

Pulp Fact

Environmental Implications of the Paper Cycle

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Preface

The pulp and paper industry might be justified in feeling under environmental siege at the moment. No sooner had companies started responding to public fears about water pollution and organochlorine contamination than demands for greater recycling began to be heard, followed by complaints about methods of forest management. Now environmental groups are increasingly demanding a reduction in total paper consumption. Battered executives may be thinking that they are trapped in a "no-win" situation.

To some extent this is difficult to avoid. Environmental scientists are constantly learning more about side effects of industry; problems that were unrecognised a few years ago are now seen as being of critical importance. Consumer pressure has added an important new dimension to corporate planning. Industry has had to become adept at meeting new challenges and demands.

Nonetheless, life would be a lot easier if both industry and environmentalists were clear about what was needed to reduce the environmental impacts of the pulp and paper industry to acceptable levels. The following WWF report is a contribution to this end. It summarises environmental issues connected with the pulp and paper industry and suggests solutions that will suit both producers and consumers of paper.

Neither WWF, nor the authors of the report, are opposed to paper. (Indeed, as writers and researchers we probably rely more than average on books, papers and reports.) However, we do believe that the environmental impacts of paper use are currently greater than is either acceptable or necessary. And we think that in some cases paper use could and should be substantially reduced.

Nor is WWF seeking a confrontation with the pulp and paper industry. Our instinct is to work with industry to seek common solutions to environmental problems. That does not mean that we will not be prepared to fight hard if the need arises. But experience with the timber industry over the last few years shows that while working towards common solutions is never straightforward, it is by far the most productive option.

We call on the pulp and paper industry to respond positively to the challenges and opportunities of moving to a more fully sustainable paper cycle.

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Executive summary

The following report has been prepared for WWF International.

Global pulp and paper use

- Over 45 per cent of the world's annual commercial timber cut goes to pulp, paper and board. The proportion exceeds 50 per cent in Europe, and this is likely to become commonplace throughout the world. A few countries, such as India are, conversely, moving away from wood use in paper production.
- The North dominates both paper production and consumption. The most rapid rate of growth is currently seen in the newly industrialising countries of Latin America and Asia, such as Brazil, Thailand and South Korea.
- Uses of paper are changing. In many countries, over half the total paper use goes for packaging and advertising. Most paper products are disposable and/or short-life.
- The industry is highly integrated, and less than 20 per cent of paper enters world trade.

Impacts in the forest

- Many forests are managed and logged principally for pulp, including natural and old-growth forests in Europe, North and South America, Russia, Australia and parts of Asia.
- The industry has sometimes tried to disguise the fact that natural forests are logged principally for pulp, because of fears about consumer objections.
- Pulp production is the main reason for development of some of the world's most intensively-managed timber plantations, often using fast-growing, exotic tree species. Examples occur in Europe, Argentina, Brazil, Chile, Australia, New Zealand, South Africa and Indonesia. Some of these are still being established in place of natural forests.
- Plantations have negative impacts on biodiversity and the environment, including soil and water. They also eliminate most non-timber uses of forests, which are often of crucial importance to local people.
- Increasingly, pulp plantations are established or purchased by foreign companies, thus further reducing the options for local government involvement and control. For example, this is occurring in Chile, Canada and New Zealand.
- Paper production sometimes also uses non-timber plant materials. Whilst these can alleviate some of the problems caused by wood pulp production, they can sometimes also result in environmental damage, for example through loss of natural bamboo forests in northern India.

Impacts during manufacture

- Pulping often releases a range of pollutants, including organic products which cause eutrophication in water, aluminium salts and sometimes also sulphur dioxide. Both of the two main pulping methods - mechanical and chemical bleaching - can cause pollution. Most papers require bleaching, which can also release pollutants including dioxin.
- Pollutants have had important impacts on freshwater and marine ecosystems near pulp mills, including causing serious damage to fisheries, in for example Canada, Scandinavia and Russia.
- Pollutants can also have direct effects on human health, through impacts on pulp workers, as a result of people eating contaminated fish, and through air pollution.
- Considerable improvements have been made with respect to pollution over the last few years. However, serious pollution still occurs in some areas. There are signs that pulp industries in the North are exporting technology to developing countries that would now not be allowed by law in their home base.

Impacts from waste

- Most waste ends up in landfill sites, where for example it makes up 40 per cent of the contents of US rubbish dumps.
- Other paper waste is incinerated. This recovers the energy contained in the plant material, but can cause serious pollution. It also means that most of the potential carbon sequestration effects of pulp plantations are only of a very short-term nature.
- Paper recycling offers savings in terms of energy and resources. It can have some associated environmental costs of its own, such as pollution from de-inking processes. Recycling is failing to keep pace with the rapid increase in paper demand in many countries.
- Recycled paper is also becoming a marketable commodity, with waste paper being shipped around the world, partly to supply fibre to countries with a shortfall, and partly to meet government and industry targets for recycling.

Responses

- The varied effects of the pulp and paper industry mean that no single strategy is enough to address all the social and environmental problems identified in this paper. Five major areas of response are identified.
 - **Improving forest management.** Steps towards reduced environmental damage during production of wood fibre should include: stopping the logging of old-growth forests for pulp; improving management in secondary forests and plantations; and incorporation of independent certification into plantation management.
 - **Increasing the range of raw materials.** There are also a number of options for changing the raw material used in paper, including substitution of agricultural wastes, growing special crops, and in some cases use of other wild plant material. Most of these alternatives have some environmental costs which need to be balanced against other factors.

- **Reducing pollution.** Although substantial gains have been made in the last decade, serious problems remain in many areas and it is important that these are addressed.
- **Promoting recycling.** Although recycling is by no means a universal or total answer to paper supply, and has some costs of its own, it offers substantial savings over the use of virgin pulp in key cases and should be increased.
- **Managing consumption.** All of these options show promise, but do not address the scale of problems posed by current and projected pulp and paper consumption. Reducing waste through changes in consumption patterns is an important fifth element in this strategy.

Chapter 1: Global pulp and paper use

The production of fibre for pulp, the processes of pulping and paper making, and the consumption of paper all currently take place mainly in the North. Production is highly integrated, and there is comparatively little international trade in constituent products; some of the largest paper makers also consume the most paper. However, this situation is gradually changing. Some countries, such as Chile, export virtually everything that they produce, and this is leading to greater cross-border trade. A number of tropical and particularly sub-tropical countries have recognised that their climate and geography allows rapid growth of pulp timber and thus creates a consequent potential for trade.

- **World pulp production was 155 million tonnes in 1991, and 243 million tonnes of paper was produced¹.**

Paper making accounts for roughly 1 per cent of global industrial output and almost 2 per cent of world trade. Precise figures are difficult to calculate. Although the UN Food and Agricultural Organisation (FAO) publishes statistics for production of wood pulp and paper, paper can also be made from other wood-based material, paper waste and non-wood products.

Table 1: Global paper production

Region	Paper production ('000 tonnes 1989-1991)	Percent change since 1979-1981
World	238,056	40
Africa	2,735	59
Asia	56,357	93
North and Central America	91,174	25
South America	7,688	43
Europe	67,016	34
Former USSR	10,348	18
Oceania	2,739	33

Source: *World Resources 1994-1995*, Oxford University Press, 1994

- **Pulp production will soon consume over half the world's annual commercial timber cut².**

Currently, around 45 per cent of industrial timber production (ie not including non-industrial and fuelwood) goes to pulp³. In Europe, the proportion rises to 50 per cent⁴, and this is likely to become a global average over the next few years. Conversely, a few countries are moving against this trend and using less wood fibre in paper production. For example Indian analysts calculate that by 2010 only 27 per cent of paper raw materials in India will be forest based⁵.

- **The North dominates both paper production and consumption.**

The North continues to dominate paper production, with 1991 figures attributing 82.5 per cent of output to the industrialised nations. The largest producers are the USA (38 per cent), Canada (15 per cent), Japan (7.5 per cent), Sweden (6 per cent), Finland (5.5 per cent), Brazil (3 per cent), Germany (2 per cent), France (1.5 per cent) and Norway (1 per cent)⁶.

Paper consumption is rising throughout the world. Since 1950, world consumption has increased five-fold, to a 1988 total of 216.3 million tonnes⁷. World newsprint demand alone rose 3.5 per cent in 1990, with above average growth rates in West Europe, Scandinavia and Asia⁸.

Consumption is far greater in the rich countries as well. Per capita use in North America is 60 times that in Africa and 150 times that in India⁹. North America accounts for 5 per cent of the world's population but 35 per cent of paper and board consumption, by tonnage, other industrial countries account for 10 per cent of population and 38 per cent consumption, whilst the rest of the world's population account for only 27 per cent consumption¹⁰. In 1994, International Paper, the world's largest paper company, had sales of over US\$10 billion¹¹.

Table 2: Top Pulp and Paper Companies 1995

Rank	Company Name	Country of Origin	No. of Countries operating	Sales US\$m	% Change
1	International Paper	USA	26	14,966	+9.4
2	Nippon Paper	Japan	1	9,678	+2.9
3	New Oji Paper	Japan	5	7,629	+15.8
4	KNP BT	Netherlands	9	7,224	+17.6
5	James River	USA	13	5,400	+14.9
6	Stone Container	USA	7	5,749	+13.6
7	Georgia Pacific	USA	2	12,738	+3.7
8	Stora	Sweden	9	6,337	-3.1
9	Scott Paper	USA	21	4,750	0.0
10	Mead	USA	10	4,558	+7.5

Source: PPI (1994), Top 150 Listing, *Pulp and Paper International*, 9/1995, Belgium (Ranking is made on the basis of earnings rather than total sales)

The paper and board industry remains confident about the potential for further expansion in the future. Use doubled worldwide between 1975 and 1991, and FAO predictions suggest that total pulp consumption will grow by 3 per cent per year between 1989 and 2010¹². Some FAO estimates are given below in Table 3. However, a recent downturn in the trade may mean that these figures are overestimates, and there has been a (probably temporary) downturn in some former Soviet bloc countries such as Romania¹³. The pulp industry in former Yugoslavia is also in disarray¹⁴. On the other hand, pulp industries in Poland, the Czech Republic and Hungary have all developed since the introduction of a market economy¹⁵. Use declined during the early 1990s in some developing countries due to devaluations and economic reforms, as was the case in Venezuela¹⁶, and in Chile where several planned new pulp mills have been put on hold¹⁷.

- **Currently the most rapid rate of increase in pulp and paper use is in Newly Industrialised Countries such as South Korea, Taiwan, Brazil and Chile.**

For example, in South Korea, demand for imports and production of paper both increased by 12-13 per cent towards the end of the 1980s, making it one of the world's most rapidly expanding pulp markets¹⁸. The 1990s have also seen a rapid proliferation of pulp mills in Latin America, particularly in Chile, which has resulted in the region's share of the top 150 market pulp production rising from 5.1 per cent in 1991 to 10.3 per cent in 1992¹⁹. In 1994, paper and board production in Thailand grew by over 27 per

cent, and by 17.5 per cent in Indonesia²⁰. However, on a global scale the continued dominance by the North makes these changes relatively insignificant. Whilst paper production in Africa increased by 70 per cent in the 1980s, Africa's total production remains only 3.5 per cent that of the United States²¹ and 20 African states have no paper-making industry at all²².

Table 3: Pulp and Paper Capacities

Area	1987 capacity ('000 tonnes)	1992 capacity ('000 tonnes)	1997 projected capacity ('000 t)
North America	88,358	100,248	105,743
Eastern Europe	5,090	5,321	6,222
European Union	37,999	46,196	52,227
Nordic countries	18,698	22,191	24,944
Other W. Europe	5,264	6,200	6,815
Former USSR	11,370	11,302	12,470
Oceania	2,565	3,087	3,303
Other developed	27,314	35,175	38,374
Africa	1,084	1,525	1,725
Latin America	12,689	14,612	16,631
Asia	20,060	36,018	42,213
World total	230,491	281,875	310,658

Source: *Pulp and Paper Capacities: Survey 1992-1997*, FAO, Rome, 1993

- **In many countries, over half the paper use is for packaging and advertising and most paper is used in disposable or short-life products.**

Uses of paper are changing. For example, the market for paper and card in packaging materials continues to expand, despite a large increase in the use of plastics. Large quantities of paper are also used in newspapers and magazines (where much of the space is for advertising), sanitary products and for office paper. In former West Germany, for example, analysis in 1986 found that over 40 per cent of paper products were used in packaging, with roughly the same amount used for printing including newsprint. The rest was divided fairly evenly between office and copy papers, tissues and hygiene products and a variety of other specialty products. In the UK, it has been calculated that the paper thrown away every year is the equivalent of pulp from some 130 million trees; about two trees per person. Recovering the print-run of the Sunday edition of the *New York Times* would leave some 75,000 trees standing. Some 15 million tonnes of wood are thrown away every year worldwide in the form of disposal nappies²³. Major uses of paper are shown in Table 4.

- **Less than 20 per cent of wood pulp enters world trade.**

The industry is one of the most highly integrated in the world. Pulp and paper-making mills tend to be located near forests or plantations (or natural forests which are then converted to plantations), in part because transport costs are a significant proportion of total investment. Until recently, pulp-making capacity has, with a few exceptions, developed as a result of a domestic market than export potential.

However, trade does occur, particularly in fibre. This is imported by countries with a domestic paper-making industry but without large enough supplies of timber, or because cheaper supplies are available abroad. The main importers of fibre for pulping are Japan (which accounts for approximately 70 per cent of world imports), Finland and Sweden, together taking more than half the total. These countries all have large forest cover and active domestic industries, but can obtain a proportion of their timber more cheaply abroad.

Table 4: Paper products

Type of paper	Details and uses
Newsprint	Made mechanical pulp and/or recycled paper, hence discolours in sunlight.
Uncoated mechanical	For printing etc, usually containing more than 10 per cent mechanical pulp. Includes directory and magazine paper.
Uncoated woodfree	For printing etc, but containing less than 10 per cent mechanical pulp. Includes many office papers, photocopy paper, computer stationary etc.
Coated graphic	For printing/graphic uses and coated with china clay, calcium carbonate etc.
Sanitary and household	Absorbent paper made from bleached or unbleached virgin fibre, secondary fibre or a combination, used for disposable tissues etc.
Wrappings	All wrapping papers including both primary and recycled fibres.
Corrugated case materials	Any paper and/or board used for corrugated wrapping, can be primary or recycled fibre, bleached or not.
Other papers	Papers made for industrial purposes including thin papers (eg for cigarettes) and industrial/building papers for roofing, waterproofing, laminating etc.
Folding boxboard	Primary and/or recycled fibres, coated or uncoated, plain or coloured.
Other paperboards	Paper and cardboards not used for corrugated wrapping.

- **More than half the world's exports of paper come from Canada (over a fifth of the total), Finland, Sweden and the US. The US is also a major importer.**

The main Northern exporters of pulp are Canada and the United States (which includes a large cross-border trade making the US also a major importer), and the Scandinavian countries, which mainly supply to the European Union. In the South, Brazil is the largest exporter, and major importers include South Korea and China. There is an increasing trade from North America across the Pacific to Korea, China, Taiwan and other Asian countries, some of which also import large amounts of waste paper. Other significant importers of wastepaper are the Netherlands, Mexico and Canada. Chile supplies wood chips to Japan, as do Australia and New Zealand²⁴. Major sources of wood pulp include the US, Canada, New Zealand, Brazil, Chile, Sweden, South Africa, Portugal and Finland²⁵. The industry is increasingly sourcing supplies from countries such as Thailand, Vietnam, Chile, Western Australia, Brazil, South Africa and Argentina. Japanese industry has been unwilling to import paper and paperboard, preferring to process fibre within the country. This has resulted in accusations of protectionism, particularly from the US.

Table 5: Paper and Board Consumption per capita in Selected Countries (kg)

Country	1992	1990	1988
Belgium	213.2	210.1	194.7
Germany	193.2	245.8	207.9
Greece	60.8	61.9	64.9
UK	166.2	165.1	163.5
Total EC	158.3	161.5	147.0
Finland	249.0	280.2	318.0
Norway	162.9	152.1	151.2
Total Scandinavia	205.5	225.8	229.3
Iceland	96.9	100.0	104.0
Monaco	206.9	155.0	148.3
Switzerland	201.0	214.5	208.6
Albania	2.1	4.6	4.8
Bulgaria	24.3	37.0	48.9
USSR	-	32.8	35.3
Total Eastern Europe	23.5	34.7	40.1
Canada	196.9	211.5	235.2
United States	308.7	311.2	309.7
Total North America	298.0	301.5	302.5
China	16.3	12.6	12.1
Hong Kong	179.8	154.9	147.6
Indonesia	9.6	7.7	4.7
Japan	228.3	228.3	204.5
Malaysia	60.8	53.2	32.6
Total Asia	22.0	19.8	18.1
Australia	157.4	165.0	155.5
New Zealand	159.2	168.9	157.0
Total Australasia	125.9	131.9	124.3
Argentina	42.6	25.4	29.7
Chile	40.1	31.8	27.4
Jamaica	18.4	35.2	33.9
Mexico	41.4	36.4	29.3
Peru	6.2	6.4	16.5
Total Latin America	28.6	26.0	25.4
Algeria	5.6	8.4	11.1
Ethiopia	0.2	0.3	0.4
Morocco	9.6	8.0	8.4
Egypt	11.7	10.6	10.4
Total Africa	5.2	5.3	5.6
World Total	45.2	45.0	44.1

Source: Matussek, Heide, Salvesen, William and Pearson, John [Editors] (1993), *Pulp and Paper International: International Fact and Price Book 1994*, Miller Freeman, California, USA

Chapter 2: The Environmental Impact of Pulp and Paper

The pulp and paper-making industry has major impacts on natural ecosystems, air and water quality and human health. As the report and case studies demonstrate, the type and intensity of impacts vary considerably around the world. However, a number of common patterns can be seen, and some of the most important are examined in the following three sections. They include:

- **Resources:** the demand for timber and other plant fibres, and the consequent impacts on a range of natural ecosystems, including particularly forests;
- **Processing:** the impacts of air and water pollution, and of resource use, during the pulping, bleaching and paper-making processes;
- **Disposal:** the consequences of waste paper disposal.

The impact on forests

The increasing importance of pulp and paper-making means that paper consumption now has enormous impacts on forest ecosystems. Natural forests continue to be logged for paper-making, although the industry has often tried to conceal this. Pulp is also the output from some of the world's most intensively-managed monoculture timber plantations, which have sometimes themselves been established in the place of native forests. New technology is allowing the use of poorer quality pulp fibre, opening up fresh areas for exploitation including some virtually pristine boreal forests. Plantations seldom offer the ecological or social benefits of other forests. Paper production also sometimes utilises non-timber plant material, which can itself have a number of environmental side effects.

- **Natural forests are still being logged for pulp and to clear land for plantation establishment.**

Although an increasing proportion of the fibre for pulp and paper comes from plantations, logging for pulp continues in natural or near-natural forests in North America, Latin America, Russia, and parts of Australia and Asia. In many countries, natural forests are being logged in order that the land can be used for plantations. Such logging has severe impacts on biodiversity, environment and, in some cases, indigenous peoples.

Natural, previously unlogged forests still form a significant part of the North American pulp feedstock. For example, according to figures from Scott Paper, total fibre used in the domestic US paper industry consists of: roundwood (38.2 per cent); plantation wood (6.9 per cent); forest residues (3.5 per cent); manufacturing residues (25.8 per cent); waste paper (25.1 per cent); and chemicals and fillers (0.5 per cent). The US Forest Service estimates that some 70-80 per cent of timber for pulp comes from previously harvested land (such as second or third regeneration forests in the eastern states)²⁶, leaving 20-30 per cent still coming from old growth forests, primarily in the north west.

A similar situation exists in Canada. The use of provincial funds to support Mitsubishi's Al Pac plant²⁷ and the clash between Daishowa and the Lubicon Lake people over its Peace River mill²⁸ have created controversy. The two operators have been granted logging rights on 11.34 million ha, some 17.5 per cent of Alberta. Daishowa's dispute with the Lubicon has continued for almost a decade and the Lubicon have accused the company of breaking verbal agreements not to log territory until a land dispute was settled²⁹.

In Australia, most of the remaining native forests are mixed age, mixed species and have frequently been cut-over in the past. Timber from such areas is not premium grade and would normally be unable to compete with plantation timber for use in pulp mills. However, artificially low royalties in crown land

sometimes means that logging for pulp is still a viable option³⁰. In theory, 14 million ha out of a total 34 million ha of native forests are suitable for pulpwood. In 1990, the domestic pulp industry used 1.1 million m³ of timber from native forests³¹. Native forest logging has become a bitterly divisive issue in Tasmania. Currently around 80 per cent of woodchip exports from Tasmania's native forest logging operations are exported to Japan³². Attempts to increase protection, particularly for eucalyptus forests, resulted in thousands of timber workers, backed by politicians from the main political parties, demonstrating against proposed conservation legislation in early 1995³³.

Russia is forming an important source of pulp for parts of Europe, principally from old-growth forests. Almost 4.5 million m³ of birch will be imported into Finland from Russian Karelia during 1995³⁴.

It is also estimated that around 1 per cent of production comes from tropical hardwoods harvested in natural forests. The Société Cellulose du Cameroun bleached kraft mill, a joint venture between the Republic of Cameroon, Austria's Voest Alpine and Sweden's Svenska Cellulosa, used virgin rainforest, but suffered a major fire in 1982, and closed due to debts in 1986³⁵, although it has since reopened. At least three pulp mills using tropical hardwoods are either at planning stage or under construction in Malaysia and there are currently proposals to use natural forests as feedstock for pulp mills in Nigeria.

Analysis of recent and projected hardwood kraft market pulp capacity increases reported in the *Pulp and Paper Analyst* found that companies plan to continue using mixed tropical and temperate hardwood in the future, as shown in Table 6 below:

Table 6: Main hardwood kraft market pulp capacity increases - 1994-1997

Year	Grade	Country	Capacity '000 t/y
94/5	Mixed tropical hardwood	Indonesia	820
95	Eucalyptus	Indonesia	80
95	Mixed hardwood	Canada	20
95	Mixed hardwood	USA	45
95/6	Mixed tropical hardwood	Indonesia	750
95/6	Eucalyptus	Chile	32
95/6	Eucalyptus	Brazil	220
95/97	Eucalyptus	Brazil	530
97	Mixed tropical hardwood	Indonesia	500
98	Mixed tropical hardwood	Indonesia	450

Adapted from: Bingham, John (1995); The World pulp market: where next; Pulp and Paper Analyst, 8/95

In several areas where pulp is reported as being a "by-product" of timber production, analysis has shown that pulp is the most important output from concessions. For example, in Indonesia, felling for pulp is usually a two stage process. Clearfelling for pulp in industrial forest estates is theoretically only allowed if less than 20m³ of timber exists per hectare. The strategy of the pulp industry has been to selectively log natural rainforest for timber, ostensibly so that it can continue to be managed on a regular basis, then to clearfell once the quantity per hectare has fallen below the permitted minimum³⁶. Again, the intention to clear for *pulp* is concealed for as long as possible. Towards the end of 1993, it was reported that Indah Kiat, a leading Indonesian pulp and paper manufacturer, had been fined Rupiah 1.36 bn (£400,000) by the Indonesian Forestry Ministry for alleged illegal tropical timber logging³⁷.

- **Pulp production is also the reason for development of some of the world's most intensively-managed timber plantations.**

Although a few countries have developed extensive plantations for fuelwood, as in parts of southern Asia, the growing market for pulp and paper is the main driving force behind development of timber plantations in many parts of the world. No accurate global figures exist for the total area under tree plantations, partly because official surveys of temperate and boreal forest areas do not distinguish between plantations and other forests. Indeed, definitions of "plantation" vary from one place to another. However, it is thought that industrial plantations currently cover around 100 million ha, or around 5 per cent of exploitable forest³⁸. Exotic fibre plantations accounted for 11 per cent of global pulp production in 1993³⁹. Although well-managed plantations can supply a sustainable source of pulp without causing unacceptable environmental damage, this is often not the case at present.

Statistics from individual countries clearly illustrate the links between paper and plantations. For example, pulp production is the main output from the intensive, often monoculture, plantations found in much of Europe, New Zealand, and Latin America. Brazil has a total pulp plantation area of over 1.4 million hectares, of which 59 per cent is eucalyptus and 38 per cent pine species⁴⁰, producing for the pulp industry. Output is expected to double in the next decade⁴¹. In Chile, 14 per cent of the forest area is made up of radiata pine plantations⁴², and the annual area planted with this species and eucalyptus reached around 130,000 hectares in 1993⁴³. In New Zealand, the majority of the pulp and paper industry is based in the central North Island area, where 523,000 hectares of radiata pine forest are planted⁴⁴. It has been estimated that Argentina needs to establish plantations at a rate of 50,000 ha per year to meet consumer demand, calculated to increase by 6.9 per cent/year⁴⁵.

Many new plantations are being established specifically for pulp, almost always situated around pulp mills. For example in Chile, *Forestal Mininco*, the forest company of *Compania Manufacturera de Papeles y Cartones* (CMPC) owns almost 415,000 hectares of land within a hundred kilometres of its mill, of which 230,000 hectares are planted with radiata pine (*Pinus radiata*), 29,000 hectares with eucalyptus and 15,000 ha with other species⁴⁶. Chile's market pulp industry is based on 100 per cent plantation trees⁴⁷. Radiata pine grows to harvesting size in fifteen years in Chile, as compared with 30 years in New Zealand and 60 years in Canada⁴⁸. A joint project with a US company developing a wood chip mill on the Orinoco River in northwest Venezuela will be fed with Caribbean pine harvested from a 329,000 hectare plantation in Estado Monogas⁴⁹.

In Indonesia, 39 out of 291 private sector projects for the establishment of timber estates in 1992 were intended to support the pulp industry; more significantly these projects accounted for almost 8 million out of 11.5 million ha covered by all the projects⁵⁰. For example, a new joint venture between Indonesian and Finnish companies is planning to set up a 100,000 hectare acacia plantation in western Kalimantan to furnish a planned 500,000 tonne/year hardwood pulp mill⁵¹. The Indonesian government has said that it plans to build or significantly expand 56 pulp and paper mills by the year 2010 and convert 10 per cent of the total land area to plantations⁵².

- **In some cases, natural forests have been replaced by pulp plantations, or "accidentally" put at risk by development of pulp mills.**

It was calculated that by the mid 1980s at least 15 per cent of all new plantations in tropical countries had been established at the cost of natural closed forest⁵³, and the proportion has probably increased in the years since. This is occurring principally in countries undergoing rapid loss of natural forests, such as Indonesia, Thailand, Brazil and Chile. Where pulp mills are built close to plantations, clearance of surrounding natural forest is often encouraged, either to supply the mill while plantations mature, or to overcome shortfalls later in the production cycle.

Table 7: Plantations in the Tropics, by Region

Region	Plantation area (ha in 1990)	Annual increase 1981-90 (ha)
West Sahelian Africa	251,000	21,000
East Sahelian Africa	762,000	32,000
West Africa	445,000	14,000
Central Africa	175,000	11,000
Tropical Southern Africa	1,057,000	47,000
Insular Africa	310,000	4,000
South Asia	19,758,000	1,480,000
Continental South East Asia	3,197,000	140,000
Insular South East Asia	9,156,000	482,000
Central America and Mexico	273,000	17,000
Caribbean Subregion	442,000	23,000
Tropical South America	7,922,000	333,000
Tropical Oceania	43,000	2,000

Note: some of these may be underestimates due to lack of data from some countries. In particular, the Tropical Oceania figures are derived solely from Papua New Guinea

Source: derived from figures in **Hammond, Allen L** (1994); *World Resources 1994-95*, World Resources Institute with UNEP and UNDP, Oxford University Press, Oxford and New York

Some 2.2 million hectares of Indonesian forest has been felled and converted to plantations. The government intends to convert another 6 million hectares within ten years⁵⁴. Plantations are attracting increasing criticism within the country. A plan by the Scott Paper Company to convert 200,000 ha of natural forest in Irian Jaya to plantation drew such opposition that the company withdrew in 1989⁵⁵. The links between plantations and clearance of natural forest are often complex. In many parts of Indonesia, pulp mills are being built which are supposed to run off timber from plantations, but will be ready long before the plantation trees are mature, and natural forest will be used in the interim. Even if timber plantations grow at the rate predicted, some thousand square kilometres of natural forest will be cleared to feed existing mills in the outer islands. Indonesia is one of the few tropical countries where pulp mills tend to be located in natural forests⁵⁶. The role of natural forests in Indonesian pulp making was highlighted by the trade magazine *Pulp and Paper International*: "The country has one big advantage...a huge wood resource. Most of this is today mixed tropical hardwoods"⁵⁷. Most Indonesian pulp companies would prefer to log natural forests and replace with plantations, than initiate plantations on previously-cleared land. In 1988, PT Indah Kiat's mill in Riau province, Sumatra, was reported to be using 400,000 tonnes of wood a year from over a hundred species of tropical hardwood. The company's vice president admitted that the company was looking for natural forest which it could fell and replace with acacia and eucalyptus⁵⁸.

Similar losses are occurring in Latin America. The Jari project, initially set up in 1967 and currently producing 291,000 tonnes of pulp in cleared natural forest 250 miles (400 km) from Belem in Brazil, is a particularly notorious example⁵⁹. In Chile, between 1978 and 1987, a total area of 48,600 hectares of native forest (mostly second growth), in regions VII and VIII, and 31 per cent of native forests of the coastal region VIII, were converted to plantations⁶⁰. In 1993, it was reported that the US-based Stone Paper Corporation was planning to build the biggest wood chip mill in Central America, to supply raw material for paper-making in the USA. Plantations of *Gmelina* were planned and local conservationists believed that important remaining natural forests would be at risk⁶¹.

- **Plantations often have negative effects on biodiversity.**

Most plantations consist of monocultures, usually of exotic species. The most common pulp trees are conifers (such as *Pinus radiata*), various *Eucalyptus* and *Acacia* such as *Acacia mangium*. Estimated areas of plantations around the world are 74 per cent conifer and eucalyptus, 14 per cent teak and 12 per cent hardwood, although not all this is used for pulp. Reasons for the dominance of conifer and eucalyptus in pulp and paper-making are the limitations of past pulping technology, but recent developments are allowing an expansion into other species such as aspen and poplar (North America and Europe), acacia (south-east Asia), and *Gmelina arborea* (Africa)⁶².

In comparison to natural forest ecosystems, biodiversity in monoculture tree plantations is low. A study in Sri Lanka observed only three species of bird in *Pinus* and five in *Eucalyptus* monocultures compared with 25 in natural forests⁶³. Studies in New Zealand have shown pine plantations to be poor habitat for native birds, particularly for those which feed on fruit and nectar, nest in holes or feed on insectivorous species⁶⁴, and in Portugal few birds are found within exotic *Eucalyptus* stands since they contain hardly any native species⁶⁵. Mammal populations see a comparable decline; in Chile the diversity of small mammals was found to be higher in native agroforestry shrubland than in adjacent *Pinus radiata* plantations⁶⁶. Plantations can also affect biodiversity through disruption of hydrological cycles. In Natal, afforestation on headlands is threatening the St Lucia Wetland Park. It has been calculated that afforestation in the area threatens 10 mammal, 24 birds, 6 reptiles, an amphibian and 2 fish species⁶⁷.

The effect of exotic tree plantations on soil properties and biogeochemistry are still not fully understood. Continuous cropping in an intensive plantation will deplete nutrients; for example it has been estimated that the loss of phosphorus from three pine rotations on an infertile soil is the equivalent of 20,000 years of natural loss, and 1000 years natural loss on recently fertile soil⁶⁸. Losses will be greater if whole-tree harvesting is carried out. The leaves of some popular plantation species, including conifers and eucalyptus, break down fairly slowly, thereby slowing overall nutrient cycling. Regular application of fertilizers is needed in plantations in many areas⁶⁹. Site preparation, planting and felling are all major contributors to erosion and reduced water quality. Plantations close to riparian strips can allow more soil into the watercourse, greater fluctuations in water temperature, loss of shade, increased inputs of fertilisers and lower water yields⁷⁰. In west coast California and Washington, salmon populations have fallen due to lack of stream shade and siltation from clearfelling⁷¹. However, in other circumstances, tree plantations can help bind soil together and reduce erosion problems⁷². There has long been a debate about whether or not eucalyptus takes a disproportionate amount of water from catchments⁷³. It is known that eucalyptus are not very effective at erosion control, but can reduce leaching and nutrient runoff⁷⁴. Detailed research in Karnataka, India suggests that in some situations eucalyptus takes up no more water than indigenous species, but in other cases water use is greater. In Australia, eucalyptus roots have penetrated into groundwater sources⁷⁵, thus increasing the likelihood that the water table will be affected.

Some environmental problems associated with tree plantations are outlined in Table 8 below.

Table 8: Environmental Problems Associated with Plantation Establishment

Problem	Notes
<i>Well-managed tree plantations have an important role to play in producing renewable source of timber and wood fibre. However, badly planned and managed plantations have a range of damaging side effects.</i>	
Loss of habitat	In many places, plantations have been established in the place of existing natural forest, ancient heathland etc.
Reduced biodiversity: trees	Plantations tend to use monocultures, exotic tree species, or narrow strains of native trees thus reducing genetic variability and adaptability of trees.
Reduced biodiversity: other wildlife	Replacing native or managed forests with plantations can lead to a dramatic reduction in biodiversity.
Introduction of exotic tree species	Exotics sometimes compete with native species, and have occasionally hybridised with native species, leading to loss of local provenances.
Soil erosion	Deep ploughing and the use of heavy machinery can lead to soil erosion and nutrient loss, as can the impact of clearfelling.
Acidification	Plantations on base-poor soils increase soil and water acidification due mainly to trees scavenging air pollutants, which are washed to the ground.
Water table changes	Planting some species, eg <i>Eucalyptus</i> , can result in lowering of the water table in drought-prone areas.
Water quality changes	Drainage, ploughing and clearfelling can increase water turbidity, which can damage breeding success of salmonoid fish and disturb other aquatic life.
Changes to the fire ecology	Plantations can either increase fires, through poor management, or artificially suppress fires. Both can have serious ecological consequences.
Increased pest and disease attack	Monocultures are prone to attack by pests and diseases. Use of exotic trees has sometimes also resulted in introduction of serious tree pests.
Agrochemical use	Pests and problems of decreasing fertility lead to increased use of pesticides and soluble fertilisers with associated environmental effects.

Source: An earlier version of this table appeared in Forests in Trouble, WWF International 1992

Pine (*Pinus*) and other exotic plantation species can be aggressive pioneer species causing disruption to adjacent natural ecosystems. In New Zealand species including lodgepole pine (*P. contorta*), Douglas fir (*Pseudotsugo menziesii*) and European larch (*Larix decidua*) have been found in native montane grasslands and *Acacia melanoxylon* has been reported as the most important invasive plant in South Africa's dry southern cape⁷⁶.

Exotic monocultures can also act as sources of pest and disease. In India, a major pest in exotic pines, *Cercospora* needle blight, is now threatening the survival of the native *P. roxburghii* and *P. wallichiana*⁷⁷ and in Kenya and Malawi, the indigenous *Juniperus procera* and *Widdringtonia nodifolia* are being damaged by a cypress aphid associated with introduced Mexican cyprus plantations⁷⁸. Plantations generally tend to suffer increased incidence of pest attack, both through introduction of exotic pests and because a monoculture can provide ideal habitat for species-specific pests. This leads to losses in productivity and also sometimes to heavy use of pesticides. In New Zealand, for example, more than 30 brands of chemicals are used on plantations, with some areas being treated over three times a year⁷⁹.

- **Plantations seldom offer the social benefits that native trees provide.**

Monocultures, particularly of exotic tree species, do not usually offer the same range of goods and services to local people as those provided by native forests. For example, a recent survey⁸⁰ identified a wide range of non-timber uses:

- **Direct financial value, resources, and/or employment from non-timber products:**
 - grazing for livestock
 - collection of fodder
 - collection of berries etc
 - collection of edible fungi
 - collection of medical herbs
 - management for hunting
 - management for display or recreation
- **Values from non-extractive uses of the forest as a standing resource:**
 - management of reserves
 - historical sites
 - education and research
 - attractive housing sites
 - provision of tourist services
 - walking, family picnics, etc
 - as a way of being alone
 - hunting and shooting
 - bird watching etc
 - forest-related sports
 - car or bicycle tours, walks
- **Interaction through the forest's provision of environmental services:**
 - maintenance of hydrological systems
 - prevention of soil erosion and landslip
 - as a reservoir of biodiversity
 - mitigation of climate change through carbon sequestration
- **Other values of the forest: local, aesthetic and spiritual values:**
 - positive landscape value
 - aesthetic values
 - local distinctiveness
 - spiritual and religious significance

- **Homeland for people:**
 - as homeland for indigenous, and peasant societies
 - use of forests for holiday homes, camping sites, etc
 - planting forests for privacy, protection from climate etc

These wider uses are often threatened by a shift of land-use to intensive pulp plantations. In Finland, research has shown that mixed and mature stands were the most popular with users⁸¹. Tax-free income from berries and mushrooms has been estimated at 35-93 million Finnmarks/year, even though much of the produce is not sold, but is used for home consumption⁸². The UN Food and Agriculture Organisation (FAO) has identified a range of non wood products, including pharmaceuticals, toxins (for hunting, pesticides etc), aromatics (including essential oils for cosmetics, unguents, incense etc), biochemicals (such as non-edible fats and oils, waxes, gums, latex, dyes, tannins, paints, varnish, etc) and fibres (for cloth, matting, cordage, basketry, brooms, stuffing for pillows, cork etc)⁸³. Resentment against pulp plantations in developing countries is often connected with loss of traditional rights to fuel, medicines, food and building materials.

In the boreal region, the rights of first peoples' claims to land are increasingly becoming a contentious issue when they come into conflict with pulp companies over access to timber resources. This has been highlighted in some provinces of Canada, where native people have been able to draw public attention to the issue, but is also important in Siberian Russia. A similar pattern of dispute is also occurring in Latin America. For example many estates sold to establish forest plantations in Chile were previously inhabited by *campesinos* on the basis of customary rights, with no legal land tenure. Similar problems have been identified in Asia⁸⁴ and Africa. The Paper Industry Corporation of the Philippines had serious clashes with local people in the past, and the army was used to keep people out of the forests⁸⁵.

On the other hand, pulp plantations can provide positive benefits to communities, including stabilisation of soil in deforested areas, local employment and, if the scheme is sensitively planned and implemented in collaboration with local communities, some social benefits⁸⁶. Unfortunately, most large pulp schemes have failed to take the necessary steps to ensure maximum benefits to local communities.

- **Increasingly, pulp mills and plantations are being set up by foreign companies or through aid finance**

Local control over pulp plantations can be further eroded when foreign companies control concessions (although conversely in some countries this can, in practice, increase rights).

Many transnational (TNC) pulp and paper companies are expanding their operations to include control of plantations and mills in other countries. There are a number of motives for this development: pressures on existing sources, ranging from price increases to public concern over environmental effects; a desire to integrate production; a wish to benefit from optimal growing conditions; cheaper labour costs in developing countries; a shortage of timber; insurance against changing economic and political conditions in any one country; an ambition to develop new markets; and fears that there will be insufficient pulp to meet future demand. For example, the Taiwan Pulp and Paper Company closed a 400 tonnes/day domestic mill at the end of 1993 and is looking to develop a new mill in either Vietnam or China and a recycled board mill in Malaysia⁸⁷.

Japanese companies are prominent amongst those TNCs anxious to develop foreign holdings. For example, New Oji Paper is investing in Australia, while Nippon Paper Industries is planting hardwood in Chile, and aims to have 30,000 hectares established in the country by the year 2000⁸⁸. The Swiss producer Cellulose Attisholz has 25,000 hectares of radiata pine, and another 100,000 hectares of land suitable for planting, to furnish its Lincancel operation in Chile. All its production is exported to western

Europe⁸⁹. Oji Paper and Nissho-Iwai are also planning a 12,000 ha eucalyptus and acacia plantation in Papua New Guinea⁹⁰. Other direct foreign investment by Japanese paper companies in pulp and paper manufacturing ventures include operations located in Alaska, New Zealand, Brazil, Thailand and Portugal⁹¹.

Foreign ownership of the plantation and pulp industry has become a controversial issue in New Zealand. Privatisation of the state forest industry resulted in the sale of almost half a million ha of land in two years. Two New Zealand companies, Fletcher Challenge and Carter Holt Harvey, were major buyers, and by 1987 they controlled 41.3 per cent of the country's productive forest. However, major purchases were also made by foreign corporations, including the US-based ITT Rayonier NZ, Juken Nissho Iwai of Japan, Earnslaw One of Malaysia and, through a joint venture, the China National Foreign Trade Transportation Corporation⁹². Since then, foreign control has further increased. Carter Holt Harvey is itself heavily influenced by foreign investors, with 11 per cent of its shares bought by the Templeton Fund in Hong Kong in 1991, and a further 16 per cent purchased by the US International Paper Group in 1992. Over the same period, at least seven Japanese companies, including C Itoh, Sumitomo and Oji Paper, bought New Zealand forest companies. Several US companies followed suit, and for example RII NZ Forests SI bought Tasman Forestry⁹³ in the early 1990s.

In addition, many pulp mills in developing countries have been financed by foreign aid, particularly from the major pulp producing countries in Fennoscandia via the official aid agencies NORaid, SIDA and FINNIDA. Vietnam's largest pulp and paper mill, Bai Bang, was also Sweden's largest ever foreign aid project. It faced many initial problems, relating to delays in development and claims of poor treatment of workers⁹⁴. It relies on 15,000 ha of plantation and 70,000 ha of natural bamboo to supply raw material⁹⁵, and has been heavily criticised by environmental groups because of its impact on Vietnam's natural vegetation.

Impact through manufacture

Pulping wood releases a range of pollutants, including organic products that cause eutrophication in water, aluminium salts and sometimes also sulphur dioxide to the atmosphere. Most paper also requires bleaching, resulting in further pollution from persistent organochlorines. These various pollutants are now known to have significant impacts on freshwater and marine ecosystems, and on other wildlife and human health. Despite improvements over the past few years pollution remains a problem. The main centres of concern are shifting from developed to developing countries, with the same companies often still involved. Pulping and paper-making also involve significant use of other renewable and non-renewable resources, such as water and energy.

Both pulping and bleaching of wood pulp cause severe water and air pollution problems. Pulp and paper manufacturing can be amongst the most polluting industries. For example, International Paper, the world's largest pulp and paper company, was named as one of the top ten polluters in the USA on a list issued by the Council on Economic Priorities⁹⁶. In 1991, the Environmental Protection Agency reported that the paper industry was the third largest source of toxic pollutants in the US, with mills releasing over 100,000 tonnes of toxic materials. Specific pollutants released by the paper industry included chloroform (largest source, making up 91 per cent of total releases) and toluene (third largest source)⁹⁷.

Paper manufacture is also resource intensive, requiring large amounts of energy and water.

- **Pulping releases pollutants, including organic products that cause eutrophication in water, aluminium salts and sometimes also sulphur dioxide.**

A variety of methods are used to separate the cellulose fibres used to make paper from other material such as lignin and hemicelluloses. These are based on two main principles:

- **Mechanical pulping**, is achieved by grinding debarked wood with a grindstone, or with rotating metal discs known as *refiners*. This is efficient in terms of conversion, but requires large inputs of energy. It produces a relatively poor quality product, only suitable for newsprint etc (although for this purpose it does a good job). Toxic wood chemicals left after mechanical pulping are often discharged into the environment.
- **Chemical pulping**, uses sulphur compounds to separate the pulp. This is a less efficient, with only 45-50 per cent conversion, but produces a higher quality product. It operates a *closed loop* system. Waste material is burnt to power the system and many chemicals are re-used, thus reducing pollution. However, depending on the method used some 1-5 kg of sulphur dioxide is emitted for every tonne of pulp produced.

The two methods are sometimes used in combination, through *Chemo-Thermo-Mechanical Pulping* (CTMP). Here, sulphur softens the tissues before steam treatment and grinding. This reduces energy requirements but still results in significant toxic releases. Not all trees are suitable for pulping by all the methods available. A choice has to be made between efficiency of conversion, strength and quality of paper, and amount and type of pollution, and resource use. Several less polluting production methods are being developed, including *solvo-pulping*, which uses alcohol to separate pulp from the lignin, but none of these are used on a large scale as yet. By far the commonest pulping method used worldwide is the *Kraft Process*, a chemical method where wood chips are boiled in caustic soda. The resulting pulp makes high quality, strong paper, but is a dark brown colour and usually requires heavy bleaching. Kraft softwood and hardwood pulp made up 65 per cent of world pulp production in 1993⁹⁸.

- **Most paper also requires bleaching.**

To obtain pure white cellulose for paper, pulp has to be bleached. Traditionally this is carried out with chlorine gas, to break down and remove the lignin, and chlorine dioxide or hypochlorite, which is used in a number of successive stages to bleach the pulp white. More than 300 compounds have been identified in spent bleach liquor. The compounds of most environmental concern are chlorinated derivatives of phenols, acids, dibenzo-p-dioxins/furans and other neutral compounds⁹⁹. Chlorine is used at concentrations of 50-80 kg/tonne of bleached pulp, of which some 10 per cent combines with organic molecules in the wood, forming organochlorines, which are discharged along with effluent. An average sized pulp mill discharges some 30-80 tonnes of organochlorines a day¹⁰⁰.

Various options exist for reducing chlorines in pulp bleaching. **ECF** or **Elemental Chlorine Free** uses chlorine dioxide, a far less toxic substance, thus reducing levels of chlorine emissions. However, pressure to eliminate chlorine altogether has led to the development of **TCF** or **Totally Chlorine Free** methods. The technology developed because of health scares in Germany during the 1980s, when traces of dioxins were found in coffee filters and other products. Nordic and German-speaking countries controlled 60-70 per cent of the TCF printing paper market by 1986. The most common methods for producing TCF paper use hydrogen peroxide. Demands for TCF products are growing¹⁰¹. However, some sectors of the industry believe that there is little to choose between ECF and TCF in terms of total pollution and environmental effects¹⁰².

- **These pollutants can have important impacts on freshwater and marine systems near pulp mills, and on associated wildlife.**

Pulping and bleaching leads to the discharge of considerable quantities of water and air pollutants. Literally thousands of organic and inorganic compounds are discharged into wastewater, which usually enters river and lake systems, and many of these cannot easily be measured. The "conventional pollutants" include waste organic materials, many of which cause eutrophication. These are usually measured by biochemical oxygen demand (BOD), ie the amount of oxygen needed to break them down into their constituent parts. However, up to half the organic material present in pulpmill waste may not be biodegradable, so the chemical oxygen demand (COD) is often used as a measure instead.

More controversially, chlorine used in the bleaching process in Kraft mills, and in other mills, can produce a range of highly toxic organochlorine by-products, including dioxins, polychlorinated biphenyls (PCBs) and carbon tetrachloride. Up to a thousand different organochlorines can be formed during the process, although only about 300 have been identified to date. The chemical properties, the long and short term toxicity and the bioaccumulation of many of these are still by no means fully understood. However, there is increasingly strong evidence that some dioxins are highly carcinogenic, including particularly 2,3,7,8-tetrachlorodibenzo-para-dioxin, or TCDD. Other hazardous organochlorine residues include chloroform, carbon tetrachloride, dichloroethane, pentachloroacetone and trichloroethane. A study by Greenpeace Sweden listed 21 known or suspected carcinogens and/or mutagens in pulp mill effluent¹⁰³.

Table 9: Energy, Resource Use and Pollution from Pulping Methods

Process	Efficiency	Quality	Energy use	Resource	Pollution and emissions
Chemical Methods	45-50%	High	low, as waste products burnt to power process	35-40,000 gallons of water used in	Closed loop system, some pollution. Cellulose fibres can cause eutrophication. Aluminium salts pollute water and kill fish. Bad odour made Germany ban this method
1. Kraft process: boiling wood chips with caustic soda	45-50%	High but needs bleaching	1,150 kWh/tonne electrical energy 5,200 kWh/tonne steam energy	20 kg sodium sulphate/tonne 75 kg calcium carbonate/tonne	1-3 kg SO ₂ /tonne
2. Sulphite pulp: boiling wood chips with sulphuric acid	45-50%	Fairly high often used for tissue paper	1,000 kWh/tonne electrical energy 4,400 kWh/tonne steam energy		5 kg sulphur dioxide/tonne
Mechanical Methods	95%	Low. Weak and discolours in sunlight	High as no use of waste. 2,000 kWh/tonne electrical energy	10-15,000 gallons water/tonne	Routinely discharge wood chemicals removed from pulp
Thermo-Mechanical Pulping: wood chips softened by steam before grinding (TMP)	95% ?	Stronger than simply mechanical pulping	Energy use significantly reduced as compared with mechanical pulping		As above

Table 9: Energy, Resource Use and Pollution from Pulping Methods (continued)

Process	Efficiency Quality	Energy use	Resource	Pollution and emissions
Chemo-Thermo-Mechanical Pulping CTMP, as above but first softened by sulphur	95% ?	Stronger pulp than TMP above		Routine effluent even more polluting through addition of sulphur. Highly toxic and difficult to degrade

Source: compiled by **EQUILIBRIUM** from data contained in the *Greenpeace Guide to Paper* by Renate Kroesa, Greenpeace International, Vancouver, 1990; *The Sanitary Protection Scandal*, Women's Environmental Movement 1989, *Dioxins*, National Swedish Environmental Protection Board, etc. An earlier version of this table appeared in *Forests in Trouble*, WWF International, 1992

Problems are particularly severe in the former Soviet Union. Several mills have already closed due to pollution, with the loss of 450,000 tonnes of capacity by 1992¹⁰⁴. Other polluting mills remain. The Baikalsk Cellulose Paper Combine (BCPC) on Lake Baikal provides an extreme example. Work began on the mill in 1961, despite opposition on environmental grounds from a large group of scientists. The 25 million year old lake is the world's largest and most ancient lake, containing 20 per cent of the planet's fresh water and some 1,550 animal and 1,085 plant species, including many endemic species. In its 30 years of operation, the mill has polluted some 200km³ of the lake's southern end, and dumped more than 900,000 tonnes of mineral salts and 18,000 tonnes of chlorides per annum. Over 4 million m³ of lignin sludge has accumulated in sediment deposits. The communities on the lake bed have been destroyed over a length of 2.5km and to a depth of 50m. Atmospheric pollutants from the mill have destroyed 1,273 ha of nearby forest and damaged a further 48,000ha. Moves have now been made to include the lake and its watershed in Unesco's *World Heritage List*, which would in theory ensure that there are no further industrial emissions into the lake. However, closing the mill has serious social implications, because 51 per cent of the male population of the 16,500 person town nearby are employed at BCPC¹⁰⁵.

The impact of pulp effluent has been studied in some detail in Scandinavia, where considerable efforts have been made to reduce pulp mill discharges. A three-year study of pulp mill effluents in the Baltic Sea found that near the effluent outflow fish biomass was low, and species composition had changed with perch (*Perca fluviatilis*) exhibiting reduced reproduction, changes in physiology and damage to the spinal column. Presence of a pulp mills affected recruitment to fish populations over an area of several square kilometres, thus having an economic impact on fisheries; in the case of perch reproductive losses of 30-70 per cent were made in the affected area. The effluent also affected the diversity, biomass and distribution of invertebrates and plants, including the crustacean *Pontoreia affinis* and the bivalve mollusc *Macoma baltica*¹⁰⁶. Further research found that the distribution of the seaweed bladder wrack (*Fucus vesiculosus*) was affected by pulp mill effluent, with the algae disappearing from the most polluted areas. Pollution also decreased the numbers of mussels and increased the frequency of malformed larvae. Bleached pulp mill effluents also apparently increased the prevalence of three fish diseases: fin erosion in perch and goldfish (*Carassius auratus* studied in New Zealand), jaw deformity in pike and gill cover deformity in perch¹⁰⁷.

A series of studies in Scandinavia found that chronic effects of pulp mill effluents could include:

- changes in reproductive and life cycles, deformities in embryos, stunted growth and higher egg mortalities;
- deformities in bones and gill erosion in fish;
- biochemical and physiological disturbances, including reduced ability of muscles to store carbohydrates, impaired stamina and increased susceptibility to predation and disease;
- changes in habitat and community structure¹⁰⁸.

Nonetheless, the causal relationships between specific effluent compounds and toxic effects is poorly understood, and sublethal biological effects occur even when dilution of waste is quite high. Synergistic and/or antagonistic effects amongst chemical compounds are probably important in some cases¹⁰⁹. Toxicity is influenced by the type of wood used and the processing procedures¹¹⁰.

Research funded by the Department of Fisheries and Oceans, Canada, and the Ontario Ministry of Environment Research Advisory Council found that several species of fish exhibited damage from pulp mill effluents at Jackfish Bay, Lake Superior. The white sucker (*Catostomus commersoni*) showed a variety of responses - including reduction in body size, delayed sexual maturity, smaller gonads, and increased liver size - when exposed to kraft pulp mill effluent. Similar effects were found in lake whitefish (*Coregonus clupeaformis*) and longnose sucker (*Catostomus catostomus*). The mill discharge into Jackfish Bay was reduced by installation of an aerated stabilisation basin in 1989. Studies in 1993 showed no evidence of recovery in reproductive function, but did find limited improvement in liver size. Further research on white sucker fish found that loss of reproductive capability occurred near pulp mills with and without chlorine bleaching, and at sites with secondary effluent treatment¹¹¹. Scientists now believe that some effects on fish are caused by non-chlorinated compounds, probably coming from the wood itself. One of these compounds has been positively identified as a steroid¹¹².

Dioxins were found in the effluent of two thirds of Japanese pulp and paper mills¹¹³. In October 1990, research Ehime University revealed that fish caught in sea water near pulp mills in Iyo-Mishima contained 9.4 parts per thousand of dioxin. The Ministry of International Trade and Industry called for the 32 mills producing bleached kraft pulp by chlorine gas to change to oxygen or chlorine dioxide. There are now no mills in Japan using chlorine gas bleaching¹¹⁴.

Other by-products of the process include 'non-filterable material' consisting of bark and wood fibres. These materials can also be of threat to aquatic organisms forming fibre mats on ocean bottoms, eliminating or altering bottom-dwelling organisms¹¹⁵. Toxic effects can extend to other groups of animals as well. In North America, both peregrine falcons and blue herons have suffered reproductive failure through accumulation of organochlorines from pulp mill effluent¹¹⁶.

- **Air pollution is important in some mills, particularly older plant.**

Although atmospheric pollution is generally reckoned to be less important than discharges to water it remains important in some areas. Sulphur dioxide is the most important component of acid rain on a global basis, and chlorinated solvents released by chemical pulping contribute to both global warming and the breakdown of the ozone layer. Hydrogen sulphide, chloroform and carbon tetrachloride can all be released from mills and result in significant health risks to workers and nearby residents. The US Environmental Protection Agency has recently added the pulp and paper industry to its category of "major sources of hazardous air pollutants" due to the presence of chlorine, other volatile organic

compounds and chloroform in waste gases. In addition, sulphuric acid fumes, released from some pulp factories, can damage the bronchial tract¹¹⁷. In Russia, the area round Bratsk in the east Siberian taiga, was declared a disaster area in 1992, as a result of air pollution from the local pulp and board producer¹¹⁸.

- **Pollutants can have direct health effects.**

The US Environmental Protection Agency estimates that people regularly eating fish caught near pulp mills have 1,000 times the chance of developing certain cancers. In 1989, a study by the Canadian Department of Health and Welfare reported that residents of British Columbia had the highest average levels of dioxin in body tissue in the country. Several areas of British Columbia, have subsequently banned shellfish collection due to mill pollution¹¹⁹. Although the impacts of dioxins remain controversial, some are now regarded as carcinogens by most regulatory authorities. Dioxin pollution problems have been addressed by many pulp mills, other effects, less clearly understood, have been identified in fish populations near pulp mills in Scandinavia and Canada¹²⁰.

Workers at pulp and paper mills appear to face some direct and long term risks from pollution. A study by the International Labour Office found wide differences in accident rates between countries and some industry-specific diseases occurred. In Finland, a number of cancers were recorded at high incidence levels amongst workers in pulp mills, probably as a result of chemicals used in the pulp process and biological agents¹²¹.

Table 10: Sulphur production from Nordic chemical pulp mills 1989-90

Country/Process	Pulp production (ADt/a)	Sulphur production (t S/a)
Finland		
Kraft	4,964,000	15,260
sulphite	224,000	3,050
NSSC	403,000	5,760
Norway		
kraft	459,000	450
sulphite	180,000	250
NSSC	90,000	5
Sweden		
kraft	6,041,000	5,425
sulphite	734,000	1,040
NSSC	284,000	(included in kraft)
Total	13,379,000	31,320

Source: Jaako Pöyry (1992); *Reductions of atmospheric emissions from pulp industry: Atmospheric Emissions of Sulphur and Nitrogen Oxides from the Nordic Chemical Pulp Industry*, report to the Nordic Council of Ministers

Concern about dioxins has extended beyond the pulp-making process to the risks from residues remaining in paper and sanitary products, particularly in Europe where scares about the impact of dioxins in coffee filters, disposable nappies and tampons has been the subject of much consumer concern. In Sweden, regulations have been tightened as a result of findings about dioxins in paper waste effluent and alternative oxygen bleaching processes have been encouraged, so that by 1993 totally chlorine free (TCF) paper was available¹²².

In North America, where anxiety about chlorine residues has not been as high, the industry has chosen to use chlorine dioxide as the primary bleaching agent, resulting in discharge which is elemental chlorine free (ECF). These developments are not without their own controversy, and questions remain about the pollution from TCF plants. Some campaign groups, including notably Greenpeace, remain totally opposed to use of chlorine in any form. In a further development, several plant in North America and Scandinavia are now attempting to develop completely closed loop systems, ie where there would be zero discharge of any effluent.

Sometimes health effects can be secondary. In the USA, Bowater's Calhoun Mill has been cited as the cause of fog-related accidents on the US Interstate Highway 73. In the last twenty years, 18 people have died and 130 been injured in accidents near the mill. Bowater has spent over US\$20 million on out-of-court settlements to the injured and bereaved families¹²³.

- **Despite improvements over the past few years, pollution still occurs.**

Although substantial improvements to pulp technology and practice have been made in many areas, pollution still occurs. In the UK, 75 per cent of pulp mills exceeded their permitted pollution emissions at least once in 1990-1992¹²⁴. A 1990 Canadian Department of the Environment report found 83 out of 122 pulp mills discharging waste above national standards.

Many of the larger transnational companies have initially responded to criticism about pollution with denial that there is any problem. Some have later worked hard to clean up their effluent problems, and the trade is taking an increasingly realistic attitude towards the inevitability of such changes. However, other companies have simply moved their operations to places where criticism will be less acute. Amongst issues that have been identified over the last few years are:

- **British Tissues** has been prosecuted for water pollution twice since 1985 at the company's mill in Yorkshire, UK for toxic releases that resulted in fish kills. A release in 1987 killed over 20,000 trout along with numerous other fish.
- **Scott Paper USA** had to pay US\$475,000 compensation in 1988 to settle charges resulted from 150 health and safety violations at their plant in Maine.
- **Tamil Nadu Newsprint and Paper Mills, India:** Over 30 environmental groups met in Pugalur in March 1994 to draw attention to pollution from the TNPL bagasse pulp mill. Villagers downstream claim that they have to buy in water from elsewhere and that fish survival was at risk¹²⁵.

- **Pulp and paper production uses a wide range of other resources, some of which are non-renewable.**

Necessary resources include water, chemical constituents, minerals (such as those used in fillers) and in addition considerable resources in developing infrastructure around mills and plantations in many countries.

Table 11: Environmental Issues Relating to the Use of Water in Pulp Mills

Issue	Possible Effects of Increased Abstraction
Sedimentation	Increased levels of siltation
Turbidity	Increased concentration of particles
Niche availability and nutrient supply to sedimentary organisms	Reduction in species diversity
Water table level	Loss of habitat, species diversity, potential concentration of toxic materials
Air/water gas diffusion rates	Stagnation
Temperature	Increased ambient water temperature reducing cleansing capacity

Source: Environmental Resources Limited (1989); *Industry and the Environment database: Pulp & Paper Sector*, dossier prepared for WWF International

Paper making requires large quantities of water, at rates of around 40m³/tonne in traditional mills. Conservation measures could reduce this. Annual use of water by Californian Paper Board Corporation was 2,473,000 m³; this fell to 689,000 m³ following conservation measures¹²⁶. Paper-making in Spain consumes 1 kw of energy and 10-30 litres of water for every kg of paper produced¹²⁷.

Fillers are used to achieve different finishes on paper, such as gloss and matt surfaces and various speciality papers. All mineral fillers are non-renewable. Some minerals (clays and calcium carbonates) require mechanical processing whilst others (eg titanium dioxide) are chemically processed. Environmental effects of filler use include damage from quarrying and pollution from waste disposal¹²⁸.

Impact from pulp and paper waste

The disposable nature of most paper products means that paper is frequently the major component in many domestic waste streams. Much of the waste ends up in landfill sites, or is incinerated. Both these disposal methods have important environmental repercussions.

- **Paper is now the dominant component of many municipal waste streams.**

Most paper is used for short term, or once-use purposes, and therefore ends up in the waste stream. It is estimated that around 15 million tonnes of wood are thrown away every year in the form of disposable nappies or diapers¹²⁹.

- **Much waste ends in landfill sites.**

Some 40 per cent of US rubbish dumps are said to be made up of unrotted paper¹³⁰. Paper is the biggest single source of waste in landfill in Australia¹³¹. The average American citizen uses 272 kg of paper products a year, 70 per cent of which end up as landfill. Newsprint accounts for 7 per cent in landfill, while fine papers make up twice as much volume¹³². Apart from the space and health effects of landfill disposal, rotting paper releases methane, a greenhouse gas, which in addition can cause explosions if it builds up underground.

- **Other paper waste is incinerated.**

Sometimes energy from waste paper is recovered and use for heating or electricity generation. Paper is not an ideal fuel and has been implicated in build-up of dioxin levels in cows' milk near incineration plants, although this issue remains highly contentious. Burning paper is nowhere near as energy efficient as burning the timber from which it is made. Paper can, in theory, be used both in composting and anaerobic digestion, although usually only as a portion of other biodegradable material and therefore the large amounts entering the waste stream tend to cut out this option in many cases¹³³.

Chapter 3: Responses to problems of pulp and paper

The environmental and social problems created by the pulp industry are complex and various, and therefore require a range of responses. Five main responses are discussed in the following section:

- changing forest management;
- changing the raw material used in paper;
- reducing pollution from paper-making;
- reducing waste through recycling;
- reducing waste through changes in consumption patterns.

Changing forest management

The first impact of the pulp cycle - the damage caused to forests and other ecosystems - can be at least partially addressed by changing attitudes towards, and methods of, forest management. Whilst no precise blueprint for ecologically and socially sustainable forest management exists, some clear indications of good practice already exist. Elements of a sustainable approach to the use of forests for pulp could include the following.

- **Elimination of pulp logging in old-growth native forests.**

WWF has identified protection of remaining old-growth forests as a priority for the coming decade¹³⁴. The use of important and sensitive forest ecosystems to provide timber for pulp is both unnecessary and extremely damaging. Any sustainable pulp strategy should start with the elimination of native forest logging in sensitive or old-growth areas.

- **Changing forest management in secondary forests and plantations.**

One response to concern about forestry management has been the development of different, more ecologically sensitive, management strategies. One of the best known attempts is the "New Forest Principles". The general philosophy behind new forest principles is that forestry should, as far as possible, mimic natural disturbance patterns within a given ecosystem thus:

(A)ttempting to balance commodity and ecological objectives by using practices based on current ecological understanding, the realistic limitations of the resource base, and societal expectations, including those expressed in (US) Federal legislation¹³⁵.

The Principles assume that current management strategies - where an even-aged stand is planted, reaches maturity and is felled - eliminate the early and late seral stages of forest development, and thus many of the species associated with old growth forest. An uneven management strategy is considered more acceptable and "...the selection of stand management systems should be based in part on the natural disturbance regime of individual sites in order to minimise or plan for effects of natural disturbances"¹³⁶. This includes:

- leaving some trees standing after cutting to maintain a varied-age stand;
- retention of a mixture of tree species, including some broadleaved trees, by allowing a proportion of those growing by natural regeneration after planting to remain;
- allowing coarse woody debris to enter streams in sufficient quantity to supply

additional habitats and nutrient retention without completely blocking watercourses;

- retention of fire refugia along riparian zones, ridges and wetlands, so that an interconnecting network of old growth can be established;
- retention of a proportion of standing dead trees and down logs in managed forests.

Such elements are indicative rather than strict rules of practice; ecosystems vary and management needs to be tailored to individual situations. Whilst these practises can help reduce damage in secondary forests, they are not panaceas that justify logging in primary or old-growth forests.

- **Developing guidelines for pulp plantations and paper-making.**

Over the last few years, there have been a number of attempts at developing guidelines for sustainable management of plantations. The International Tropical Timber Organisation has developed guidelines for planted forests in tropical areas¹³⁷ and WWF UK cooperated with the Royal Dutch Shell corporation in developing an eleven-volume *Shell/WWF Tree Plantation Review*, which included some *Guidelines*¹³⁸. These give a valuable framework, but further development work is still needed. In addition, WWF has produced a position paper on plantations and carbon sequestration which outlines the shortcomings in planting trees purely to offset the effects of global warming¹³⁹. At the same time, many independent codes of practice have been developed by timber and paper producers around the world. Most of these have no legal standing, or any way for consumers to check whether the code is being followed.

- **Independent timber certification.**

One way of formalising a change in forest management is for pulp companies and plantation owners to submit their forest management operations to independent certification, under the auspices of the Forest Stewardship Council (FSC) or some other similar body. The FSC is an umbrella organisation overseeing and controlling independent certification companies, to ensure that their forest management operations reach the minimum standards laid down in the FSC's *Principles and Criteria*¹⁴⁰. Although the FSC is fully operational, and principles for natural forest management have been agreed, the principles for plantations are still being discussed. WWF has supported the FSC since its initial proposal, and has worked with governments and the forest and timber industry in several countries to develop national certification systems. FSC certification is now required by many UK retailers belonging to WWF's 1995 Group, including Boots, Sainsburys and for example for wallpaper in many DIY stores.

Changing raw materials to non-wood plant materials.

*A second option open to paper-makers is to change the raw material used. Alternatives can include agricultural wastes, bamboo, hemp etc. Whilst these can relieve the pressure on natural forests, they also all have potential environmental effects and for example wild bamboo collection is currently a major environmental concern in India*¹⁴¹.

- **Some countries already use large amounts of non-timber pulp.**

Some countries have deliberately substituted other materials for wood pulp in paper-making. China currently accounts for 60 per cent of the world's production of non-wood pulp, utilising anything from farm waste to discarded fishing nets¹⁴². Chinese mills use 80 per cent fibres from annual crops¹⁴³. Raw materials include rice and wheat straw, bagasse, bamboo, Chinese alpine rush, cotton waste and reed and grass. China also has several paper mills running on hardwoods¹⁴⁴. Although non-wood pulp only accounted for 6 per cent of global pulp production in 1991, it supplied 32 per cent of the pulp used in

developing countries. Non-wood fibre production rose from 12 million tonnes in 1980 to 21 million tonnes in 1992 and is estimated to reach 23 million tonnes by 1998¹⁴⁵.

In northeastern Brazil, *João Santos* mills are probably the biggest producers of paper from bamboo in the world. The 6,800 hectares of "valgani" bamboo is established in Pernambuco, an area formerly used for sugar plantations until rising costs caused a collapse of the industry. Bamboo is now being planted in poorer, hilly land and productivity has been doubled over natural yields by use of fertilisers¹⁴⁶. An Australian company, River House, intends to build a straw pulp mill near Perth. Straw is also used in Europe, in Spain, Italy and France, and STFi in Sweden is reportedly interested in straw pulping methods¹⁴⁷. Hemp is now being grown for paper-making on an experimental stage in the UK, and hemp paper is available for sale. Non-wood products are increasingly being investigated by big companies as possible alternatives or additives to wood pulp. For example, Weyerhaeuser in the USA is considering adding rye straw to board furnish¹⁴⁸. However, on a worldwide scale uses of alternative fibres remains negligible, and it seems unlikely that this situation will change in the near future.

Table 12: Some Alternatives to Wood for Paper-making

Common name Details

Farm/other wastes Increasing interest shown in use of agricultural residues for paper, even in some traditional timber producing areas such as the Western USA¹⁴⁹.

Bagasse Sugar cane, an important pulp source in eg India¹⁵⁰ and Argentina; in the latter case supply 17 per cent of pulp raw material¹⁵¹. A mainly bagasse pulp mill is also planned in Ethiopia¹⁵² and 3 mills are located in Brazil.

Cassava Experiments with using nitric acid to pulp cassava waste carried out in Cameroon¹⁵³.

Cotton waste Widely used in China and elsewhere. A small experimental unit was set up in the late 1980s in Mali¹⁵⁴.

Malt fibre Residue after beer-making, planned for use in Japan for cardboard cartons¹⁵⁵.

Rice straw Widely used in part of Asia.

Sorghum Subject of experiments in pulping in France¹⁵⁶

Wheat straw Used widely in some areas as feedstock for pulping¹⁵⁷.

Crops

Abaca A manilla hemp

Chinese alpine rush Fast growing wild grass¹⁵⁸.

Flax Suitable for high quality linen papers¹⁵⁹ and cigarette papers¹⁶⁰.

Grass Various grasses have been used as pulp material.

Hemp Hemp (*Cannabis sativa*) can be pulped to produce paper, and hemp-based paper is now being marketed in the UK¹⁶¹.

Jute Four pulp and paper mills in Bangladesh produce 30,000 tonnes/year from jute, and a further mill is planned¹⁶².

Kenaf *Hibiscus cannabinus*, grown for paper in eg north-east Thailand¹⁶³ and there are plans to develop an industry in Australia¹⁶⁴.

Sisal Brazil is the world's largest producer with 6 mills making 150,000 tonnes/year

Harvested from the wild

Bamboo Major source of pulp in some Asian countries, including India and Vietnam; collection can itself be environmentally damaging.

Esparto grass Basis of Tunisia's small domestic pulp-making industry, grows abundantly in the centre of the country¹⁶⁵.

Compiled by **EQUILIBRIUM**, February 1995

Reducing pollution from paper-making

Over the last few years, considerable progress has been made towards pollution control in pulp mills, particularly within Scandinavia, former West Germany and parts of the USA. However, pollution remains everywhere and continues to be a serious problem in many developing countries. In some cases, corporations are thought to have exported outdated technology to the Third World, using techniques that would be illegal in their home base.

- **Considerable progress has been made in reducing pulp mill pollution.**

In Finland, for example, pollution loading from the pulp industry is 70-80 per cent lower today than it was in the 1980s, although the industry is still Finland's biggest polluter, contributing 90 per cent of all dissolved solids and solid wastes discharged to water and 20-40 per cent of air pollution. Some mills have achieved spectacular reductions in pollution, for example at Metsä Serla's Äänekoski mill, BOD loading has been reduced from 40 tonnes/day to 2 tonnes/day since the early 1980s, despite a doubling of capacity. Since 1987, sulphur dioxide emissions at the mill have fallen from 27,000 tonnes/year to 4,000 tonnes per year¹⁶⁶. Closed loop systems, whereby most materials are re-used and thus do not cause pollution, have also been developed. The Finnish wood processing industry has undertaken to continue the process of pollution reduction, and to meet the following targets, set by the government, between 1995 and 2000:

- BOD into waters: 160 tonnes/day (65 per cent less than 1986)
- AOX into waters: 1.4kg/tonne of pulp (65 per cent less than 1986)
- Phosphorus into waters: 1.5 tonnes/day (25 per cent less than 1986)
- Sulphur into the air: to be cut by 80 per cent from the 1980 figure by 2000
- Nitrogen into the air: to be cut by 30 per cent from the 1980 figure by 2000¹⁶⁷

Such improvements are expensive. In February 1994, the Swedish-based company Stora AB announced that it was to spend C\$36.5 million on environmental improvements at its newsprint mill in Nova Scotia, Canada to meet new government regulations, but has applied for an extension on the deadline for compliance to effluent improvements to an adjacent sulphite market pulp mill¹⁶⁸.

- **Unfortunately, serious problems remain.**

The remaining problems of water pollution from pulp mills have been described earlier in this report. While some countries are now acting to address pollution problems, such as Canada, others continue to use old and unsafe plant. Worryingly, some of the Scandinavian companies which have made such progress at home continue to operate dangerously polluting pulp mills in the South.

Reducing waste through recycling

Recycling offers a major opportunity for reducing waste, taking the pressure off forest resources and closing the paper cycle. An increased recycled paper component is now generally seen as beneficial. However, recycling is not without its own environmental costs, which also need to be addressed.

Recycling already provides a quarter of the raw material for pulp and paper manufacture on a global basis. In Germany, waste paper now accounts for 53 per cent of the raw materials used in paper-making¹⁶⁹. Trade in waste paper is already a major industry and some countries, such as Hong Kong, rely almost entirely on recycled materials¹⁷⁰. In others, for example Australia, governments have

provided financial incentives for using recycled paper and thus created a significant import trade¹⁷¹. There is currently no internationally accepted definition of recycled paper and according to the US Environmental Defense Fund the present definition of 'recycled' allows 95 per cent of total US paper production to qualify as recycled¹⁷².

- **Waste paper is already of major importance in several countries.**

Waste paper is often imported in regions where domestic pulp supply is inadequate for demand. In Pakistan, for example, 70,000 tonnes/year are currently imported¹⁷³. Around 76 per cent of Thailand's domestic pulp production was based on waste paper¹⁷⁴.

- **Paper recycling can offer substantial resource saving.**

The Warmer Campaign in the UK has calculated that replacing virgin pulp with recycled paper reduces industrial water use by 58 per cent, energy use by 40 per cent, air pollution by 74 per cent and water pollution by 35 per cent¹⁷⁵. The highest theoretical level of recycling possible has been calculated at 79.5 per cent, although the highest reached in practice is 53 per cent in the Netherlands. The amount recycled varies widely between countries, from eg 16 per cent in New Zealand to 50 per cent in Japan¹⁷⁶. There are some examples of very high rates of recycling. Some US cities, including Buffalo, Honolulu and Tampa, collect up to 80 per cent of office wastepaper for recycling¹⁷⁷.

Worldwide, wastepaper recovery reached 38.2 per cent in 1993, with Asia achieving 37 per cent, North America 39.4 per cent and Western Europe 41.9 per cent¹⁷⁸.

Table 13: Actual and projected growth of recycled fibre consumption by paper industry

Year	Recycled Fibre		Virgin Pulp	
	(M/tons)	(% of total fibre)	(M/tons)	(% of total fibre)
1985	59	30	141	70
1990	79	33	162	67
1995	114	39	175	61
2000	151	45	187	55
2005	190	49	197	51

Source: Capps, Clive (1994); Environmental legislation, *World Paper* June 1994 219:5

- **Paper recycling is also criticised for its environmental effects.**

Whilst generally favoured from an environmental perspective, recycling itself has potentially damaging side effects. Recently, there has been some criticism of recycling, and even claims that paper recycling is more environmentally damaging than use of virgin pulp. Some of these claims are clearly politically motivated, coming from the primary fibre industry, while others are more measured¹⁷⁹. Problems include pollution (through de-inking technologies etc) and the high amounts of energy use in collection, sorting and recycling paper. The quality of recycled paper is also raising questions; eg if recycled tissues are half as absorbent as those made with virgin pulp, consumers may use twice as many, which would have a major effect on overall resource consumption. These criticisms gained official recognition in the UK, with criticism of high targets for recycled paper made by a Select Committee of the House of Lords¹⁸⁰.

Despite these reservations, analysts still see an important role for recycling in the future in reducing the overall environmental impacts of the pulp and paper trade.

Reducing waste through changing consumption patterns

Minor changes to production processes, and an increase in recycling, will not be enough to address the problems of pulp and paper manufacture if current projections for increases in consumption are correct. Some developing countries, such as China, offer potentially vast new markets for paper. One element in any strategy to reduce overall impacts must therefore be development of new social and industrial patterns which reduce the need for paper.

- **There is a strong argument for reducing total paper consumption.**

The measures described above presuppose that pulp and paper consumption levels are low enough to allow such strategies to be effective. If the vast, projected, growth in paper consumption actually occurs, it seems likely that many of the generally beneficial developments described above will be ignored or never achieve widespread adoption. At present, paper consumption appears to correlate well with economic growth, and vast new markets are opening up in Asia and Latin America.

Underlying the changes in technology and management there is also a necessary and a more basic change, namely a reduction in our total demand for paper. Detailed strategies for achieving an overall reduction in paper use remain in their infancy, but could include for example:

- greater use of electronic mail and communication systems, including for advertising (although to date studies suggest that these systems have led to increased paper use);
- increase in recycled content of many paper products;
- reduction in packaging, including greater use of reusable bags;
- easier ways to avoid mass mailings of advertising material; etc.

Development of a rounded and achievable strategy for reduction in paper consumption should be an urgent step in any strategy for sustainable paper use.

Over the last few years the detrimental environmental impacts of many industries have been scrutinised, publicised and made the subject of environmental campaigns. In response there has been a wide range of proposals from governments, trade bodies and pressure groups to set standards which lead to more effective environmental protection and industry accountability. Table 14 summaries some of the key forms and details examples which affect the pulp and paper industry.

In an industry subject to considerable world trade, such as the pulp and paper industry, to ensure that strict environmental guidelines/legislation are met one has to deter companies importing goods from countries with lower environmental standards to reduce costs. The GATT trade talks and the resulting World Trade Organisation (WTO) has opened up the possibility of increased world trade. Although on the signing of the Uruguay round in 1994 ministers agreed to establish a committee on trade and the environment to review the need for trade rules to be modified to take account of international environmental agreements, it is currently illegal under the WTO for trading countries to discriminate on environmental grounds.

Table 14: Environmental Standards: From Company Scheme to Regional Legislation

The pulp and paper industry is not insensitive to its image as a major polluting industry. There have been a wide array of attempts to improve the industry's environmental credentials, from industry initiatives to national and international legislation. Identified below are some of the various forms of 'environmental' schemes and legislation which have an effect on the industry along with representative examples for each category.

Individual Company

As pressure from NGOs, Government and Consumers for environmental protection grows individual companies are producing their own environmental standards.

Nippon Paper Industries

Japan's largest paper company and the first Japanese company to publish numerical targets for environmental improvement. Targets include reduced pollution, energy conservation, waste utilisation, waste reduction, technology transfer and education.

AT & T USA

Like many other companies worldwide the huge US tele-communications company has set public targets for recycling its waste paper and usage of recycled paper products.

Associations of Business

Groups of businesses are increasingly working together to develop sustainable business practices and promote their environmental credentials. Similarly, trade associations, which are set up to protect and promote specific market activities, are producing environmental and social principals.

American Forest and Paper Assoc. (AFPA) Forest Management

AFPA has recently approved what they call a set of "comprehensive sustainable forestry principles and implementation guidelines".

International Chamber of Commerce's Business Charter for Sustainable Development

Supported by at least 15 major pulp and paper companies who have committed themselves to implement 16 environmental management principles.

Industry, NGO, Consumer Confederations

Parties working on pulp and paper initiatives are beginnings to realise that a multidisciplinary group approach to environmental improvements can be a more productive method of satisfying the different interest groups.

WWF 95 Group

A partnership between WWF UK and British companies committed to phasing out unsustainable timber. Although initially designed for the timber trade, the implications of its definitions and procedures are applicable to the paper industry, eg in Boots and Sainsburys.

WWF 97 Group

A partnership between WWF Belgium and Belgium companies, aiming to develop sustainable forest management, also working on projects with the European Commission. Currently mainly aimed at the timber trade, but with implications for pulp and paper use.

Canadian Pulp and Paper Roundtable

An alliance of over 30 industry, environment and consumer groups who have adopted a draft set of principles including: ecological limits, ecosystems interaction, protection of biodiversity, workplace safety, education and recognition of aboriginal rights and values.

National Office Paper Recycling Project

A joint effort in the US of over 250 private companies, public interest groups and the EPA. the project aims to triple office paper recycling by 1995 from 1.7 to 5.1 million tons, increase the number of companies involved and develop a national office paper recycling strategy.

Table 14: Environmental Standards: From Company Scheme to Regional Legislation (continued)

NGO Actions

Many NGOs working on environmental issues have launched specific campaigns which have effects on pulp and paper companies and consumer purchases.

Greenpeace's Chlorine Free '93 and Women's Environmental Network Campaign

A parallel campaign to promote paper products produced without chlorine bleach. The campaign has led several major publishers to switch production to chlorine-free paper and has increased consumer demand for these products.

Consumer-Orientated Standards

Independent consumer-orientated standards have developed as environmental considerations became more important to consumers, who wish to make a positive statement concerning specific issues through their purchasing power, and companies have realised they can gain considerable publicity from, and often add price premiums to, 'environmentally-friendly' products.

Blue Angel Scheme, Germany

A well-established scheme covering consumer products. Categories for various paper products include that they should be bleach free and stipulate recycled fibre content. Companies apply for, and pay for, award of the blue angel which is widely recognised by consumers.

EU eco-labelling Scheme

The EU eco-labelling scheme was born out of increased awareness of environmental problems and recognition of successful schemes running in member states. The scheme will cover a life-cycle assessment of a wide variety of consumer goods, including pulp and paper. Criteria have now been agreed for toilet paper and kitchen rolls and work is continuing on fine papers.

Forest Stewardship Council

An independent certification scheme which aims to produce a working definition of sustainable forest management and establish an international system for certifying 'well-managed forests'.

Voluntary Schemes undertaken by Industry

By taking part in official industry guidelines companies can show their trading partners, competitors, consumers etc that their working practices meet set criteria.

UK's BS7750

The independent British Standards Institute is funded by the UK government. BS7750 is an across the board environmental management system for companies.

US EPA 33/50 Waste Reduction Programme

A voluntary programme aimed at reducing emissions of 17 priority chemicals by 33% by 1992 and 50% by 1995.

Official Guidelines for 'Environmentally Friendly' Products

There has been a rapid increase in the promotion of 'environmentally friendly' policies in local, regional, national and international policies. Those concerning paper products usually cover increased usage of recycled paper and recovery rates of used paper.

EPA's Guidelines for Federal Procurement of Paper and Paper

The guideline's require US federal government agencies to buy recycled paper. The guideline's cover the **Products** definition of recovered materials, require affirmation of procurement, a certification/verification programme and recommended content standards for selected products.

Table 14: Environmental Standards: From Company Scheme to Regional Legislation (continued)

Direct Legislation on Industry

The effectiveness, amount of and standards of legislation which affect industry vary between individual cities, regions, countries and continents. Environmental legislation in Northern countries has grown considerably in the last few decades and is now moving to a more integrated approach affecting all outputs from a range of industries.

US EPA 'Cluster Rules'

The legislation if passed aims to combine regulations on toxic levels in air and water and includes effluent limitation on chlorinated organic matter in wastewater and dioxin emissions.

International Controls

International controls remain elusive, with many proposals and few firm agreements. The Convention on Biological Diversity has failed, so far, to address forest issues effectively, and plans for a Global Forest Convention remain unclear.

Helsinki Process

Launched in Finland, in June 1993, at a *Ministerial Conference on the Protection of Forests in Europe*, it aims to develop criteria and indicators of good forest management. Currently 6 criteria and 27 indicators have been agreed, although these have not yet been field tested. The Helsinki Process is legally binding.

Montreal Process

Designed to develop temperate forest criteria and indicators for non-European countries and currently has 10 member states. Seven criteria have been identified although the last, on institutional frameworks, is considered different from the others and treated separately. The Montreal Process is not legally binding.

Global Forest Convention

Following a rejection prior to the Earth Summit, there are, once again, moves towards developing a Global Forest Convention although no agreement about form or content has been reached as yet.

Compiled by **EQUILIBRIUM**, February and October 1995. **Sources include:** IIED (1994 draft); *The Sustainable Paper Cycle: Phase 1 Review Report*, IIED, London. **Capps, Clive** (1994); Environmental Legislation, *World Paper* **219:5**. **Galín, Rob** (1994); Industry says Cluster Rules, based on inaccurate data, go to far; *Pulp and Paper*, April 1994. **Webb, Leslie** (1993); How green's your labelling scheme?, *Pulp and Paper International* **35:5**. **Department of Administrative Services** (1990); *A guide to the Use of Recycled Paper*, Australian Government Publishing Services, Canberra, Australia; *Journal of Forestry* **93** (1), January 1995, USA

Conclusions

Paper products serve a number of essential functions in society, and statistics show that paper use generally increases with the level of per capita GDP. In most modern societies, paper continues to play a key role in the written and visual arts. However, our research has demonstrated that pulp and paper production also puts considerable strains on the environment resulting in habitat loss, pollution and unsustainable use of resources. It is vital that a balance is established between the legitimate desire for pulp and paper products and their social and environmental costs.

WWF suggests that two strategies are required:

- **A reduction in paper consumption and waste, through:**
 - **reduction and elimination of unnecessary uses;**
 - **re-use where appropriate;**
 - **recycling.**

Fears have been expressed about the side effects of recycling and about the risks of undermining the world's forest industries through demand reduction.

Whilst we recommend that research continues to minimise the side-effects of recycling technology, we believe that recycling makes an important contribution to waste minimisation.

We reject the suggestion that recycling and waste reduction threaten the forest industry. Some analysts have projected a serious shortfall of timber in the future and strategies to reduce demand are therefore essential¹⁸¹. Trends indicate that there will be an increasing demand for timber products, as well the development of new or expanded markets. Therefore, maximising efficiency should remain an important overall goal of the industry.

- **Development of an overall strategy for sustainable paper production.**

Paper use will continue to require the input of large amounts of virgin fibre, and sometimes this may be more appropriate than recycling. In the future, an increasing proportion of this fibre will come from plantations.

WWF believes that - from the perspective of both industry and the environment - an integrated strategy for sustainable paper production is required, taking into account all aspects of pulp and paper production. For this to work efficiently, and for responsible pulp and paper producers to be adequately rewarded for good practice, an effective monitoring system is required.

The best way to achieve this would be for **the development of an independent certification scheme for paper from sources that minimise environmental damage**. Any such scheme should be closely allied to, but remain distinct from, the Forest Stewardship Council. Meeting FSC forest management criteria would be a key, initial, stage in any paper-making relying on wood fibre.

WWF calls on the pulp and paper industry to work with a range of NGOs, human rights groups and the Forest Stewardship Council to develop a paper certification scheme. A suggested target date by which such a scheme should be fully operational is 1998.

Appendix 1: Questions to ask before buying or using paper

Choosing paper that causes a minimal amount of environmental and social damage during its manufacture is made more difficult because there is no single answer to which is the "best" paper to use - the balance changes with application, place and other circumstances.

The following set of questions and footnotes do not attempt to give definitive solutions, but rather have been designed to help people make an informed choice about which paper to use for any particular purpose. In some cases they raise questions that it is still difficult to answer. The references and addresses suggested may be able to supply further information. Questions should be taken in order.

1. **Necessity:** is use of paper:

- avoidable;
- important but could be reduced;
- essential?¹

2. **Substitution:** would the use of some other material or technique instead of paper be:

- possible and easy;
- possible but have some costs;
- impossible?²

3. **Re-use:** would the re-use of existing paper products be:

- possible and completely satisfactory;
- possible but has limitations;
- impossible?³

¹ The first question to ask is whether the use of paper is necessary at all. For example:

- Does an E-mail message really need printing out?
- Can a copy of a letter be kept on a computer file for a few months and then erased?
- Could a telephone call or voice-mail message substitute adequately for a letter?
- Will a separate publication really do more than an article in an existing journal, or a letter to the press?
- Could a CD-Rom substitute for a large publication?

² Allied to the first question. Does substitution really work? It is worth monitoring any innovations. E-mail may not be much of a saving if many short messages all get printed out on virgin fibre and abandoned within a few days. Several studies within offices have shown that computers and use of electronic mail have increased overall paper use.

³ Re-use has many advantages and is a more resource-efficient option than recycling. Re-use can include for example:

- using the back of unwanted paper for printing rough drafts, copies or for faxes;
- re-using envelopes through application of address labels; through to domestic uses such as,

4. **Reduction:** is reduction in the *amount* of paper used for a particular task:

- possible and causes no problems;
- possible but causes some difficulties;
- impossible?⁴

5. **Lifetime:** is the paper going to be used for a:

- long-term use;
- relatively short-use purpose;
- disposable item?⁵

6. **Presentation:** is the appearance or other attributes of the paper:

- relatively unimportant;
- important but flexible;
- important and an integral part of the overall purpose⁶?

-
- use of paper for fire-lighting; etc.

Again, there are costs, in terms of both time and other resources. Covering a small envelope with labels and sticky tape may be more resource-intensive than using a new envelope.

⁴ Reduction requires planning. Printing costs tend to reduce per unit with number printed, thus encouraging printing more than necessary. Fast, efficient photocopiers encourage production of multiple copies of documents rather than circulation of one or a few copies. Reduction can include:

- careful planning of publications with all departments involved to allow printing the optimum number of a particular publication;
- substitution of photocopying or instant-print methods for printing jobs where suitable, thus allowing copies to be printed in small batches as needed;
- replacement of long published reports by short summary documents, with the full report available photocopied on request only;
- routine use of double sided printing in photocopiers;
- printing copies for record with small typeface or narrow fonts; etc;
- using reduced *weight* of paper.

⁵ Intended lifetime is an important factor in choosing type and quality of paper, although there is no simple relationship between lifetime and quality or type of paper. In general terms, disposable items, if necessary at all, should use recycled or recycled/virgin mixtures, taking note of the provisos in questions 7 and 8 below. Books and other more-or-less permanent products should use high quality paper, although this does not preclude recycled sources.

⁶ Presentation needs to be good enough for the particular job in hand. In general, internal organisational use of paper (memos, drafts, notes etc) can rely on the lowest quality consistent with their being read at all. Those for external use have a scale of qualities, which may extend to fully virgin white paper if this is needed for a particular purpose (although see questions 10, 12 and 13 below). Alternative paper sources may themselves offer interesting design options whilst making a point about paper.

7. **Recycled paper:** does use of recycled paper present:
- present no problems;
 - some problems or require research;
 - serious problems?⁷
8. **Sources of recycled paper:** is recycled paper:
- easily available and relatively cheap;
 - available with some difficulties and/or at a high cost;
 - unavailable without long distance transport and import?⁸
9. **Mixtures:** is use of a mixture of recycled and virgin fibre:
- possible and acceptable;
 - possible but causes some difficulties and needs to be researched;
 - impossible?⁹
10. **Sources of virgin fibre:** are sources:
- mainly or entirely from domestic sources;
 - available from domestic sources but limited;
 - imported?¹⁰

⁷ Recycled paper can present particular problems for designers and printers and may not be suitable for some purposes. On the other hand, range and quality of recycled paper is growing all the time. A useful, albeit expensive, guide for printers is a report by Gerry Matthews, published by Anderson-Fraser, London.

Note that "recycled" does not invariably equal "good". Heavily bleached recycled paper may have a range of impacts at pulp making stage. Some recycled toilet papers contain polluting dyes. See **Virtanen, Yrjö and Sten Nilsson** (1993); *Environmental Impacts of Waste Paper Recycling*, Earthscan Books, London

⁸ The relevance of this question is decreasing with time, as recycled papers become more widely available. However, there are some countries where printing quality recycled papers still have to be imported and if domestic virgin pulp supplies from well-managed forests are also available, these may be more suitable from an overall environmental perspective. Conversely, other countries import waste paper to make recycled paper supplies, and this in turn will have high transport costs. Many governments now publish positions or guides. See, for example, *A Guide to Use of Recycled Paper*, Australian Government Publishing Service, Canberra.

⁹ Getting information on mixtures of recycled and non-recycled paper is still difficult, although is getting easier in many places. Note that in some countries, including the USA, a statement that paper is recycled does not necessarily mean that all the fibre is recycled.

¹⁰ On the whole, a well-managed domestic source of fibre is likely to have the lowest overall environmental costs. In countries with abundant supplies of sustainably managed timber it may make more sense to use virgin fibre than recycled paper.

11. **Non-wood fibres:** are the use of non-wood fibres:
- a good and competitively-priced option;
 - an option, but with limitations and/or considerable extra cost;
 - virtually or completely impossible?¹¹
12. **Forest management:** does the fibre come from:
- well-managed and independently certified sources;
 - sources that are adequately managed or where management practices are unknown;
 - from natural or old-growth forests or where there are known to be serious problems with management?¹²
13. **Pulp processing:** is pulp processing:
- from mills with good pollution prevention and resource-recovery systems;
 - from unknown mills;
 - from mills known to be polluting or wasteful?¹³
14. **Dyes and inks:** are the colours used on the paper:
- harmless to health and the environment;
 - have unknown effects;
 - known to be harmful?¹⁴

¹¹ Currently, use of non-wood fibres is frequently promoted as an environmentally-friendly alternative to wood pulp. Detailed assessments of the environmental impacts of non-wood paper products is still very limited, and this assessment may change with time. The report *Bioregional Fibres - the potential for a sustainable regional paper and textile industry based on flax and hemp* is available from the Bioregional Development Group, Sutton Ecology Centre, Honeywood Walk, Carshalton, Surrey SM5 3NX, UK.

¹² Currently, the best option available is to buy paper made from independently-certified timber assessed under the auspices of the Forest Stewardship Council. However, very little of this is available as yet, and in the interim buyers may have to make value judgements based on what is known about forest management within a region on a more general level. Reference: *A WWF Guide to Timber Certification* by Christopher Elliott, WWF UK, 1995

¹³ Some paper manufacturers provide information about mill safety and discharges. Most of this is currently self-certification, although government-run surveys of pollution discharges exist in some countries. Global comparisons are difficult and no overall sources exist. See, for example, *Biological Effects of Bleached Pulp Mill Effluent*, Anders Södergenen, National Swedish Environmental Protection Board Report, 3558, Solna, Sweden

¹⁴ Some dyes are themselves highly polluting and can offset the beneficial impacts of recycled and other papers. For example, a few years ago in the UK recycled toilet tissue was sold coloured with a bright pink dye which later proved to be toxic. At the present time it is usually difficult to get information about paper dyes. Eliminating the use of highly coloured papers for non-essential purposes is a good initial strategy.

15. **Social impacts of paper:** is the social impact of timber production and pulp processing:

- generally beneficial to local communities;
- unknown;
- known to be causing problems?¹⁵

16. **Machinery efficiency:** is paper-using machinery (photocopier, printer etc)

- well-maintained and efficient;
- fairly well-maintained;
- inefficient?¹⁶

17. **Certification:** are some or all of the stages of pulp production:

- independently certified;
- subject to industry-controlled guidelines;
- uncontrolled and unmonitored?¹⁷

There is currently no agreed independent certification for paper made from sustainable sources and produced in a non-polluting, resource efficient and socially acceptable way. Time will be needed to develop such an eco-label. For the moment, supporting those companies which are trying to introduce or sell responsibly-produced paper is a good start, although proof of this is impossible without independent certification. Those concerned about the paper they are using can also help straighten out a confused market by stating clearly and briefly what paper they are using, and why.

¹⁵ Far less is known about this issue, and paper buyers are basically reliant on their own research or knowledge of individual and particularly bad practices. Environmental organisations, indigenous peoples groups and networks such as the Taiga Rescue Network may be able to supply information on particular paper sources to avoid because of their social impact, but it is still more difficult to get information about areas where socio-economic impacts are positive.

¹⁶ One of the greatest sources of paper waste is badly maintained machinery; in general *minimising waste* is more effective than changing paper sources and proper maintenance of machinery therefore a priority.

¹⁷ This is a future option rather than a present reality in most cases. For details on certification of timber see note to question 12.

Notes and References

1. Figures calculated from **Food and Agricultural Organisation** (1993); *FAO Yearbook of Forest Products 1991*, FAO, Rome
2. **Kroesa, Renate** (1990); *The Greenpeace Guide to Paper*, Greenpeace, Canada
3. **Food and Agriculture Organisation** (1994); *Pulp and Paper: Towards 2000: An executive summary*, FAO, Rome
4. **Nectoux, François** (1992); in a paper to a WWF European Forests Workshop in Gland
5. **Chemprojects Design and Engineering prt ltd** (1992); *Indian Scenario for Raw materials for the Pulp and Paper Industry*, Development Council for Pulp, Paper and Allied Industries, New Delhi
6. **FAO** (1993); *op cit*
7. **Uutela, E** (1989); Strong growth predicted to year 2000, *Pulp and Paper International*, January 1989
8. **Canadian Pulp and Paper Industry** (1991); *Statistics of World Demand and Supply*, Montreal
9. **FAO** (1993); *op cit*
10. **Pira International** (1995); *Pulp and Paper beyond 2000*, Pira International, UK
11. **Matussek, Heide, William Salvesen and John Pearson** (1993); *Pulp and Paper International*, September
12. **FAO** (1991); *Forestry Statistics Today for Tomorrow*, Rome
13. **Anon** (1993); Pulp and paper in Romania, *Paper Technology* **34** (3), 12-13
14. **Shevchenko, S M** (1994); Pulp and paper between peace and war, *Tappi J.* **77** (1), 61-66
15. **Ljunggren, A** (1994); The changing landscape of Eastern Europe, *International Papermaker* **57** (5), 20-23
16. **Marcus, Amanda** (1992); Venezuela: Vying for a visible future, *Pulp and Paper International* **34** (12), 21-23
17. **Orgill, M** (1994); Chile feels the pinch, *World Paper* **219**, p 21
18. **Business Korea** (1990); Publications mushroom, stimulating paper industry, **7** (8), February 1990
19. **Matussek, Heide et al** (1993); *op cit*
20. **Brennan, W and Pappens, R A** (1995); Annual Review, *Pulp and Paper International* **37.7**, July 1995
21. **FAO** (1993); *op cit*
22. **Forsstrom, A** (1994); Report on Africa, *International Papermaker* **57** (2), 16-21
23. figures from: **VDP** (1986), the West German Industry Association, quoted in **Kroesa, Renate** (1990); *op cit*; **Elkington, John and Hailes, Julia** (1988); *The Green Consumer Guide*, Gollancz, London; **Pollock, Cynthia** (1987); *Mining Urban Wastes: The Potential for Recycling*, Worldwatch Paper **76**, Worldwatch Institute, Washington DC; and **Postell, Sandra and John C Ryan** (1991); "Reforming Forestry" in *State of the World 1991*, The Worldwatch Institute, Washington DC
24. **FAO** (1993); *op cit*

25. **FAO** (1993); *FAO Yearbook: Forest Products 1980-1991*; FAO Forestry Series No. 26, FAO Statistics Series No. 110, Food and Agriculture Organisation of the United Nations, Rome
26. **Conway, Stephen** (1992); Hype and reality about recycling, in **Payne, Mark**; *World Waste Paper: Growth and Opportunities in the 1990s*, FT Business Info Ltd, UK
27. **Marx, Michael** (1994); Mitsubishi: The money and the power behind Alpac, *Boreal Forest Campaign Educational Report 13*(7), Western Canada Wilderness Committee, Edmonton
28. **Pratt, Larry and Ian Urquhart** (1994); *The Last Great Forest: Japanese Multinationals and Alberta's Northern Forests*, NeWest Press, Edmonton
29. **MacDonald, J** (1990); Daishowa wants to talk about logging on Lubicon claim, *The Edmonton Journal*, 11 October 1990
30. **Clark, Judy** (1992); *The Future of Native Forest Logging in Australia*, Centre for Resource and Environmental Studies, Working Paper 1992/1
31. **Ferguson, Ian S** (1991); Pulpwood resources for Australia, in **Crossland, Chris** [editor] *International Conference on Bleached Kraft Pulp Mills: Technical and Environmental Issues*, 4-7 February 1991, World Congress Centre, Melbourne, Australia, National Pulp Mills Research Program, CSIRO, Dickson
32. **Anon** (1994) Australian forests sold for pulp, *World Rainforest Report 11* (3), Rainforest Action Network, San Francisco
33. CNN news report, January 1995
34. **Rinne, P** (1995); Finland not seeing forest future through all its trees, *Pulp and Paper International 37* (6), June 1995
35. **Anon** (1986); Cellucan of Cameroon shuts down for good, *Pulp and Paper 60* (11)35.
36. **Rasmusson, Ulf** (1994); *Swedish/Scandinavian involvement in Indonesian forestry - the industrial forest plantations and pulp mill sector*, WWF Sweden, Solna
37. **World Paper** (1993); volume **218** (12), December, London
38. **Bazett, Michael D** (1993); *Shell/WWF Tree Plantation Review: Study no. 3: Industrial Wood*, Shell, London and WWF Godalming
39. **Stephan, V C** (1995); Market pulp figures signal a new brand of recovery, *Pulp and Paper International 37* (8), August 1995
40. **Higgs, Richard** (1994); Brazil, *World Paper 219* (5), May 1994
41. **Brennan, W and R A Parsons** (1995), *Pulp and Paper International 37* (7), July 1995
42. **Lara, Antonio** (1992); in *Forests in Trouble*, WWF International, Gland
43. **Orgill, Margaret** (1994); Chile feels the pinch, *World Paper 219* (2), February 1994
44. **Turner, Clare** (1994); Kiwis out of crisis, *World Paper 219* (1), January 1994
45. **Schmucler, H** (1992); *Paper Industry in Argentina* (original in Spanish)

46. **Anon** (1993); CMPC Enterprises: Leader of the Chilean pack, *Pulp and Paper International*, August 1993, page 16
47. **Marcus, Amanda** (1993); Chile: Latins in a league of their own, *Pulp and Paper International* **35** (11), November 1993
48. **Crawford, Leslie** (1991); Eucalyptus joins Chilean paper chase, *Financial Times* 4th June 1991, London
49. **Anon** (1993); S-C seals Venepal deal, *World Paper*, December 1993
50. **Economist Intelligence Unit** (1993); *Indonesia: Industrial Development Review*, published on behalf of UNIDO
51. **Anon** (1994); Worldwide news, *Pulp and Paper International* **36** (8), August 1994, and site visit by Nigel Dudley, January 1995
52. **Anon** (1992); *Mistaking Plantations for the Forest: Indonesia's Pulp and Paper Industry, Communities and Environment*, The Indonesian Forum for the Environment and The Indonesian Legal Aid Institute
53. **Postel, S** and **Heise, L** (1988); *Reforestation of the Earth*; Worldwatch Paper No. 83, Worldwatch Institute, Washington, USA
54. **Women's Environmental Network** (1990); *A Tissue of Lies? Disposable Paper and the Environment*, WEN, London
55. **Economist Intelligence Unit** (1993); *Indonesia: Industrial Development Review*, published on behalf of UNIDO
56. **Rasmusson** (1994); *op cit*
57. *Pulp and Paper International* (1988); January
58. **Down to Earth** (1991); *Pulping the Rainforest*, Down to Earth: International Campaign for Ecological Justice in Indonesia, Special Report number 1, Asia Pacific People's' Environmental Network, Penang, Malaysia
59. **Lamb, Christina** (1992); A strange case of jungle fever, *Financial Times* 4th November 1992, London
60. **Lara, Antonio** (1992); Case Study, Chile, in *Forests in Trouble: A Review of the Status of Temperate Forests Worldwide* by **Nigel Dudley**, WWF International, Gland
61. **Rainforest Action Network** (1993); *World Rainforest Report*, April June 1993, San Francisco
62. **Thunberg, Jerker** (1993); Entering the age of the tree, *European Papermaker* **1** (2), March 1993, Sweden
63. **Senanayake, R** (1987); Some strategies for effective communication in tropical forest issues; *Loris* 17
64. **Clout, M N** (1984); Improving exotic forests for native birds, *New Zealand Journal of Forestry* **24**:2
65. **Sawyer, J** (1993); *Plantations in the Tropics: Environmental Concerns*, IUCN, UNEP, WWF, Switzerland
66. **Rosoman, G** (1994), *The Plantation Effect*, Greenpeace, New Zealand
67. **Porter, R** (1990); Future afforestation and the potential impacts on nature conservation in Natal, unpublished proceedings of a forest impacts workshop at the University of Natal, Pietermaritzburg, quoted in Sawyer, *op cit*.
68. **Adams, J A** (1978); Long-term aspects of nutrient loss from forest soils and ecosystems; *New Zealand Journal of Forestry* **23**:1

69. **Sawyer, Jacqueline** (1993); *op cit*
70. **Rosoman, G** (1994), *op cit*
71. **Mestel, R** (1993); Clinton wants to reconcile forestry and wildlife; *New Scientist* 10th April
72. **Good, John. Gerry Lawson and Paul Stevens** (1993); *Shell/WWF Tree Plantation Review Study no. 8: Natural Environment*, Shell, London and WWF, Godalming
73. **Shiva, Vandana and J Bandyopadhyay** (1984); *Ecological Audit of Eucalyptus Plantations*, Dehra Dun, India
74. **Poore, M E D and C Fries** (1985); *The Ecological Effects of Eucalyptus*, FAO Forestry Paper number 59, Food and Agriculture Organisation, Rome
75. **Blockhus, Jill** [editor]; *IUCN Forest Conservation Programme Newsletter* number 20, November 1994, Gland, Switzerland
76. **Rosoman, G** (1994), *op cit*
77. **Singh, S; Khan, S N; Misra, B M and Uniyal, K** (1982); Some important diseases of pines in India, *Indian Forester* **108**
78. **Ciesla, W M** (1991); Cypress aphid: a new threat to Africa's forests; *Unasyiva* **167:42**
79. **Rosoman, G** (1994), *op cit*
80. **Dudley, Nigel** (1995); *People and Forests*, A Report for the Forests and People in Rural Areas: Scotland Initiative, Equilibrium, Bristol
81. **Kellomäki, S** (1975); Forest stand preferences of recreationalists, Tiivistelmä UI-koilijoiden metsikköarvostukset, *Acta Forestalia Fennica* **146**
82. **Kujala, M** (1988); Ten years of inquiries on the berry and mushroom yields of Finland, 1977-1986; in Proceedings of the Finnish-Soviet Symposium on Non-Timber Forest Resources, edited by I Vänninen and M Raatikainen, *Acta Botanica Fennica* **136**, 11-13; and **Saastamoinen, O and S Lohiniva** (1989); Picking of wild berries and edible mushrooms in the Rovaniemi region in Finnish Lapland, Tiivistelmä Luonnonmarjojen ja sienten poiminta Rovaniemen seudulla, *Silva Fennica* **23** (3), 253-258
83. **Food and Agriculture Organisation** (1991); *Non-Wood Forest Products: The Way Ahead*, Forestry Paper **97**, UN FAO, Rome
84. **Lohman, Larry** (1990); Commercial tree plantations in Thailand: deforestation by any other name, *The Ecologist* **20** (1)
85. **Bass, Stephen** (1993); *The Shell/WWF Tree Plantation Review Study Number 7: Social Environment*, Shell and WWF UK
86. **Shell and WWF UK** (1993); *Guidelines for Plantations*
87. **Anon** (1993); Taiwan expands at home and abroad, *PPI This Week* **8** (34), p 3
88. **Pearson, John** (1994); Japan, *Pulp and Paper International* **36** (8), August 1994
89. **Marcus, Amanda** (1993); *op cit*

90. **Anon** (1993); Japanese joint venture plans afforestation in Papua New Guinea, *PPI This Week* **8** (6), p 5
91. **Penna, Ian** (1992); *Japan's Paper Industry: An Overview of its Structure and Market Trends*, Chikyu no Tomo/ Friends of the Earth Japan, Tokyo, May 1992
92. **Birchfield, Reg J and Ian F Grant** (1993); *Out of the Woods: The Restructuring and Sale of New Zealand's State Forests*
93. **Foreign Control Watchdog** (1993); Campaign Against Foreign Control of Aotearoa, Christchurch, New Zealand
94. **Sherwell, C** (1985); A paper mill's tale of trial and tribulation, *Financial Times*, 3rd April 1985
95. **Anon** (1993); Bai Bang rolls on, *Paper Asia* **8**, 27-28
96. **Anon** (1994); USA, *Pulp and Paper*, San Francisco, April 1994
97. **Capps, Clive** (1994); Environmental legislation, *World Paper* **19** (5), June 1994
98. **Matussek, Heide and Rik Peppens** [editors] (1994); *International Fact and Price Book 1995*, Pulp and Paper International, Miller Freeman Inc, USA
99. **Carlberg, G E** (1991); Composition of effluents from bleached Kraft pulp mills, in **Crossland, Chris** [editor] *International Conference on Bleached Kraft Pulp Mills: Technical and Environmental Issues*, 4-7 February 1991, World Congress Centre, Melbourne, Australia, National Pulp Mills Research Program, CSIRO, Dickson
100. **Kroesa, Renate** (1990); *The Greenpeace Guide to Paper*, Greenpeace, Canada
101. **Pira International** (1995); *Pulp and Paper Beyond 2000*, Pira International, UK
102. **Reeve, Douglas** (1995); ECF bleaching and TCF bleaching verses chlorine bleaching, *Canadian Market Pulp*, September 1995
103. **Rainey, Margaret** (1991); *Sustainable paper production: recycling closes the loop*, 1991 Tissue making, September 19-20, Karlstad, Sweden
104. **Leaver, Nigel** (1992); Lumbering around, *Arguments and Facts International* **3** (20), pp 6-7
105. **Speranskaya, Olga** (1993); Russia: hope again, *Paper* **128** (10), October 1993
106. **Södergren, Anders** [editor] (1989); *Biological Effects of Bleached Pulp Mill Effluents*, National Swedish Environmental Protection Board Report **3558**, Solna, Sweden
107. **Södergren, Anders** [editor] (1993); *Bleached Pulp Mill Effluents: Composition, fate and effects in the Baltic Sea*, Swedish Environmental Protection Agency, Report **4047**, Solna, Sweden
108. **Abel, Kay** (1993); *Pulp Mill Effluents* National Pulp Mills Research Program, CSIRO, Dickson, Australia
109. **Priha, Maarit** (1991); Toxic characteristics of effluents from bleached Kraft pulp mills, in **Crossland, Chris** [editor] *International Conference on Bleached Kraft Pulp Mills: Technical and Environmental Issues*, 4-7 February 1991, World Congress Centre, Melbourne, Australia, National Pulp Mills Research Program, CSIRO, Dickson
110. **Fandry, C B, R E Johannes and P J Nelson** (1989); *Pulp Mills: Modern Technology and Environmental Protection: Report to Senator the Hon. John Button, Minister for Industry, Technology and Commerce, Commonwealth of Australia*, Commonwealth Scientific and Industrial Research Organisation, June 1989

111. **Munkittrick, K R** and **G J van der Kraak** (1994); Receiving water environmental effects associated with discharges from Ontario pulp mills, *Pulp and Paper*, **95** (5), May 1994, Canada
112. **Cockram, Richard** (1994); Are they doing their best for the environment?, *European Papermaker* **2** (3), April 1994, Sweden
113. **The Women's Environmental Network** (1990); *op cit*
114. **Kondo, Tadahiro** (1993); Japan's Pulp and Paper Industry faces Dramatic Changes, *Paper & Packaging Analyst*, No **15**, November 1993, Pira International, UK
115. IIED (1994), **The Sustainable Paper Cycle**, IIED, London
116. **Kroesa, Renate** (1990); *op cit*
117. **Becker, J** (1988); *Paper Technology and the Third World: Economic conditions and technical alternatives for the production of cultural paper*, Eschborn JTZ
118. **Stolton, Sue** and **Nigel Dudley** (1994); *The Timber Trade in Russia: A Report to WWF UK*, Equilibrium Consultants, Bristol and Machynlleth
119. **Greenpeace** (1990); *No Time To Waste*, broadsheet produced by Greenpeace Canada, Vancouver
120. **Carey, J H**, **P V Hodson**, **K R Munkittrick** and **M R Servos** (1993); *Recent Canadian Studies on the Physiological Effects of Pulp Effluent on Fish*, Environment Canada, Ottawa
121. **International Labour Organisation** (1992); *Social and Labour Issues in the Pulp and Paper Industry*, ILO, Geneva
122. **Women's Environmental Network** (1989); *The Sanitary Protection Scandal*, London; and **National Swedish Environmental Protection Board** (1989); *Dioxins: A Programme for Research and Action*, Stockholm, Sweden
123. **McLaren, James** (1994); Bowater's Calhoun mill at center of fog-related highway pile-up dispute, *Pulp and Paper*, August 1994, San Francisco
124. **Women's Environmental Movement** (1990); *op cit*
125. **Krishnan, G V** (1994); Paper mill blamed for polluted water, *Times of India*, 7th March 1994, New Delhi
126. **Worldwatch Institute**, Washington DC
127. **Martinez, J L A** (1994); The papermaking sector in Spain, *Investment Technical Papers* **30** (120), 189-223 (in Spanish)
128. **Webb, Leslie** (1994); Green purchasing: forging a new link in the supply chain; *Pulp and Paper International* **36** (6), June 1994
129. **Postel, Sandra** and **John C Ryan** (1990), Worldwatch Institute
130. **Rathje, W** and **Murphy** (1992), *Rubbish: The Archaeology of Garbage*, New York
131. **Australian Government Publishing Service** (1990); *A Guide to the Use of Recycled Paper*, Canberra
132. **Mouyal, Pierre** (1994); Issue focus: Recycling, *Pulp and Paper*, April 1994, USA

133. **Rathje, W** and **Murphy** (1992), *Rubbish: The Archaeology of Garbage*, New York
134. *WWF's Global Forest Strategy*, (1994); WWF International, Gland
135. **Swanson, F J** and **J F Franklin** (1991); New Forestry Principles from Ecosystem Analysis of Pacific Northwest Forests, paper given to AAAS meeting, Washington DC 19th February 1991, submitted to *Ecological Applications*
136. *ibid*
137. **ITTO** (1993); *ITTO Guidelines for the Establishment and Sustainable Management of Planted Tropical Forests*, Policy Development Series **4**, ITTO, Yokohama, Japan
138. **Poore, Duncan** and others (1993) *Shell/WWF Tree Plantation Review: Guidelines*, Shell, London and WWF, Godalming
139. **Adeleke, 'Wale** (1993); *The Greening Concept: What Does it Really Mean?*, WWF International, Gland, Switzerland
140. **Forest Stewardship Council** (1994); *Principles and Criteria*, Oaxaca, Mexico
141. **Singh, Shekar** (1994); *personal communication* from WWF India
142. **Glasse, James** (1993); China's pulp and paper industry: the pace quickens, *Paper and Packaging Analyst* number **12**, February 1993
143. **Thomas, Bridget** (1993); Coming through the rye, *World Paper* **218** (12), December 1993
144. **Thivierge, Gail** and **Peter Sharman** (1993); China: Up for grabs, but at a price, *Pulp and Paper International* **35** (7), September 1993, 20-22
145. **Sadawarte, N S** (1995); Better technology needed to cleanup non-wood fibre, *Pulp and Paper International* **37** (6), June 1995
146. **Knight, Patrick** (1994); Benefits of bamboo blossom in Brazil, *Pulp and Paper International* **36** (9)
147. **Thomas, Bridget** (1993); Coming through the rye, *World Paper* **218** (12), December 1993
148. **Thomas, Bridget** (1993); Coming through the rye, *World Paper* **218** (12), December 1993
149. **Forrest, R** (1994); The troubled forest, *American Papermaker* **57** (4), 22-25
150. **Anon** (1993); Mill on a barge?, *Paper* **218** (5), p 6
151. **Valade, J, R Repetti** and **G D Braier**, Argentina: Its Pulp and Paper Industry, *Paper* **34**, 43-47
152. **Anon** (1989); Bagasse mill planned, *PPI This Week* **4** (28), p 4
153. **Ngamveng, J N** and **M Ndikontar** (1990); Pulping cassava stalks by the nitric acid process, *Cellul. Chem. Technol.* **24** (4), 523-530
154. **Anon** (1988); Mali mill project, *Paper* **210** (15), p 15
155. **Maeda, H** (1994); Sapporo collaborates to develop malt fibre paper, *JPI J* **32** (4), 4-8 (originally in Japanese)
156. **Granger, V** (1994); Moulin-vieux: wheat and sorghum in pulp, *Papeterie* no 179, pp 60-61

157. *ibid*

158. **Zhang, T-Y, S-Z Kuang, Y-S Wu, and Z Huan** (1993); The mechanism and technology of pulping of Chinese alpine rush, paper presented at the Seventh International Symposium On Woods and Pulping Chemistry, Beijing, China, 25-28 May 1993

159. **Eason, L** (1994); Fibre from flax and linseed - the problems and the possibilities, paper presented at a conference Non-Wood Fibres for Industry, at Silsoe, UK

160. **Easson, E** (1994); *op cit*

161. **Hanson, John** (undated); *An Outline for a UK Hemp Strategy*

162. **Anon** (1994); Jute for Bangladesh, *PPI This Week* **9** (22), p 4

163. **Anon** (1994); Thai experiences in pulp production using Kenaf, *Paper Asia* **9**, 33-38

164. **Kirschbaum, Miko U F** (1991); *Prospects for a kenaf-based pulp and paper industry in Australia*, Bureau of Renewable Resources, Bulletin number 9, Department of Primary Industries and Energy, Australian Government Publishing Service, Canberra

165. **Chabane, O** (1994); Tunisia makes good use of its own natural resources, *Pulp and Paper International* **36** (3), p 68

166. **Anon** (undated); *What Metsä Serla is Doing for the Environment*, Espoo, Finland

167. *ibid*

168. **Anon** (1994); Stora commits to secondary treatment at Port Hawkesbury, NS Newsprint mill, *Pulp and Paper Weekly* **16** (7), 3-4

169. **Allen, Julian** [editor] (1993); *Paper: European Databook 1994*, Benn Business Information Services Ltd, UK

170. **Dudley, Nigel** and **Sue Stolton** (1994); *The East Asian Timber Trade*, WWF UK, Godalming, Surrey

171. **Matussek, Heide, William Salvesen** and **John Pearson** [editors] (1993); *Pulp and Paper International: International Fact and Price Book 1994*, Miller Freeman, California

172. **IIED** (1994 draft); *The Sustainable Paper Cycle: Phase 1 Review Report*, IIED London

173. **Anon** (1994); new capacity planned for Pakistan, *PPI This Week* **9** (8), p 5

174. **Laitalainen, R** (1994); Thailand: The fibre issue, *Paper Asia* **9**, April 1994

175. Warner Campaign quoted in **Women's Environmental Network** (1990); *A Tissue of Lies? Disposable Paper and the Environment*, WEN, London; see also **Pollock, Cynthia** (1987); *Mining Urban Wastes: The Potential for Recycling*, Worldwatch Paper **76**, Worldwatch Institute, Washington DC, for references to recycling efficiency

176. **Pulp and Paper International** 1987 and 1988

177. **World Resources Institute**, Washington DC

178. **CJC Marketing Associates** (1995), Norwich, UK

179. **Virtanen, Yrjö** and **Sten Nilsson** (1993); *Environmental Impacts of Waste Paper Recycling*, Earthscan Books, London

180. **House of Lords Committee on the European Communities** (1993); *Packaging and Packaging Waste*, HMSO, London

181. **FAO** (1994); *op cit*