has been growth in consumption of bleached sulphate pulp. This mostly reflects the structural change in demand over the last four decades towards higher grades of paper and paperboard. Currently, consumption of bleached sulphate pulp accounts for about three-quarters of all chemical wood pulp consumption, while consumption of unbleached sulphate pulp accounts for almost all of the remainder.

Growth in consumption of mechanical wood pulp and semi-chemical wood pulp consumption has been much more subdued over the period (with average annual growth rates of 1.7 percent and 2.1 percent respectively) and consumption of both of these types of pulp has hardly increased at all over the last decade. This decline in the growth in consumption reflects changes in the supply of fibre to the industry (especially the growth in the use of hardwood fibre to produce wood pulp) as well as changes in the demand for pulp.

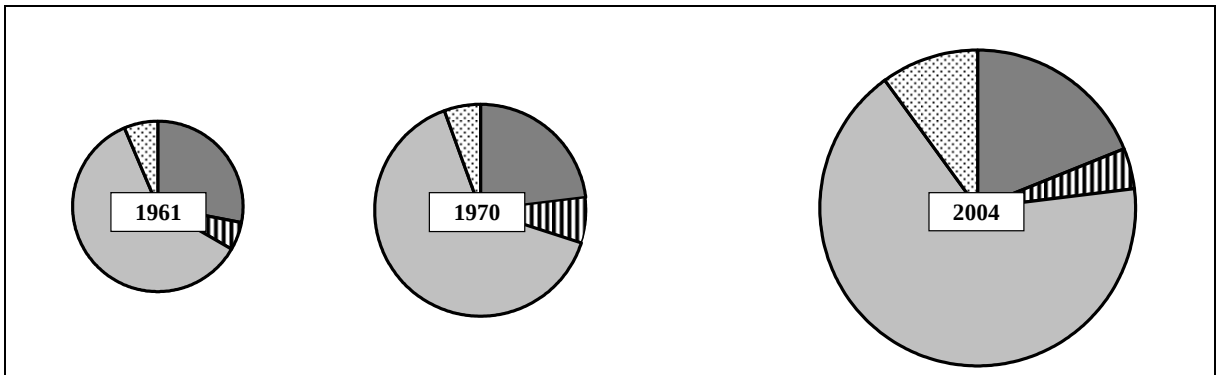
The other noticeable change in the consumption of pulp for paper is the growth in the consumption of other fibre pulp. Apart from very specialised uses, pulp made from non-wood fibre is generally considered to be of poorer quality when compared to wood pulp. However, in countries where wood is relatively scarce, manufacturing pulp from other fibres is a viable alternative (i.e. again, the growth in this sector is due to the supply of fibre rather than changes in demand). Consumption of other fibre pulp has generally declined in all regions except the developing Asia-Pacific region (especially in China and India), where it has increased substantially since the mid-1980s.

Figure 20 Trends in global pulp and recovered paper consumption from 1961 to 2004



Source: FAO (2005).

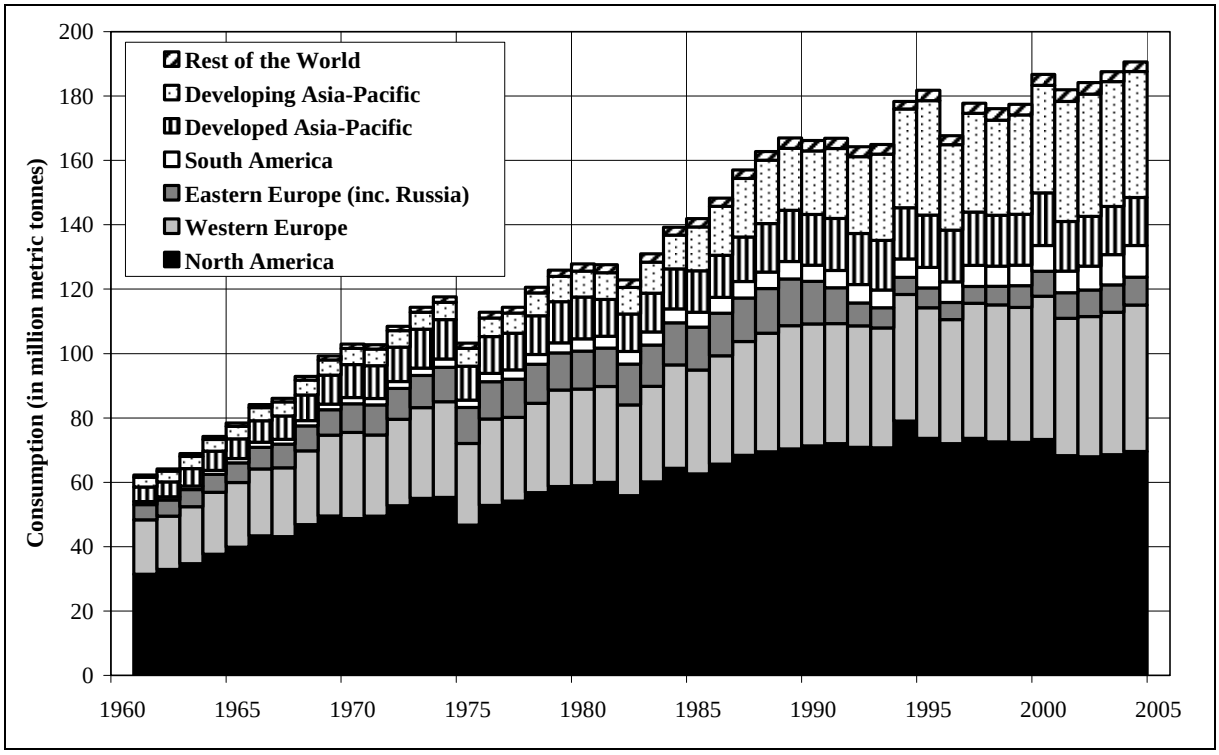
Figure 21 Comparison of global pulp consumption in 1961, 1970 and 2004



Global consumption (in million metric tonnes)	1961	1970	2004	Average growth rate
Mechanical wood pulp	17 (28%)	24 (23%)	36 (19%)	1.7% per year
Semi-chemical wood pulp	3 (5%)	7 (7%)	8 (4%)	2.1% per year
Chemical wood pulp	38 (60%)	66 (64%)	127 (67%)	2.9% per year
Other fibre pulp	4 (6%)	6 (6%)	19 (10%)	3.7% per year
Total	**62 (100%)**	**103 (100%)**	**191 (100%)**	**2.6% per year**
Recovered paper	*n.a. (n.a.)*	*31 (+30%)*	*149 (+78%)*	*4.7% per year*

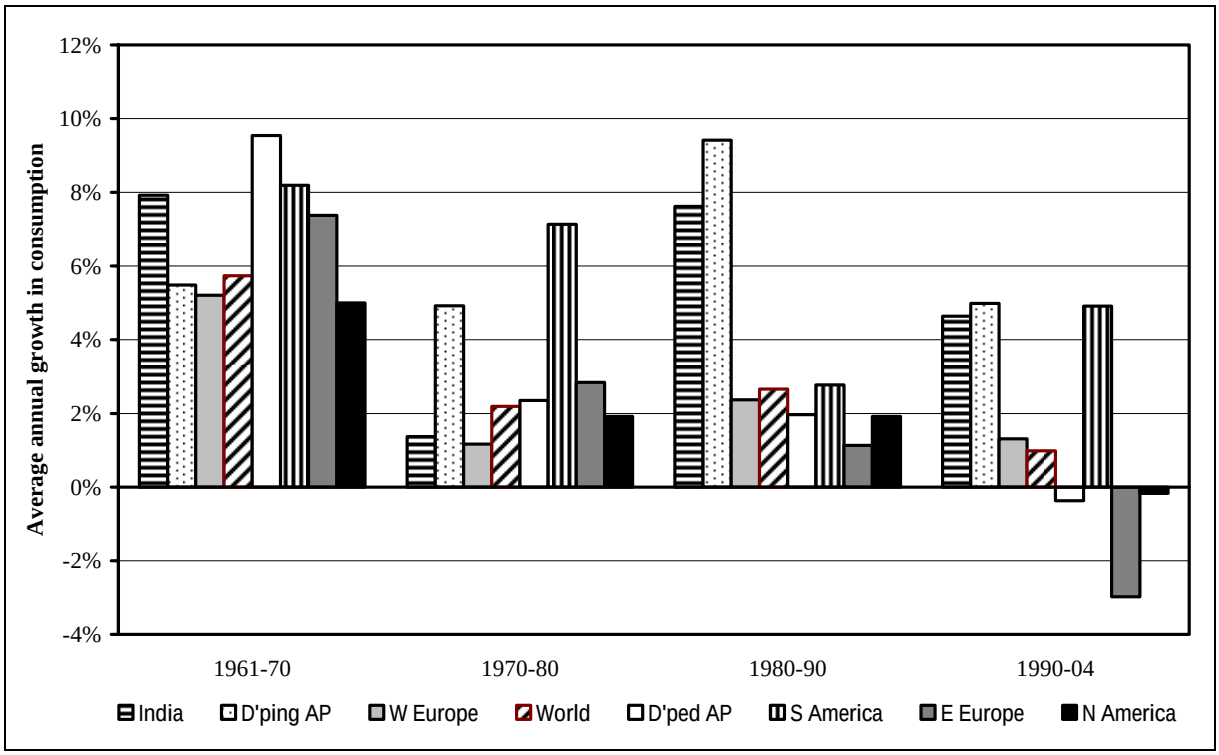
Source: FAO (2005).

Figure 22 Trends in pulp for paper consumption by region from 1961 to 2004



Source: FAO (2005).

Figure 23 Growth in pulp for paper consumption by region since 1961



Source: FAO (2005).

Regional trends in pulp for paper consumption since 1961 are shown in Figure 22 and Figure 23. The most significant pattern in these trends is the change in the global distribution of wood pulp consumption (between the regions) that has occurred over the last four decades.

In 1961, the three developed regions (North America, Western Europe and the developed Asia-Pacific region) accounted for 85 percent of global consumption of pulp for paper. By 2004, their share had declined to less than 70 percent. In contrast, South America's share of global pulp for paper consumption increased from 1.5 percent in 1961 to 5.2 percent in 2004 and consumption in the developing Asia-Pacific region expanded from 4.9 percent to 20.5 percent of global consumption over the same period.

These changes are due to the substantial regional differences in consumption growth over the period. With the single exception of the developed Asia-Pacific region in the 1960s, growth in consumption of pulp for paper in South America and the developing Asia-Pacific region has been consistently higher than in the three developed regions for each of the last four decades.

In addition, these figures demonstrate the significant impact that the use of recovered paper has had on pulp for paper consumption, especially in the three developed regions. For example, global consumption of pulp for paper has increased by only 1.0 percent per year since 1990 (compared with much higher growth rates in earlier decades). Furthermore, consumption in North America and the developed Asia-Pacific region declined during the 1990s and grew by only 1.3 percent per year in Western Europe. At the same time, consumption in South America and the developing Asia-Pacific regions grew at about 5 percent per annum, accounting for almost all of the growth in consumption at the global level since 1990.

Conclusions about pulp and paper demand

Currently, the structure and growth in demand for paper and paperboard varies significantly between developed regions and developing regions. Indeed, a very simple interpretation of the trends would be to say that the current pattern of demand in developing regions is very similar to the pattern of demand in developed regions about 20-30 years ago. However, it is not necessarily true that the markets in developing regions will evolve in the same way as they have in developed regions. In the pulp for paper sector, demand for pulp is largely tied to developments in the markets for paper and paperboard, although the structure of consumption is probably affected most strongly by developments in fibre supply rather than demand. Based on the analysis above, a summary of the conclusions about pulp and paper demand are as follows.

Paper and paperboard demand in developed regions. Paper and paperboard consumption has grown to become the most significant sector of the forest products industry in almost all developed countries. Furthermore, growth in consumption of paper and paperboard remains higher than growth in consumption of most other forest products. However, growth has slowed down in recent years. This is partly due to market saturation and increased competition from substitutes.

Consumption of newsprint accounts for a declining share of the total paper and paperboard market and, in some regions, is currently declining in absolute terms. This is probably due to changes in the way that consumers access information and, especially, the growth in internet usage in recent years. Consumption of printing and writing paper has been the fastest growing sector over the last few decades and currently accounts for about one-third of total consumption, but there is evidence that growth in consumption of this product is also slowing, perhaps for the same reasons.

Other paper and paperboard accounts for about 60 percent of total consumption and growth in consumption has been quite stable over the last few decades. Wrapping and packaging paper accounts for the majority of other paper and paperboard consumption, so demand in this sector is closely linked to manufacturing output. Substitution by other types of packaging materials has occurred in the past, but this appears to have come to an end, as producers of paper packaging have responded to this threat

by developing new and improved products. As most of these countries are at a high level of economic development, it seems likely that growth in consumption will be driven by demand for higher quality packaging materials and that this sector will continue to dominate the markets for paper and paperboard.

Paper and paperboard demand in developing regions. Paper and paperboard is also the fastest growing sector of the forest products industry in most developing countries. However, per capita consumption is still generally quite low and varies considerably between countries at different levels of development.

The more advanced developing countries are entering a period of rapid economic growth and increasing incomes, which will continue to increase the demand for paper and paperboard and also broaden the demand for different product types. Thus, the currently high levels of growth in consumption of all types of paper and paperboard can be expected to continue in the foreseeable future.

In general, the current structure of demand for paper and paperboard in developing regions is heavily weighted towards other paper and paperboard. This is due to the link between demand for this product and manufacturing output and the fact that manufacturing output is rapidly expanding in many developing countries. However, there are significant differences between different developing countries. For example, in India, newsprint and printing and writing paper currently account for one-quarter and one-third of total paper and paperboard consumption respectively.

As these economies mature, they will be likely to shift towards more service activities and the relative importance of manufacturing will decline somewhat. Thus, it can be expected that the structure of paper and paperboard demand will also shift towards relatively higher demand for printing and writing paper. However, this will probably not occur in the near-term. In addition, it is possible that they may make the transition towards greater use of competing media (e.g. the internet) very quickly. This is probably the largest uncertainly in the outlook for paper and paperboard demand in these countries.

Demand for pulp for paper. Demand for pulp is very closely linked to developments in the demand for paper and paperboard and, until recently, growth in pulp consumption mirrored the growth in demand for paper and paperboard. However, during the 1990s, growth in pulp consumption declined due to increases in the use of recovered paper.

The most significant increases in the use of recovered paper have occurred in developed regions, where pulp for paper consumption has not increased significantly since 1990. However, there are now signs that the growth in the use of recovered paper (as a proportion of total fibre inputs) may be reaching technical limits. Thus, it seems likely that growth in the consumption of pulp for paper might increase again in the near future.

In developing regions, the use of recovered paper has also increased (in absolute terms and as a proportion of totals fibre inputs), but this increase has not matched the growth in total fibre demand. Thus, consumption of pulp for paper has continued to grow strongly and the two main developing regions (South America and the developing Asia-Pacific region) accounted for almost all growth in global pulp for paper consumption since 1990. It seems likely that significant growth in demand for pulp will continue in the near future at the same rate as in recent years (5 percent per annum). However, the major uncertainty about future growth in consumption is whether (and, if so, how much) recovered paper utilisation will increase and reduce the demand for pulp for paper.

PULP AND PAPER SUPPLY

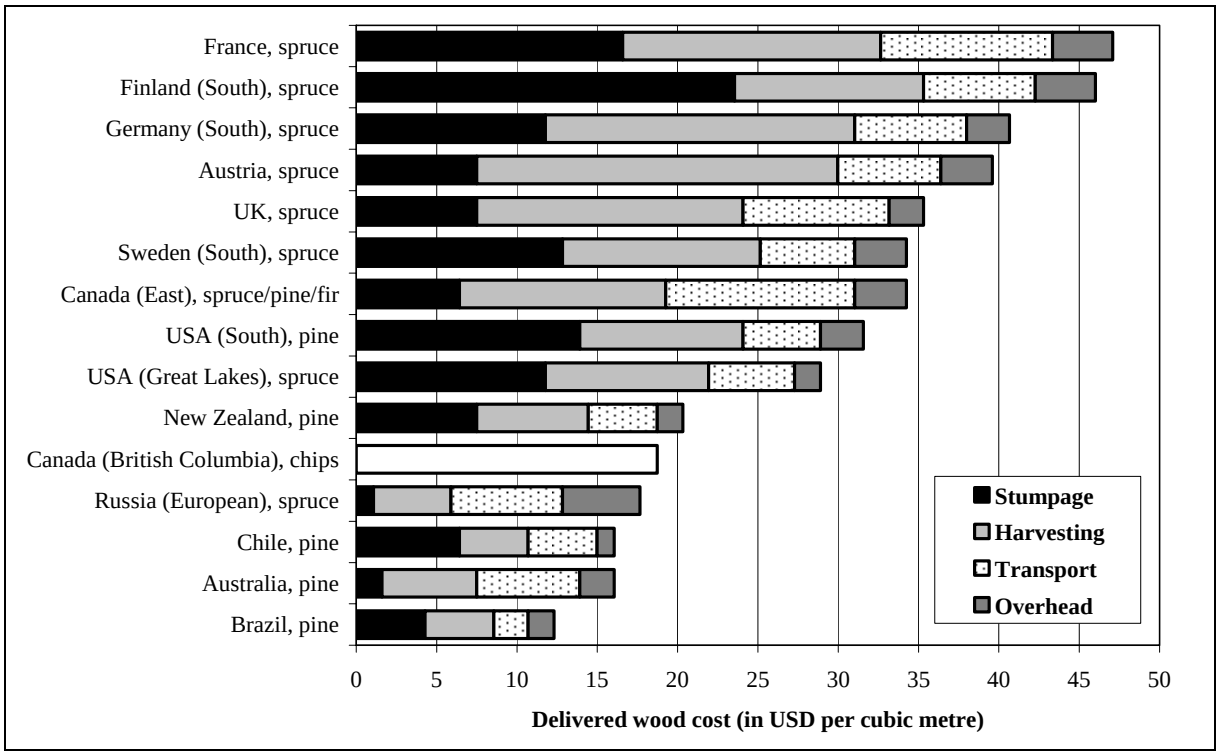
The development of pulp and paper capacity is driven by a number of factors, including: market prices and demand; production costs (especially the cost of fibre, energy and labour); the cost and availability of capital; and government policies in areas such as trade, environment and energy. These factors combine to determine the value-added and profitability of producing different pulp and paper products in different locations that, in turn, drive the expansion of capacity.

The text below describes some of the main trends for each of these factors in recent years and then presents the regional trends for production of each of the main pulp and paper products. It finishes by summarising some of the main conclusions about recent production trends.

Trends in production costs

After the cost of capital, the most significant costs in pulp and paper production are the costs of fibre, energy and labour. In many developed countries, the cost of fibre production has increased in recent years, due to a decline in the accessibility of high-quality forest stands, which leads to higher extraction and transport costs (Industry Canada, 2002), and increased regulation that requires a higher and more costly standard of forest management. However, as Figure 9 showed, the average price paid for fibre has declined in recent years.

Figure 24 Comparison of delivered cost of coniferous pulpwood in different countries in 2003



Source: Wilson (2004).

The explanation of this dichotomy is the emergence of new cost-competitive fibre suppliers in Eastern Europe and the South. For example, Figure 24 compares the delivered wood cost for mechanical wood pulp production in a number of different countries in 2003. With the exception of wood chip production in British Columbia, production costs in the major pulpwood producers in the North (Sweden, Canada and USA) are in the range of about USD 30 to USD 35 per cubic metre and the production costs in some other European countries are even higher than this. In contrast, production costs in Russia, New Zealand, Australia and South America range from USD 12 per cubic metre (Brazil) to USD 20 per cubic metre (New Zealand). The expansion of pulpwood production (often

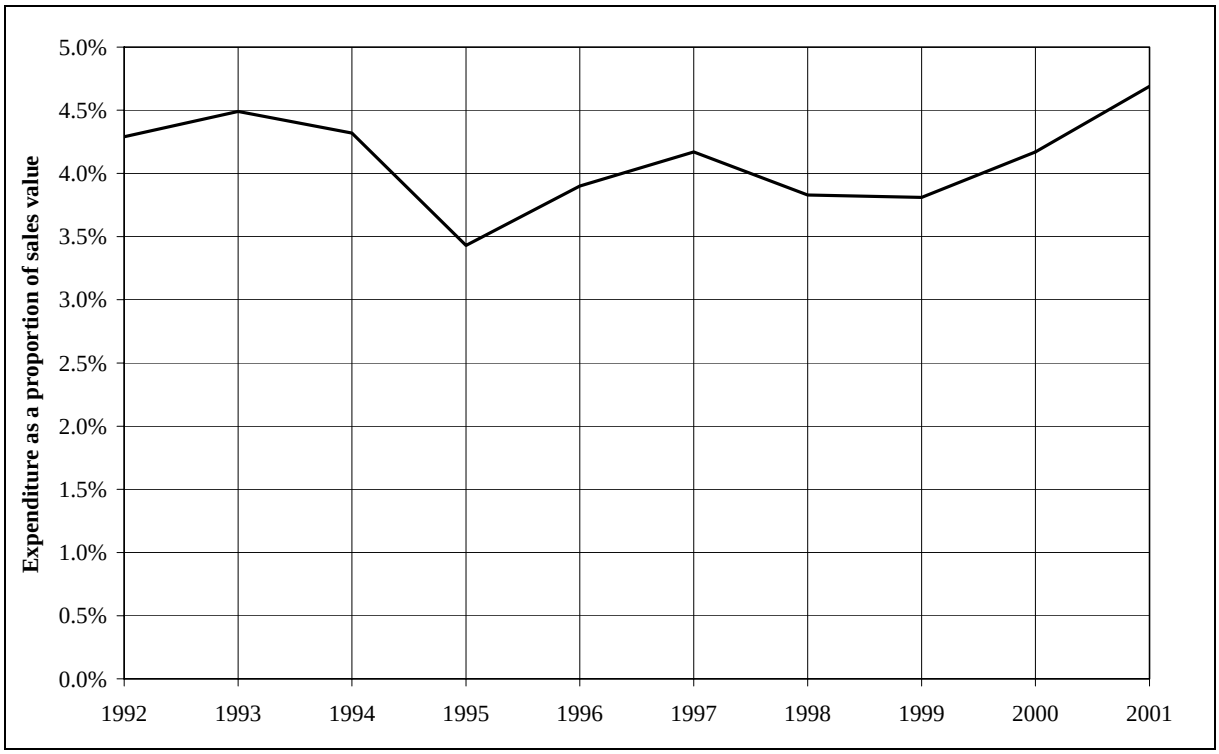
from forest plantations) in these low-cost countries has driven down global fibre prices and given these countries a significant comparative advantage in pulp and paper production.

In terms of energy consumption, pulp and paper production is one of the most energy intensive industries in the manufacturing sector (EIA, 2005). Information about the cost of energy consumption in the pulp and paper industry is not generally available, but Figure 25 shows the trend in energy purchases by the pulp and paper sector in the USA from 1992 to 2001. In this figure, expenditure on energy is shown as a proportion of the total value of sales by the industry.

For most of the period, expenditure on energy has been in the range of 3.5 percent to 4.5 percent of the value of sales with, perhaps, a slight upward trend in recent years. However, it should be noted that the industry also uses a lot of energy produced from black liquor (which does not appear in this figure), so the total consumption of energy is higher than these figures would suggest.

It should also be noted that the physical amount of energy used to produce one metric tonne of output has declined considerably in most developed countries over recent decades, due to improvements in technology and efficiency. For example, the American Forest and Paper Association estimates that the amount of energy required to produce one metric tonne of output in the USA fell from 19.1 million Btu in 1971 to 11.5 million Btu in 1997 (AFPA, 1997).

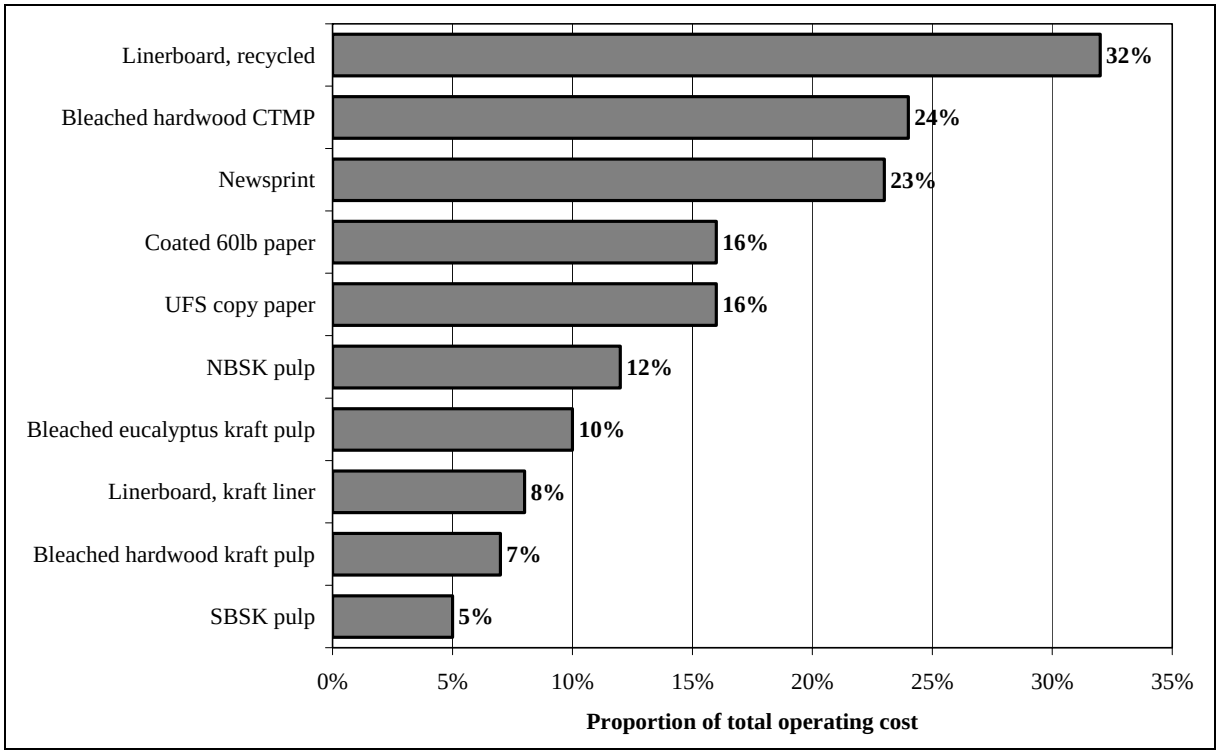
Figure 25 Expenditure on energy by the pulp and paper sector in the USA from 1992 to 2001



Source: EIA (2005).

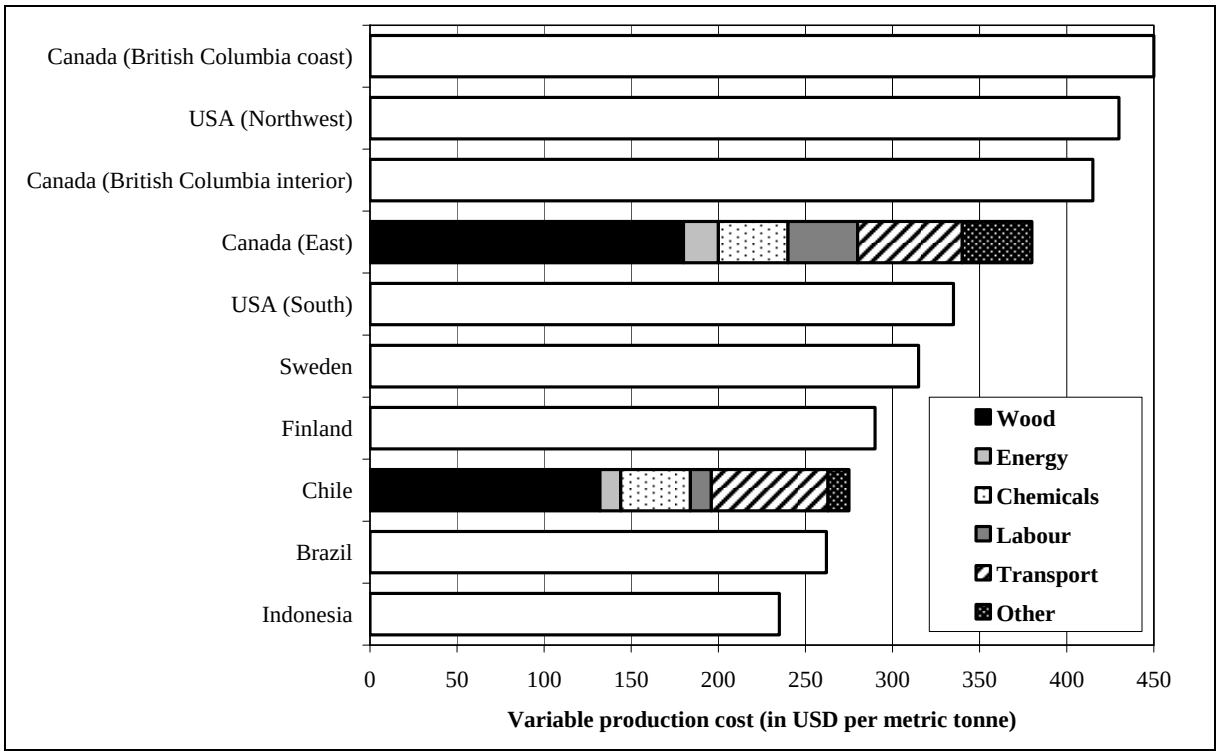
Energy consumption in the pulp and paper industry is also determined by the type of product that is produced. For example, Figure 26 shows some recent estimates of the energy cost (as a proportion of total operating costs) for some major pulp and paper products. This figure shows that the cost of producing some products (e.g. recycled linerboard, bleached hardwood chemi-thermo-mechanical pulp and newsprint) is very sensitive to energy costs. Therefore, if the currently high level of energy prices persists, it can be expected that the costs of production will increase and operating margins will come under pressure in some pulp and paper producers.

Figure 26 Energy as a proportion of operating cost for some major pulp and paper products



Source: Roberts (2003).

Figure 27 Comparison of market kraft pulp production costs in different countries in 2000



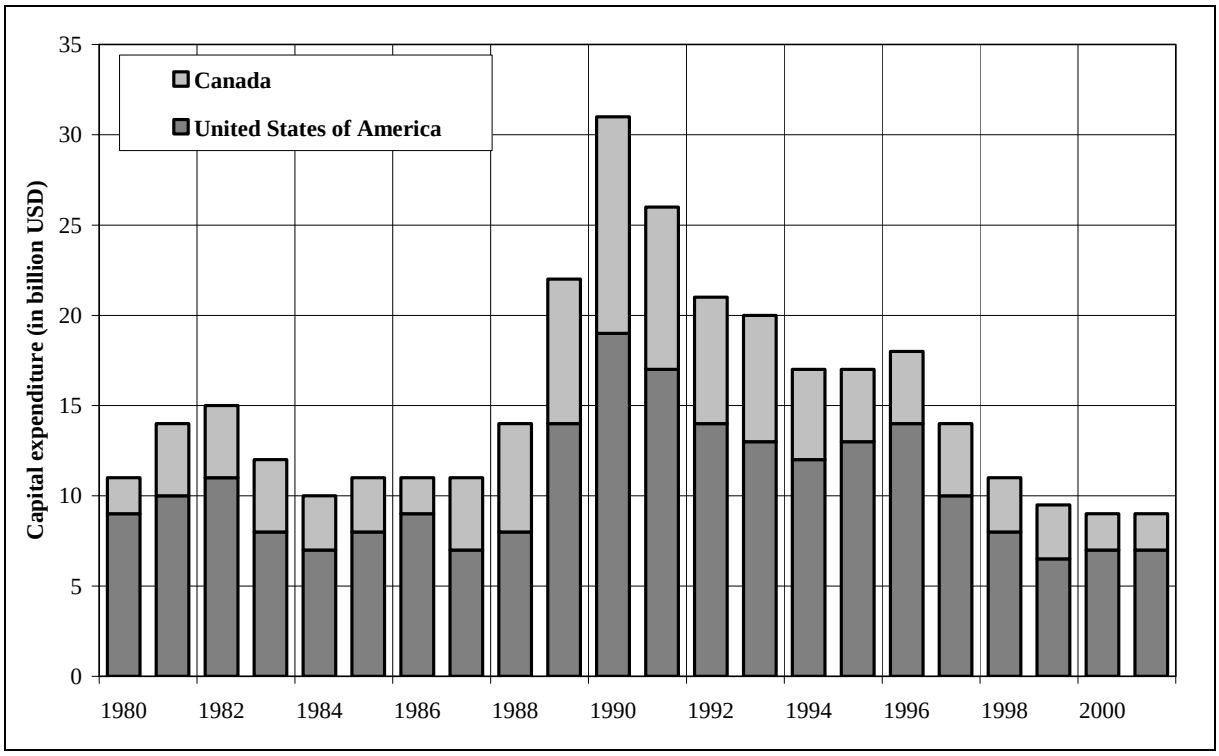
Source: Industry Canada (2002).

The combined impact of regional variations in fibre, energy and labour costs is shown in Figure 27. This figure presents the total variable production cost of market kraft pulp production in a number of countries in 2000 and a comparison of the cost structure in Chile and Eastern Canada. The figure shows that the range of variable costs is significant, from USD 450 per metric tonne in coastal British Columbia to USD 230 per metric tonne in Indonesia. Examination of the cost structure also reveals that almost all of the difference in production costs in Chile and Eastern Canada is due to differences in wood, energy and labour costs and it is very likely that these are the main cost advantages in the other low cost producers (e.g. Brazil and Indonesia).

Trends in investment

In response to the competitive pressures described above, pulp and paper manufacturers in Europe and North America have decreased capital expenditure and consolidated their operations in recent years. For example, Figure 28 shows the trends in capital expenditure in North America over the last two decades. Capital expenditure in 2001 was 70 percent lower than in the early-1990s and equal to about 80 percent of depreciation and amortisation allowances (implying a decrease in the total value of the stock of capital). This manoeuvre also improved short-term cash-flow, reducing the financial pressure on producers at the bottom of the business cycle.

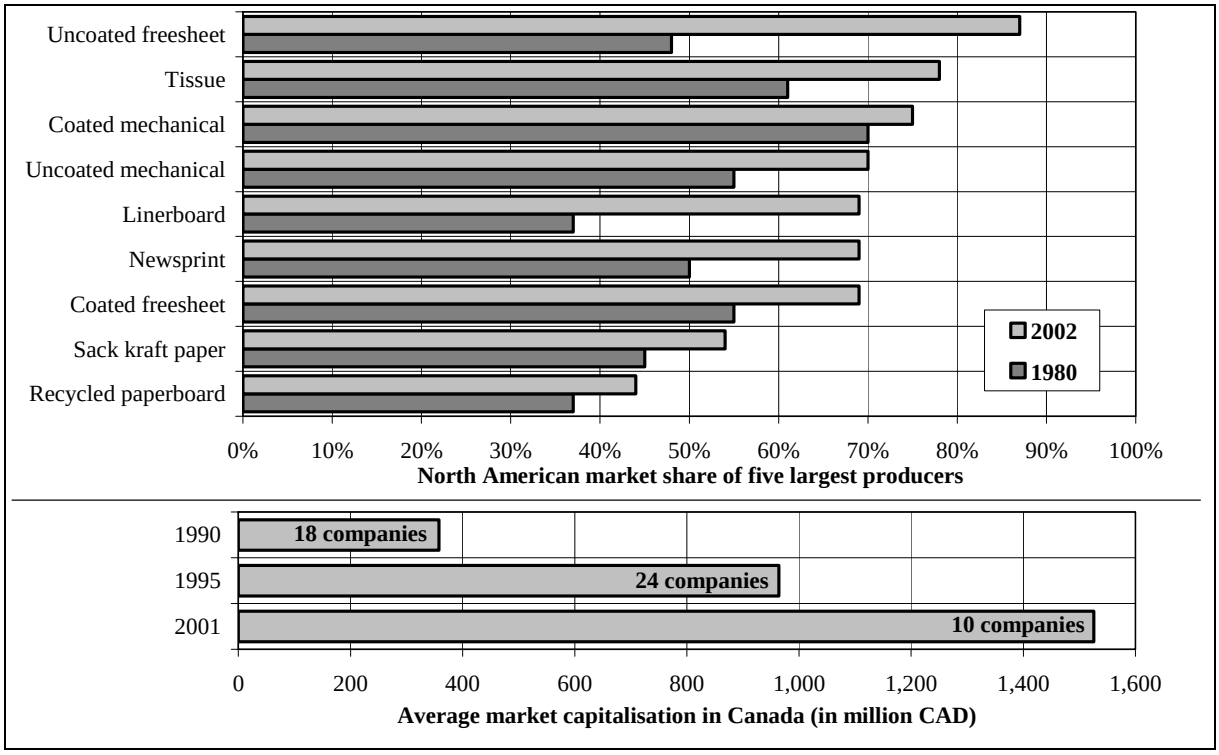
Figure 28 Trends in capital expenditure in the North American pulp and paperboard sector



Source: Roberts (2003).

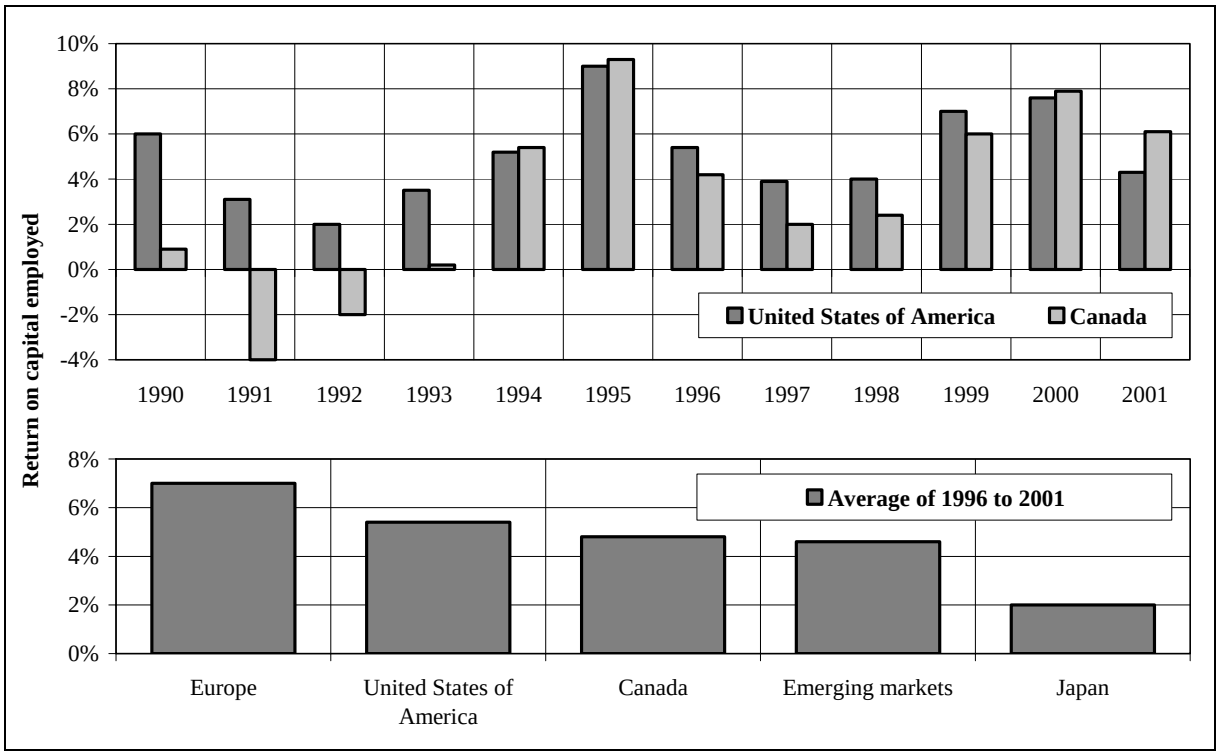
The impact of consolidation in the North American pulp and paper industry is shown in Figure 29. The top half of this figure shows the domestic market share of the top five producers of a range of products in 1980 and 2002. Most consolidation has occurred in the uncoated freesheet, linerboard and newsprint sectors but, in addition, the top five producers now account for around 70 percent or more of the market in almost all of the main product categories. Further evidence of consolidation in the industry is given in the bottom half of the figure, which shows the number of paper and forest products companies in Canada. This has decreased from 18 to 10 over the last decade, resulting in a five-fold increase (in nominal terms) in the average market capitalisation of each company.

Figure 29 Trends in pulp and paper capitalisation and market share in North America



Source: Roberts (2003).

Figure 30 Comparison of returns on capital employed over time and between regions



Source: Roberts (2003).

The results of the restructuring and consolidation of the pulp and paper industry in North America can be seen in Figure 30. During the early-1990s, the returns on capital employed in the industry were poor, averaging 4.8 percent in the USA and 1.7 percent in Canada over the period 1990 to 1995. For the period 1996 to 2001, average returns increased to 5.4 percent and 4.8 percent in the USA and Canada respectively. Most importantly, the industry continued to make money at the bottom of the business cycle. In addition to higher returns, some other financial benefits of consolidation have included lower costs of equity and debt, improved debt ratings and stronger cash-flow (Roberts, 2003).

Consolidation in the pulp and paper industry is a global phenomenon that has reduced over capacity and increased the efficiency of operations, but it has been particularly important in Europe and North America. For example, 15 of the World's 16 largest paper and forest products companies (by market capitalisation) are from these two regions. From the developing regions, only Sappi in South Africa (ranked eleventh) is of a comparable scale. As the bottom half of Figure 30 shows, this consolidation has helped these regions to retain a high return on capital employed despite the disadvantage of relatively high production costs compared to producers in emerging markets.

Trends in product prices and value-addition in the industry

Recent trends in pulp and paper prices are shown in Figure 31 and Figure 32. All of these figures show a gradual downward trend in nominal prices, although it is probably more correct to interpret these trends as a gradual shift towards relatively stable, but lower, prices in the late 1990s.

In the paper and paperboard markets, the total decline in average World trade prices since 1990 amounts to between 12 percent (for other paper and paperboard) and 18 percent (for printing and writing paper). Again, these prices are not adjusted for inflation, so the fall in real prices is probably around 30 percent more than shown here.

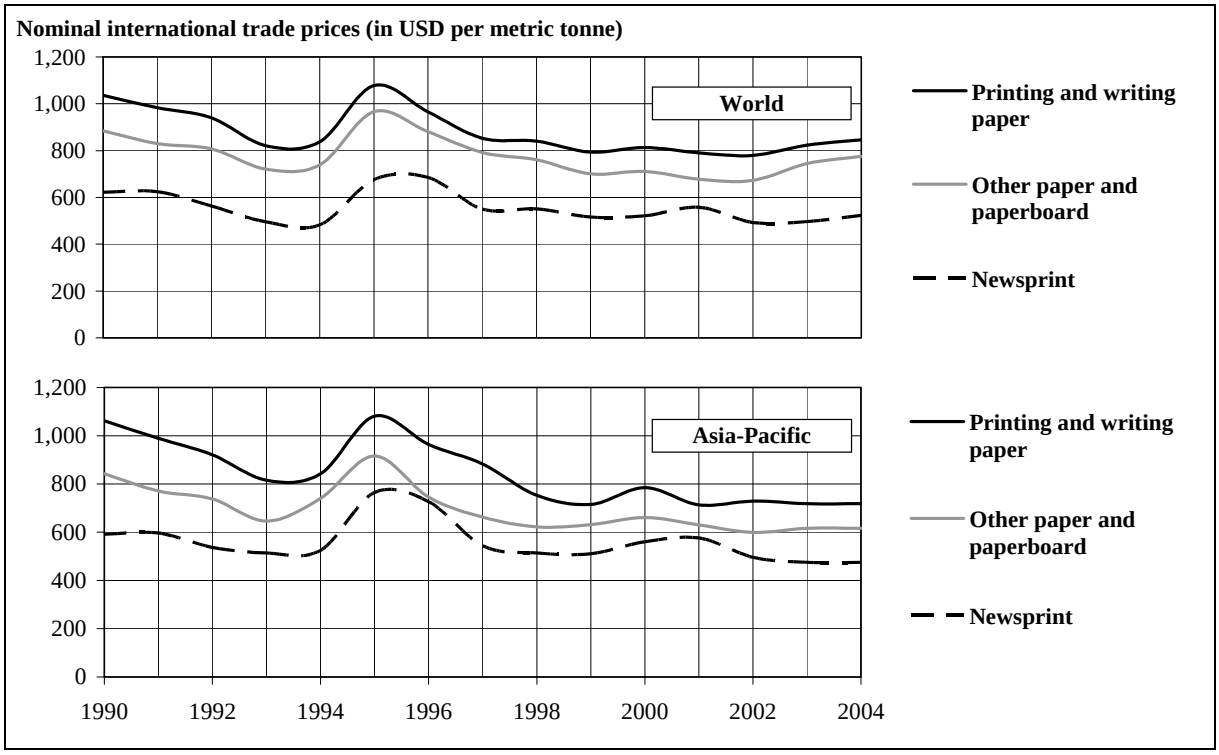
The decline in prices has been even more significant in the Asia-Pacific region, with a fall in nominal prices of 20 percent for newsprint, 27 percent for other paper and paperboard and 32 percent for printing and writing paper. In addition, newsprint prices in the Asia-Pacific region are currently about USD 50 (or 10 percent) below the global average, printing and writing paper prices are USD 130 (or 15 percent) lower and other paper and paperboard prices are USD 160 (or 20 percent) lower.

The trends in prices of pulp for paper are very similar to those described above, except that the decline in prices has been even greater. Since 1990, average World trade prices have fallen by 5 percent, 13 percent and 29 percent for semi-chemical, mechanical and chemical pulp respectively. Given the dominance of chemical wood pulp in global pulp and paper production, this represents a substantial fall in the price of the most significant type of wood pulp.

Trends in the Asia-Pacific region are similar to those at the global level, except that the price of chemical wood pulp in this region has fallen even further (35 percent). In addition, prices in the Asia-Pacific region are generally closer to average World prices (in absolute and percentage terms) compared to the situation in the markets for paper and paperboard. This perhaps reflects the nature of the two markets, where wood pulp is more of a basic commodity that is traded globally (so great regional price variations would not be expected) whereas paper and paperboard tends more to be marketed and traded regionally and between neighbouring countries.

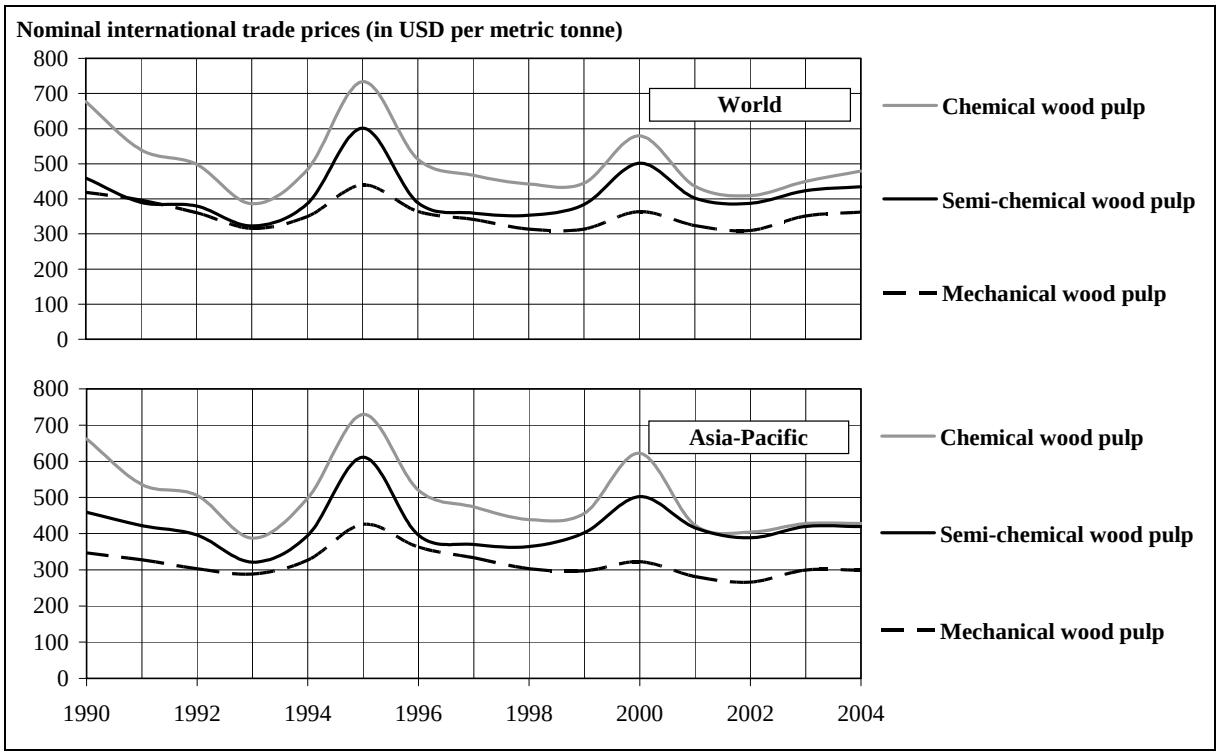
This general shift towards a low-price environment has undoubtedly been caused by the rapid increase in production in the cost-competitive regions (already described above). This has increased global production capacity at a rate that is higher than the underlying increase in demand and, through more intense competition, driven down prices.

Figure 31 Trends in paper and paperboard prices from 1990 to 2004



Source: derived from FAO (2005).

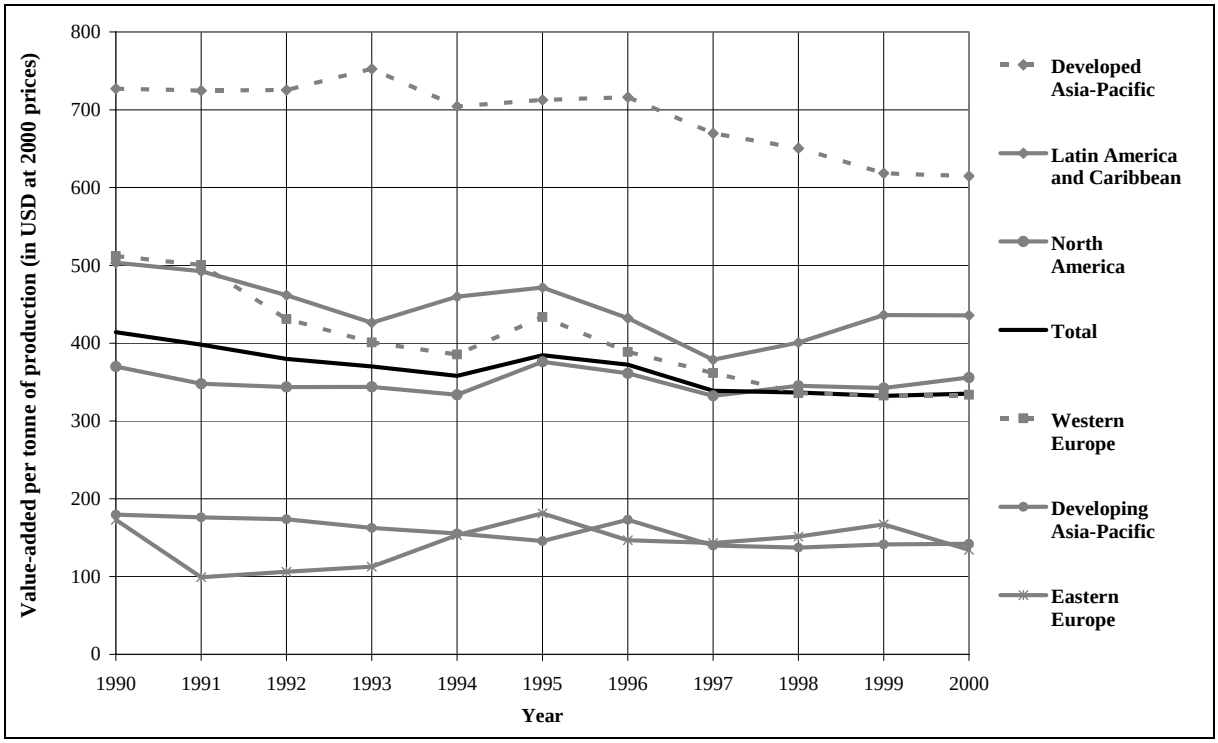
Figure 32 Trends in pulp for paper prices from 1990 to 2004



Source: derived from FAO (2005).

Because the value-added in production is simply the value of output less the cost of purchases from other sectors, the price trends described above would seem to imply that the value-added in pulp and paper production has suffered considerably over the last decade. However, the benefits from the recent structural changes in the industry (e.g. reduced capital expenditure, consolidation, increased efficiency) have mitigated some of the effect of these negative price trends.

Figure 33 Trends in value-added in the pulp and paper industry from 1990 to 2000



Source: Lebedys (2004).

Figure 33 shows the trends in value-added per metric tonne of pulp and paper production at the global and regional levels during the 1990s. The figures shown here are adjusted for inflation and converted to USD per metric tonne (at 2000 prices and exchange rates). Despite the fall in real pulp and paper prices of 30 percent to 60 percent already described above (i.e. nominal price changes plus 30 percent to adjust for inflation), real value-added in pulp and paper production has only fallen by 20 percent, from USD 410 per metric tonne in 1990 to USD 335 per metric tonne in 2000.

Furthermore, the figure shows a significant difference in the level of value-added between the developed regions and Latin America and the Caribbean compared to Eastern Europe and the developing Asia-Pacific region. Labour costs are not subtracted from the value of output in the calculation of value-added, so total value-added is equal to the returns to land, labour and capital used by the industry (i.e. the sum of rents, wages and profits). Thus, the high level of value-added achieved in developed regions is reflected in their ability to pay high wages and a relatively high return on capital.

The price differences between regions are not as great as these differences in value-added and previous sections have already shown that developing regions have comparably low operating costs. Therefore, the explanation for why the developed regions achieve a much higher level of value-added is that their use of capital is much more efficient than in developing regions (i.e. the consumption/cost of equipment and machinery per unit of output is much lower). This is the competitive advantage of production in the developed regions, which has been further enhanced by the recent consolidation in the industry. The challenge for developing regions is now to achieve similar levels of efficiency in their utilisation of capital in the future.

Trends in pulp and paper production

Global and regional trends in pulp and paper production are shown in Figure 34 to Figure 37 on the following pages. In general, these trends are very similar to the trends in consumption, so no detailed description is required. However, there are a few points worth noting, particularly with respect to the differences between growth in production and consumption that have led to changes in net trade.

Trends in newsprint production (Figure 34) have very closely matched the trends in consumption, so they display the same deceleration in growth in developed regions in the last decade and a continuing high growth rate in the developing Asia-Pacific region. Net trade in newsprint between regions is very small and has not changed much over the last four decades. Europe and North America are small net exporters, while the developing Asia-Pacific region and the rest of the Word are small net importers.

For printing and writing paper production (Figure 35), the major feature of these trends is the relatively high level of growth in production in Western Europe during the 1990s (growth in production of 3.5 percent per year, compared with growth in consumption of only 2.0 percent per year). Western Europe has always been a modest net exporter of printing and writing paper, but production and net trade increased considerably during the 1990s. For example, by 2004, net exports from Western Europe amounted to one-quarter of production in the region (or 10 percent of global production). This indicates that Western Europe has a significant comparative advantage in the production of this type of paper compared with importing countries (mostly in Eastern Europe and other developed regions).

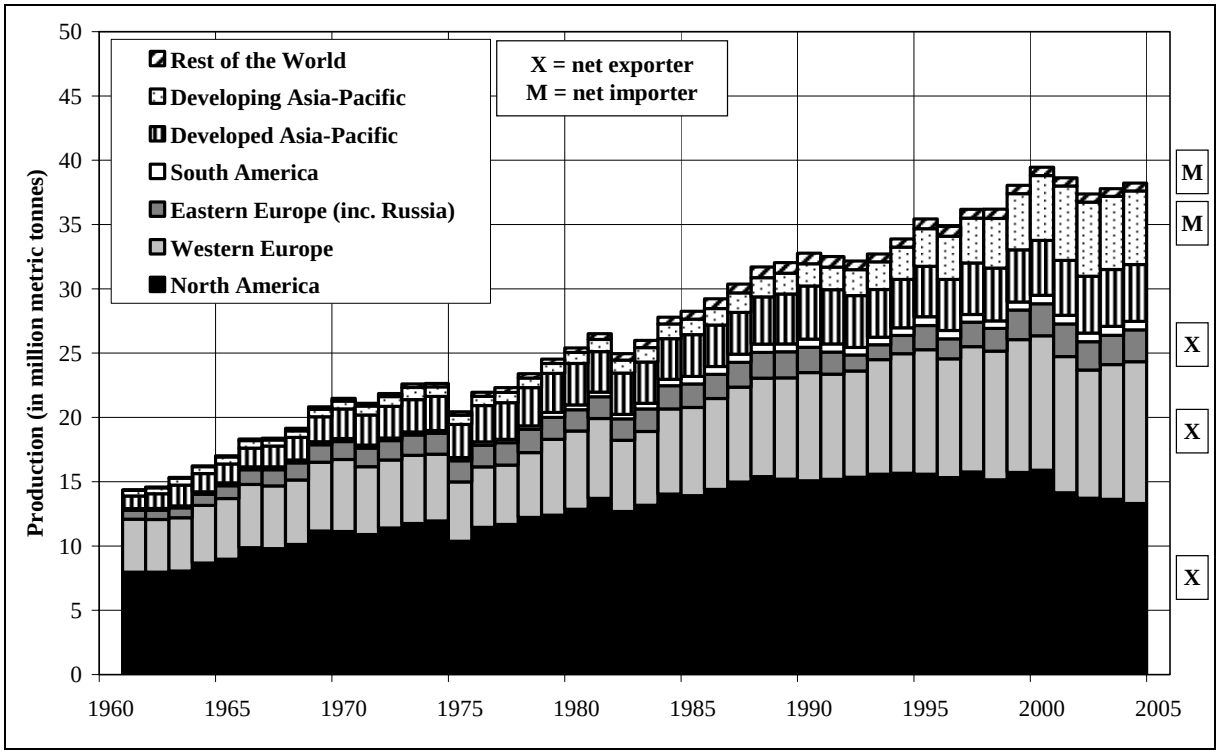
In the case of other paper and paperboard (Figure 36), the growth rates for production and consumption have been relatively close in all regions and the amount of net trade is quite modest (less than five percent of global production). However, a recent development has been the trebling of net imports into the developing Asia-Pacific region since 1990. This is because growth of production in the region (6.5 percent per year) has failed to keep up with the growth in consumption (6.7 percent per year). Both parts of the Asia-Pacific region are net importers of other paper and paperboard, while the net exporters are North America and Western Europe. Net exports from North America have not changed very much in recent decades, but net exports from Western Europe have expanded quite a lot since 1990.

Finally, Figure 37 shows the trends in pulp for paper production. The first point to note is that all of the major regions are either a net importer or net exporter of these products. Furthermore, the total amount of net trade between regions is significant, amounting to about eight percent of global production. This is possibly due to the fact that pulp is an intermediate product and, as such, international trade is often encouraged by governments in both exporting and importing countries.

Historically, the major international trade flow in pulp for paper was between North America and Western Europe. For many years, North America has been a significant net exporter and Western Europe has been a significant net importer of pulp for paper. However, over the last decade, production in South America has expanded rapidly, resulting in a six-fold increase in net exports. In the opposite direction, production in the developing Asia-Pacific region has not increased as fast as consumption, leading to a significant increase in net imports. Indeed, this region is now a larger net importer of pulp for paper than Western Europe.

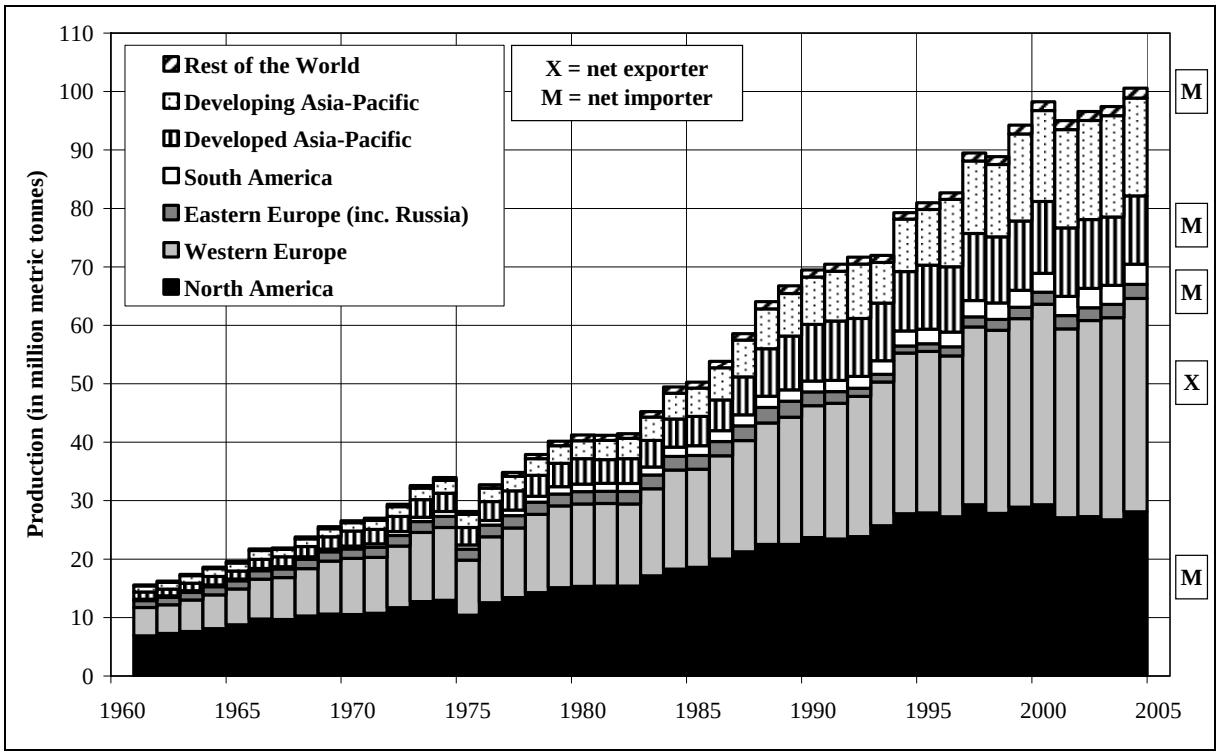
The developed Asia-Pacific region is also a net importer of pulp for paper and Eastern Europe is a net exporter. However, net trade with these regions is relatively modest and has not changed by much in the recent past.

Figure 34 Trends in newsprint production by region from 1961 to 2004



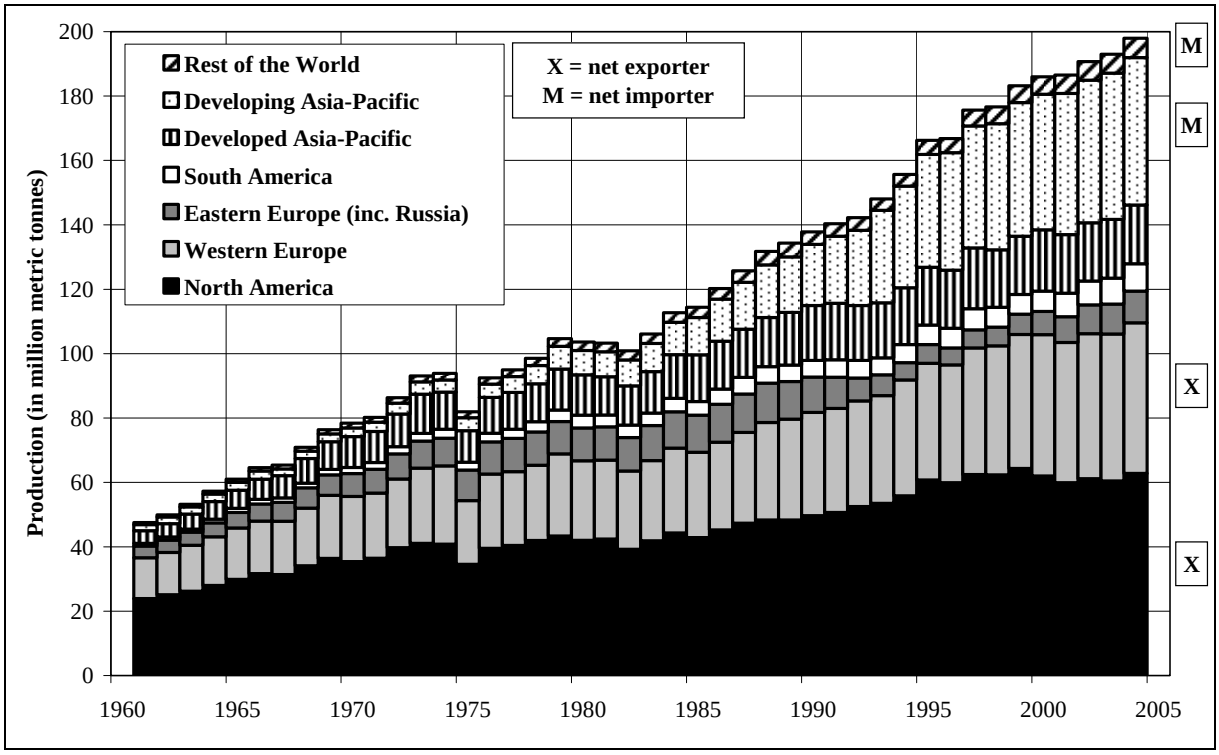
Source: FAO (2005).

Figure 35 Trends in printing and writing paper production by region from 1961 to 2004



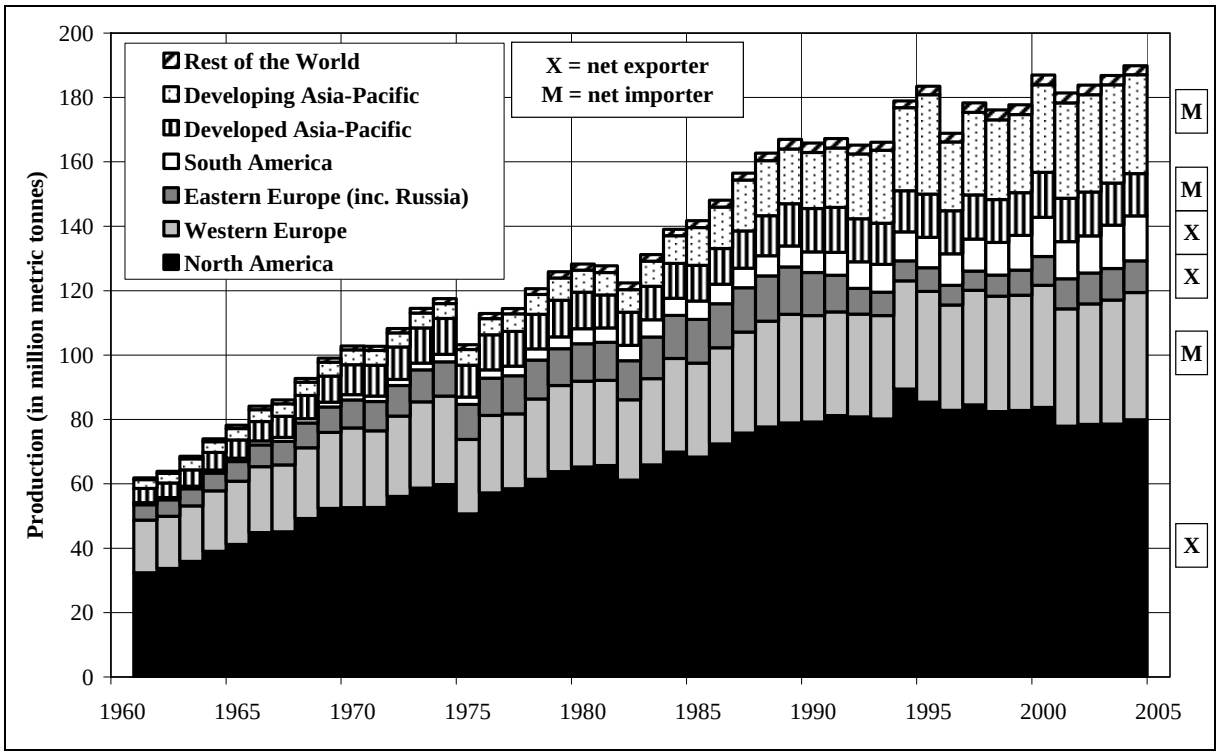
Source: FAO (2005).

Figure 36 Trends in other paper and paperboard production by region from 1961 to 2004



Source: FAO (2005).

Figure 37 Trends in pulp for paper production by region from 1961 to 2004



Source: FAO (2005).

Conclusions about pulp and paper supply

At the global level, the most significant feature of the trends described above is the major structural changes that have occurred in the pulp and paper industry during the 1990s. Global production has increased more rapidly than the underlying increase in demand, resulting in downward pressure on prices. Furthermore, this effect has been multiplied by the increase in production in low-cost countries. However, at the same time, regional differences in supply and demand have also increased, resulting in an increase in global trade. For example, despite the huge increase in pulp and paper production in the developing Asia-Pacific region since 1990, this increase has not matched the expansion in demand and has led to an increase in net imports.

Pulp and paper supply in developed regions. In most developed countries, the pulp and paper industry has responded to the new competitive pressures by reducing capital expenditure, consolidating the industry and cutting excess capacity. The competitive advantages of the industry in these countries are their closeness to large, high-income markets, their advantages in skills and technology and their economies of scale. These advantages have enabled the industry in developed regions to increase exports despite their relatively high operational costs. This has largely been achieved by increasing their efficiency in capital utilisation (e.g. due to the improved economies of scale as a result of consolidation).

The outlook for pulp and paper supply in these regions is positive, but they will have to develop new strategies to maintain their position in the face of increasing competition from low-cost suppliers. It is quite likely that this will include increased investment and acquisitions in developing regions.

Pulp and paper supply in developing regions. Pulp and paper production in developing regions has expanded more rapidly than in developed regions over the last decade, but has still not been able to match the increase in demand. Consequently, net imports of pulp and paper have actually increased. The rapid growth in consumption in these regions is an advantage, but the benefit of this is reduced by the low purchasing power in many of these countries and the existing competition from producers in developed countries at the high end of the market. Thus, the "*demand-pull*" effect on capacity expansion has been somewhat limited.

These countries have a significant cost advantage in several areas (e.g. fibre, labour and, in some cases, energy), but this is offset by their relatively low efficiency of capital utilisation. The latter is due to their relatively small scale of operations and, in many cases, the need to divert investment funds towards increasing fibre supply. Indeed, a major constraint to growth in many of these countries is their reliance on fibre supply from forest plantations, which are often in the early stages of development.

The outlook for pulp and paper supply in these regions is positive and should improve as fibre supply increases along with their scale of operations.

IMPLICATIONS FOR THE PULP AND PAPER SECTOR IN INDIA

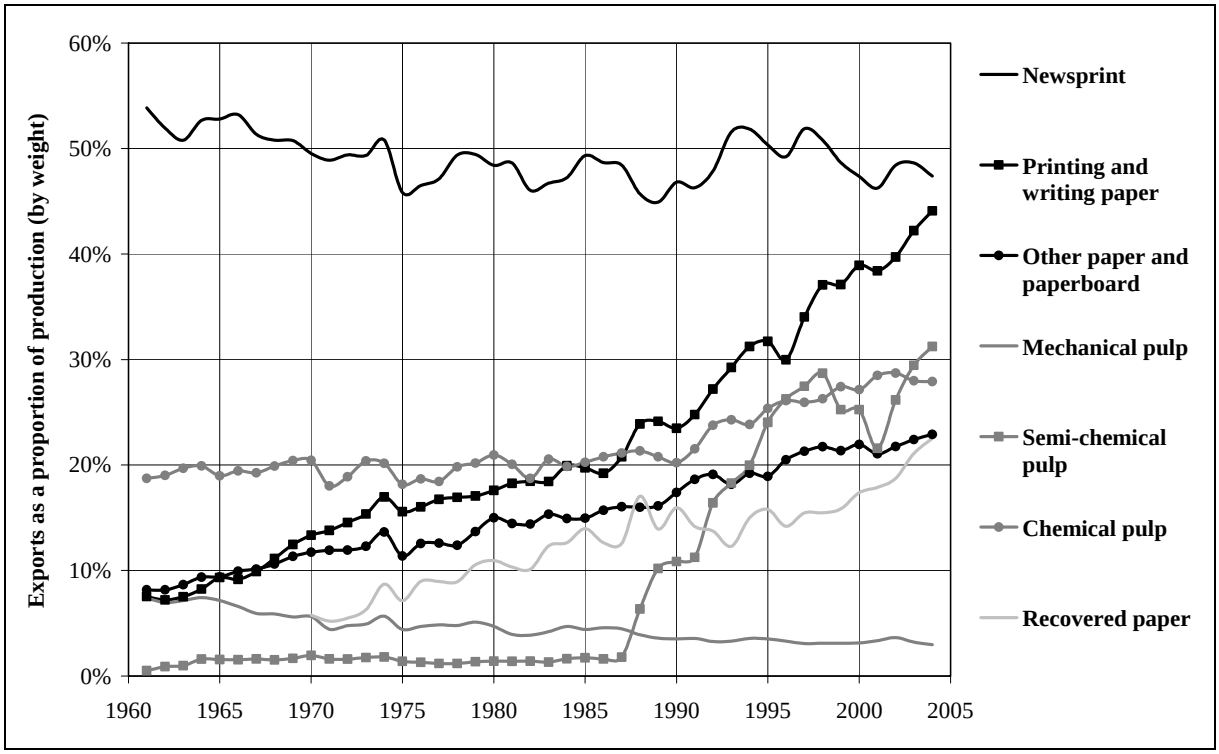
This last section presents some general observations and then some specific points that should be considered by the pulp and paper industry in India.

General observations

There are two major conclusions that can be drawn from recent trends in forest products markets. The first is that the forces driving the development of the forestry sector have changed somewhat due to the impact of increased globalisation on the sector. The second conclusion is that government policies continue to play a major role in shaping developments.

Globalisation in the forest products sector. Historically, forest industries developed in countries with significant forest resources and international trade was driven by the geographical mis-match between countries with vast resources and countries with high levels of consumer demand. However, in recent years, these natural advantages have become less important and development of the forest industry has been driven more by economic advantage (e.g. factors such as: labour costs; levels of research and technology; and access to capital).

Figure 38 Trends in pulp, paper and recovered paper exports from 1961 to 2004



Source: derived from FAO (2005).

Figure 38 shows the trends in one indicator of globalisation in the pulp and paper sector, which is the proportion of global production that is exported each year. For some products (e.g. newsprint and chemical pulp), a significant proportion of production has always been exported. However, the figure shows that exports as a proportion of production has increased significantly over the last four decades in almost all product categories (the two exceptions are newsprint and mechanical pulp, which comprise a relatively small share of total production). Furthermore, there has been a marked acceleration in these trends in the 1990s for two major products - chemical wood pulp and printing and writing paper - and, to a lesser extent, recovered paper.

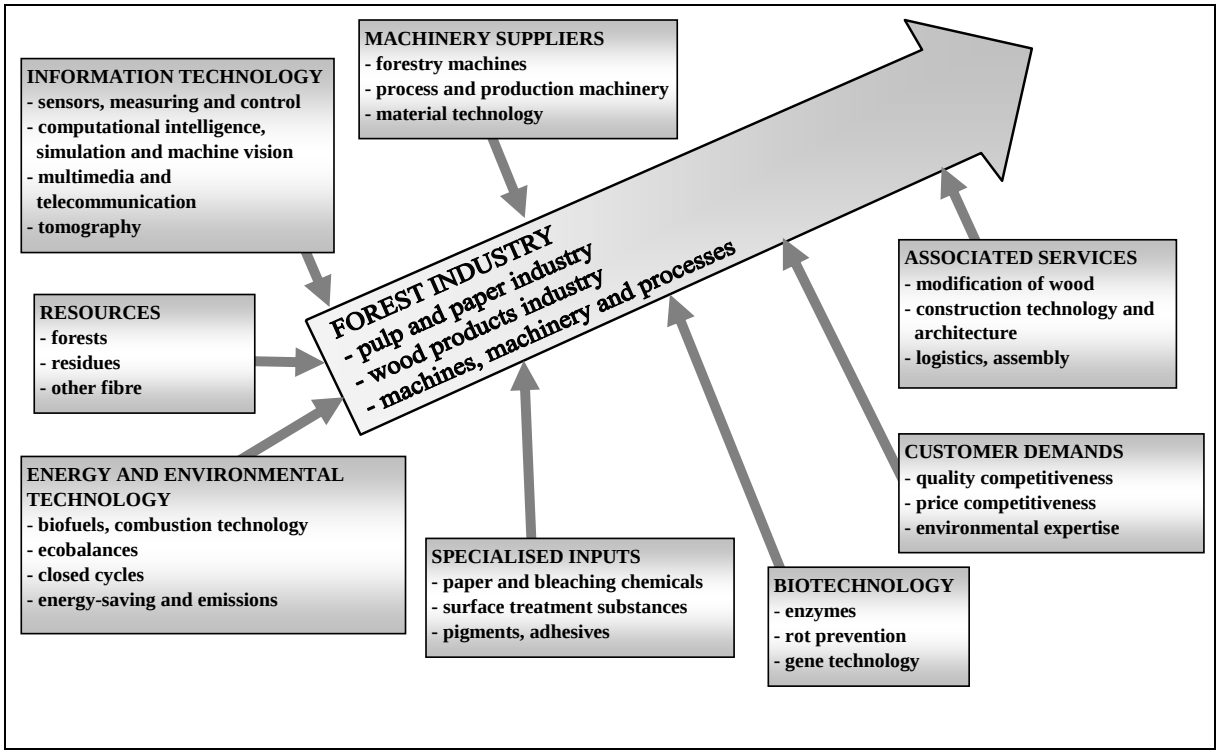
As noted in the previous section, the industry has also become more globalised through consolidation, acquisitions and the creation of large-scale multi-national forest products companies. Thus, it is now quite common for the largest forest products companies to operate in several different countries and to move significant amounts of raw materials, partly-processed products and finished goods across national borders.

Historically, pulp and paper production has also been tied to fibre supply and most production occurred in the countries with significant areas of forest. More recently, with the rising importance of forest plantations, the advantage of abundant fibre supplies has started to shift from countries with large forest areas to countries where trees grow fast (i.e. the tropics and sub-tropics). However, wood fibre is only one factor of production and the countries that will be most successful in the future will be those that manage to develop the full range of necessary market conditions, suppliers and related industries that support industrial expansion.

One example of how countries have responded to the new competitive pressures of globalisation is the development of forest industry clusters. A cluster is a geographic concentration of companies, related industries and institutions in a particular business sector, which compete but at the same time co-operate ("*co-opertition*"). By working together, companies and institutions can provide improved access to specialised inputs and employees, public goods and knowledge. This reduces the barriers to entry in the industry, leading to more innovation and faster product development. In addition, although it increases competition within the cluster, it also leads to increased productivity and competitiveness of firms within the cluster compared to other producers (Aleksejenko, 2002).

In the light of increased competition from new, low-cost producers, a number of countries in the Northern Hemisphere have supported the development of forest industry clusters (e.g. UK, USA, Finland and Latvia) and some in the South are also starting to develop clusters of their own (e.g. Brazil and New Zealand). For example, Figure 39 shows the range of producers, customers, suppliers, supporting industries and associated service providers that are considered as part of the forest industry cluster in Finland. By working together, this well-established cluster has helped to maintain Finland's position as a leader in the global forestry sector.

Figure 39 The forest industry cluster in Finland



Source: derived from Albäck (2005).

Government policies. In addition to market forces, the other major factor that has influenced developments in the forestry sector is government policies (both within and outside the sector). Many of the changes described above have been influenced by government forestry policies as well as policies in the areas of industrial development, trade, land use, technology and the environment. Some major examples are as follows:

> Forestry policies: restrictions on access to forest resources; stricter forest management regulations; support for tree planting and industrial development; pricing policies (for access to state-owned resources); and privatisation and other changes to land ownership and land tenure.

Environmental policies: support for recycling and restrictions on waste disposal; water quality standards; carbon taxes; and support to the development of bioenergy.

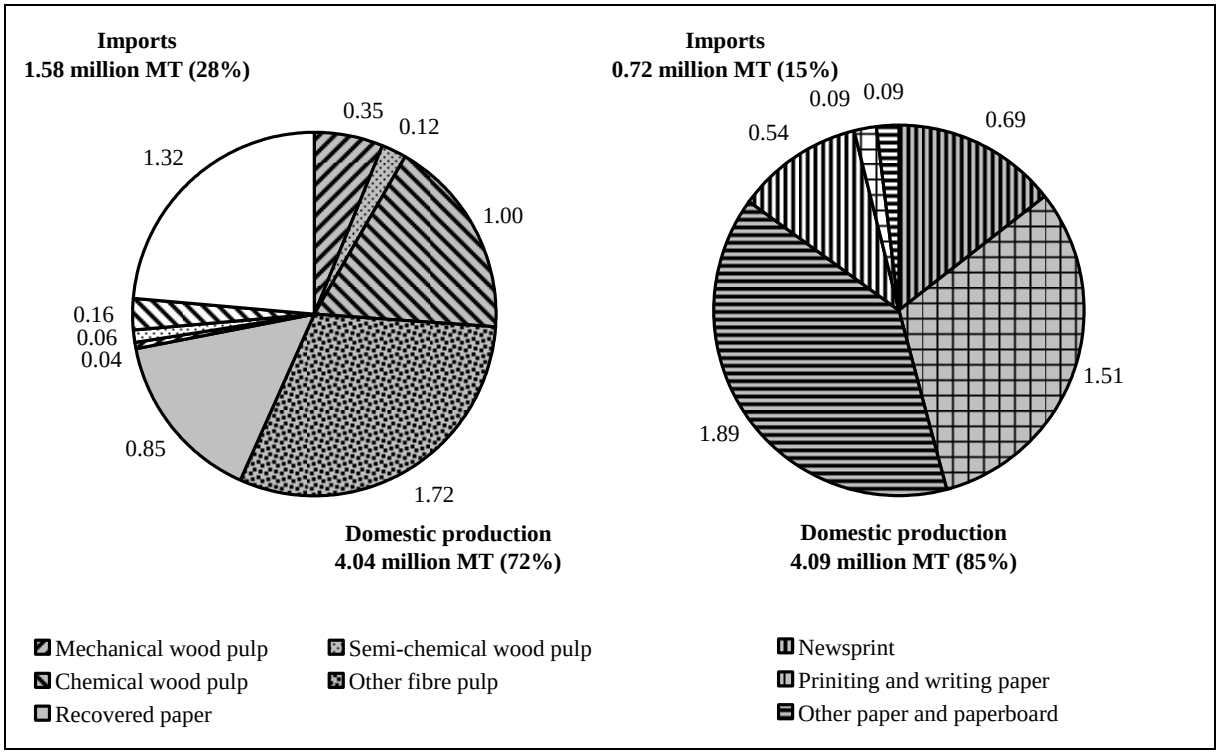
Trade policies: tariffs; export bans and/or trade quotas; other non-tariff measures.

These policies have in some places restricted fibre supply (e.g. limits on access to forest resources and trade restrictions); while in others they have increased supply (e.g. support for plantations and recycling, waste disposal regulations and forest privatisation). They have probably had most impact in developed countries so far, but it can be expected that they will play a greater role in the future in many developing countries.

Implications for the pulp and paper sector in India

The current status of pulp and paper consumption in India is shown in Figure 40. Total consumption of fibre furnish (pulp for paper plus recovered paper) amounts to 5.62 million metric tonnes, of which recovered paper and other fibre pulp consumption accounts for almost three-quarters of total consumption. Furthermore, imports (mostly of recovered paper) account for 28 percent of consumption. Total paper and paperboard consumption amounts to 4.81 million metric tonnes, of which 15 percent is imported. The shares of newsprint, printing and writing paper and other paper and paperboard in total consumption are 26 percent, 33 percent and 41 percent respectively.

Figure 40 Pulp and paper consumption in India in 2004



Source: FAO (2005).

Rapid expansion of paper consumption in India will almost certainly occur in the future across all categories. Annual growth in consumption over the last 15 years amounted to 8.5 percent, 4.1 percent and 5.1 percent for newsprint, printing and writing paper and other paper and paperboard respectively and similarly high growth rates can be expected in the future. However, the share of newsprint in total consumption is currently relatively high, so a decline in growth in this sector might be expected, while growth in printing and writing paper could accelerate as the service sector increases in importance in the economy.

In light of these expected increases in demand, there will be room for considerable expansion in the pulp and paper industry in India. Thus, the challenge for the industry will to be address any potential constraints on development, so that they can take full advantage of the positive outlook for demand.

Fibre supply. Currently, the quality of roundwood production statistics supplied to FAO is quite weak For example, Table 2 shows the statistics for 2004 held in the FAOSTAT database. This indicates that total pulpwood production amounts to only 310,000 cubic metres, while the statistics on wood pulp production imply consumption of around 7 million cubic metres. It is possible that a lot of wood supply to the pulp and paper industry comes from wood residues (e.g. from the sawmilling and plywood industry), but there is another problem with these statistics in that reported sawnwood and plywood production amounts to around 13.6 million cubic metres (implying that consumption of sawlogs is somewhat more than indicated here). Any serious analysis of wood supply to the industry would require an improvement in the quality of basic statistics such as these.

Table 2 Roundwood production in India in 2004 (in million cubic metres)

Type of roundwood	Coniferous	Non-coniferous	Total
Sawlogs and veneer logs	*2.54*	*15.81*	*18.35*
Pulpwood	*0.14*	*0.17*	*0.31*
Other industrial roundwood	*0.04*	*0.13*	*0.17*
Total industrial roundwood	2.72	16.11	18.83
Woodfuel	9.14	294.70	303.84
Total roundwood	**11.86**	**310.81**	**322.67**

Source: FAO (2005). Note: the statistics for other industrial roundwood and woodfuel are estimates, while the other statistics are supplied to FAO by the Government of India.

Table 3 Potential roundwood production from plantations in India (in million cubic metres)

Forest plantation scenarios	1995	2000	2010	2020	2050
Scenario 1 (no new planting)					
Industrial forest plantations	*2.5*	*4.1*	*12.1*	*26.3*	*20.1*
Non-industrial forest plantations	*30.2*	*62.4*	*73.7*	*72.6*	*84.6*
All forest plantations	32.7	66.5	85.8	98.8	104.7
Scenario 2 (new planting at 1% of current area)					
Industrial forest plantations	*2.5*	*4.1*	*12.1*	*26.8*	*28.1*
Non-industrial forest plantations	*30.2*	*62.4*	*77.6*	*84.1*	*119.9*
All forest plantations	32.7	66.5	89.7	110.8	148.0
Scenario 3 (new planting declining from current rate)					
Industrial forest plantations	*2.5*	*4.1*	*12.1*	*29.5*	*57.5*
Non-industrial forest plantations	*30.2*	*62.4*	*97.0*	*137.7*	*226.4*
All forest plantations	32.7	66.5	109.1	167.1	283.9

Source: Brown (2000).

Despite these limitations in the data, it seems likely that the potential availability of fibre in the future should not be a major constraint to expansion of the pulp and paper industry for the following reasons:

> Forest plantations: India has ideal conditions for growing pulpwood in fast-growing short-rotation plantations. This will require a considerable investment in tree planting, but India has already embarked on a major programme of forest plantation establishment. FAO's study on the potential wood production from forest plantations (Brown, 2000) shows that a considerable expansion in supply from plantations can be expected in the future (Table 3).
>
> Trees outside forests: It is also believed that there is considerable production of wood (especially for fuel) from trees outside forests. Indeed, the existence of this significant (but poorly monitored) component of wood supply may explain why official production statistics

are so weak. As with forest plantations, there is probably considerable scope for expansion in this sector in the future.

Wood residues: With the currently reported level of sawnwood and plywood production of around 13.6 million cubic metres, it can be assumed that a similar volume of wood residues are produced each year by the sawnwood and plywood industry. This is another major potential source of wood supply that may not be fully utilised at present.

Recovered paper: The current level of paper recovery is quite low, but increasing. This is likely to increase in the future as paper and paperboard consumption expands and urbanisation continues.

Woodfuel: A recent study by FAO on the outlook for global woodfuel consumption (Broadhead *et al*, in prep) suggests that woodfuel consumption in India may have reached a peak and decline in the future. If and when this occurs, this will reduce demand from the major competitor for small-sized roundwood. The existing infrastructure for woodfuel supply could also be redirected towards supplying pulpwood to the pulp and paper industry.

As the above text has indicated, the potential to supply larger amounts of wood and fibre to the industry is there. What will be required is a considerable effort to organise the wood supply chain, which is likely to comprise a large number of small producers. Other countries have managed to do this by the creation and strengthening of logistics (e.g. through the establishment of forest owners associations, creation of co-operatives and forestry extension activities) and it seems likely that this would be required in India.

Manufacturing capacity. In addition to fibre supply issues, it will also be important for the pulp and paper industry to consider its optimal position within the forestry-wood-chain. India has the advantage of a large pool of relatively cheap skilled labour and adequate wood supplies for expansion. However, potential constraints on the development of manufacturing capacity are likely to be in the areas of energy supply and water scarcity.

Energy supply: As already noted in previous sections, pulp and paper manufacturing is a very energy intensive activity. This is especially the case for newsprint production, which is relatively important in India. Numerous studies have raised concerns about the outlook for energy supply in India (e.g. IEA, 2002) and it will be important for policymakers to address some of these issues if industrial development is not to be constrained in the future by energy shortages.

Water consumption: The pulp and paper industry is also a major consumer of water. For example, in Canada, around 70 cubic metres of water are consumed per one metric tonne of pulp and paper output (FPAC, 2001). In many developed countries, water consumption and emissions of pollutants have declined considerably in recent years (e.g. water consumption per unit of output has halved in Canada over the last three decades), but most developing countries are probably some way behind in this respect. With a growing population, it is certain that water consumption in India will increases substantially in the future and it is likely that concerns about water quality and quantity may increase.

Given these constraints, it will be necessary to consider the optimal structure of the industry in terms of which products are produced locally and which are imported.

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