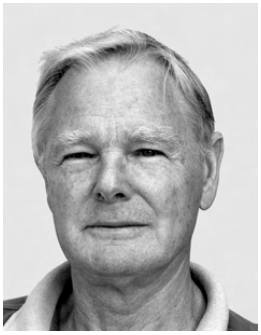
Supplying Forest Services and Products from Natural Forests and Plantations: Can We Meet the Challenge?

D.I. Bevege

Paper prepared for presentation at the "Forests, Wood and Livelihoods: Finding a Future for All" conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, August 16, 2005



Supplying Forest Services and Products from Natural Forests and Plantations: Can We Meet the Challenge?

D.I. BEVEGE

Email: ian.bevege@bigpond.com

Sensible and equitable use of the world's forests while ensuring sustainable delivery of forest-based goods and services devolves upon many interlinked social, economic, environmental and developmental issues. Increasing global population, rising standards of living with concomitant consumption of forest products, and widening expectations of the forests to provide environmental services and regulate water supplies, are placing huge demands on forest resources. While the yield from industrial and fuelwood plantations increasingly complements the harvest of wood products from native forests, the establishment of plantations is not offsetting the current rate of deforestation. Clearing for agriculture, often associated with uncontrolled logging and fuelwood collection, remains the major cause of net forest loss. Conversion of tropical forest to industrial plantations may have negative implications for biodiversity, but positive ones for carbon sequestration and wood production. Harvesting traditional non-wood forest products can have mixed outcomes on the forest, depending on the levels of exploitation and management.

DR IAN BEVEGE retired in 2002 after 30 years in professional forestry in Queensland and NSW, and 15 years in overseas aid management. From 1991 until retirement he was Principal Advisor with ACIAR from where he established the Center for International Forestry Research in Indonesia for the Consultative Group on International Agricultural Research. From late 1986 until mid-1991 he was an Assistant Director General with AIDAB (now AusAID) and Executive Director of AIDAB's Centre for Pacific Development and Training. His last domestic forestry appointment was as Chief, Wood Technology and Forest Research Division NSW Forestry Commission 1982–86. He was involved in planning and review of forestry aid projects in Fiji and China for FAO, ADAB and the World Bank. Forestry experience includes forest management, silviculture, nutrition and soils research, mining rehabilitation and research management. Postgraduate research extended over 5 years at UNE and CSIRO.

The level of exploitation of forest products is determined by need, demand and price. In general, forest commodity prices have steadily dropped over the last several years in line with many other commodity prices. This places pressure on producers to reduce costs, and this pressure is reflected in the level and effectiveness of forest management. Current forest valuation processes tend to ignore the value of forest services and goods other than wood; this leads to a restricted forest policy horizon and undervaluation of forests, and consequently to inappropriate pricing for goods and services and levels of investment in forest management. This situation is reflected in a lack of sectorally-integrated forest policies, run-down forest management authorities and inadequate R&D, and a lack of investment in training of staff. The capacity for ecologically sustainable forest management is inevitably severely compromised.

The international development community needs to take stock of what past development assistance in the forest sector has achieved. A paradigm shift is necessary, focussed on governance, forest policy and capacity building if the pressures on forests are to be met and the expectations of the global community realised.

Introduction

The world's forests face a challenge unprecedented in their long history. From where does this challenge come? Increasing global population, rising standards of living with concomitant consumption of forest products, a reducing forest resources base through deforestation, and increasing expectations of this shrinking forest to provide a wider suite of services and products are placing huge demands on remaining forests. The challenge lies in meeting these multiple and potentially conflicting demands while ensuring that the ecological integrity, functionality and productive capacity of the forests — fundamental to their sustainable use — are maintained. At the same time we need to ensure the equitable sharing of the benefits the forests provide. What are these beneficial goods and services provided by forests? How are these exploited? By whom? Who pays? Who benefits?

Development of forest management

Traditionally through human history forests have been regarded as a free good to be exploited as open-access resources, with all the elements of the tragedy of the commons that that connotes — lack of responsible management, over-exploitation, resource degradation and capture of benefits by powerful minorities. Perhaps the Romans were the first to attempt some form of forest regulation; the history of the mediaeval royal forests of Europe, essentially royal preserves excised from the commons for hunting, is well documented (Watkins 1998). The wooded areas of these hunting preserves evolved into managed forests, as we understand the term today, in the 18th century. This time coincided with the industrial revolution with its increased demand for charcoal — traditionally used for iron smelting (rapidly overtaken by coal) — and timber for ship building. The latter serviced the fighting navies of a Europe and Britain more or less continuously at war, and, as global trade became a practical reality, the burgeoning mercantile fleets. Trade in timber was significant from this period as forests in Europe were cut-over and regenerated. The forests of colonies in the Americas, Africa, Asia and the Pacific were exploited to make up the shortfall in European domestic production and to provide special-purpose timbers, e.g. mahogany from central America for furniture and ship building, white pine from New England for masts and spars, admiralty teak from India, Burma and Thailand for shipbuilding, Australian eucalypts for wharfage and railway construction. Red cedar and Norfolk Island pine were among the very first exports from the NSW colony in the 1790s, cedar developing a trade that remained very strong for the next hundred years. This early export trade, together with the pressures to clear forest land for agriculture and domestic demand for construction timber, laid the foundation for forest regulation and reservation of state forests in Australia towards the end of the 19th century. Ensuring a regular supply of cheap wood for domestic markets became the political imperative and major forest policy of all states for the next several decades, reinforced by the huge demands for timber created during and post two world wars.

Thus the evolution of modern forest policy and forestry practice in Australia mirrored wider global developments that had their genesis in the industrial revolution in Europe and formed the basis of the formalised system of forest ownership, policy, management, usage and trade we have today.

Since the Second World War, global community understanding and appreciation has developed of the wider role and functions of forests in providing services other than wood products. These include catchment protection and water supply regulation, biodiversity conservation, air quality regulation and associated carbon sequestration, and cultural services linked to amenity, recreation and the deep ecology movement. This increasing recognition translates into a demand for wider services that creates a major dilemma for generally under-resourced forestry authorities that have traditionally been tasked primarily with providing their communities with cheap and readily-available wood supplies. They are now expected to provide all these other goods and services under the rubric of their traditional management mandate, without concomitant financial resourcing to do so. Private forest owners are increasingly being subjected to the same pressures without any compensation by their communities for providing these wider public goods; these have become a cost to the wood production sector that in many instances now effectively cross-subsidises water, environmental and cultural services. Eventually these costs will be passed on through pricing mechanisms, indirectly in the public sector and more directly by private grow-

ers. Another community response is to zone forests for single rather than multiple use by changing tenure of wood production forests into conservation reserves. Some 12% of global forests (480 million ha) are now in such reserves. One outcome of this is to put further pressure on the remaining forests to provide the wood products demanded by the community. This can create scarcity of some products, with a consequent increase in prices, and unwittingly a more perverse outcome of a return to the old cut-out-and-get-out approaches that forest services everywhere worked so hard over the last century to replace with sustained yield management.

In the developing world, with a largely informal or poorly managed public forest sector, domestic and cross-border pressures on water supplies and international pressure from the industrialised countries for tropical forest conservation create difficulties for governments and their forest-dependent communities that are least able to turn to other endeavours — forest-based or not — as a source of livelihood. Even in a developed country like Australia, the Australian Bureau of Statistics estimates there are 61 'statistical local areas' economically dependent on forestry (BRS 2004). I will return to these aspects later when I consider forest valuation in the context of the multi-purpose nature of forests and the future role of development agencies in sustainable forest management.

Pressures from rising population and living standards

Global population presently is about 6.5 billion, having grown 2.6 times in the last 55 years from 2.5 billion in 1950. While annual growth has fallen in that period from 1.7% to 1.2% (and anticipated growth rates are even lower at 0.8%), the population is expected to reach around 8 billion by 2025. Global growth of GDP has been steady at 2–3% per annum over the last 25 years, i.e. it has been growing faster than population, and this is reflected in steadily increasing per capita GDP which has increased 5% per annum over the last 5 years (Table1). A consequence of this is greater buying power and pressure on resources, not the least being on traditional forest resources that provide a multitude of wood-based products, notably value-added building materials, panels, furniture and paper products. Not all parts of the world, however, share in this largesse — GDP base levels are extremely uneven and growth highly variable — and it is notable that those countries with continuing high rates of population growth are also those with chronically low and stagnant GDP and low consumption of processed wood products. Pressures on forest resources in these poverty-stricken countries are grounded rather in survival strategies associated with pressing needs for basic energy, food, shelter and income generation, frequently from non-wood forest products. Hence we have an immediate dichotomy in the level and nature of forest product consumption between the economies with middle to high incomes and those with low incomes.

The changing focus on delivery of forest services

The time span from now to 2025 is well within the current planning horizon of industrial forestry, being less than one cutting cycle for natural forests and about one sawlog rotation for plantations. However, as I have already pointed out, global community expectations from the forests do not lie solely in the supply of these conventional wood and non-wood-based products and fuel. Increasingly forests are being set aside from wood production for biodiversity conservation, a process stimulated by country obligations under the imprimatur of the Convention on International Trade in Endangered Species of Wild Flora and Fauna 1975 (CITES) and the Convention on Biological Diversity 1992 (CBD).

Table 1. Global population and income trends

Year	1950	1990	1999	2002	2003	2004	2015	2025
Population (billion)	2.52	5.25	6.0	6.2	6.27	6.34	7.10	7.82
Population growth (% y^{-1})	1.7		1.3	1.2	1.2		0.7	0.7
Global GDP growth (% y^{-1})	2.5	2.2	3.1	1.8	2.8			
GDP per capita ($US)			5117	5242	5794	6444		

Data from World Resources Institute (WRI 2000) and World Bank (2005)

Otherwise-laudable initiatives such as certification and labelling under various schemes, including the Forest Stewardship Council and the Montreal Protocol, aim to ensure that timber is sourced from sustainably managed forests. These protocols, however, have the potential for perverse outcomes for developing countries dependent on export of forest capital in the form of logs or primary processed products. Such countries may generate the foreign exchange necessary for their development through forest-based exports, but frequently do not have the infrastructure or skills capacity as yet for sustainable forest management. This is another aspect to which I will return later.

By their nature, forests and woodlands are in the better-watered regions of the world, and hence form the primary cover for water catchments, essential for purposes ranging from agricultural irrigation to urban water supplies and thus critical for all human endeavours. Increasingly, the real value of water is being recognised and reflected in water allocation and pricing policies. There is a growing recognition in developing countries of the role of forests in catchment protection and regulation of flow (e.g. ground-breaking water policies in South Africa which recognise plantations as users of water as well as protectors of catchments — South Africa 1997) and the need for appropriate restrictions on clearing and poor forest practices that compromise catchment function (e.g. the Natural Forest Protection Program and Sloping Land Conversion Program in China — Xu *et al.* 2001). However, as yet there is comparatively little pro-active forest management for water supply and, much less, recognition of the value of water as an economic product, in financing management of forested catchments. This, despite water being the major economic product of many forests, and even here in Australia, the driest continent with a highly urbanised populace (92%, FAO 2005). When such recognition is forthcoming we will see the debate among competing uses of the forest extended from the current one between biodiversity conservation and wood supply to include water, and a further vigorous debate on the nature of the forest cover best suited to optimise water supply values in terms of water yield, quality and flow regulation. These debates will be all the more vigorous and politically sensitive where forested catchments and major river systems cross sovereign or jurisdictional boundaries.

There is a major expectation that forests will provide a significant sink for greenhouse gases in a scenario of increasing levels of ambient carbon dioxide. While this is somewhat problematic for mature natural forests in which nett growth (and therefore carbon sequestration) is low, there is potential for regrowth forests and plantations with high growth rates to be significant carbon sinks. This is recognised by the Kyoto Protocol 2005 (UNCTAD 2005) whereby the Clean Development Mechanism (CDM) facilitates offset trading in carbon between producers of greenhouse gases, such as energy generators powered by fossil fuel, and growers of plantations. While there is still a long way to go in putting in place appropriate processes for the CDM to be effective, it does provide an incentive to establish large areas of man-made forests for this purpose. However, the extent to which these carbon offset plantations, on maturity, may participate in the global trade in wood products presents a conundrum on which the jury is still out. If such use is restricted, supply pressures on plantations established solely for wood production pre-Kyoto will be increased. If the CDM is perceived by investors to exclude carbon offset plantations from contributing to the wider traded wood supply, this may militate against their entering carbon offset arrangements in the first place, and hence have the negative effect of reducing significantly the value of the CDM as a strategy for reducing atmospheric carbon dioxide levels resulting from carbon-energy generation.

The global forest resource

The world's forests and woodlands in 2000 covered almost 3.9 billion ha, or around 30% of the total land area. The forest endowment, however, is very unevenly distributed across the continental landmasses and among countries with regard to area, forest type and potential productivity (Table 2).

Within Africa, Democratic Republic of Congo (DRC) has by far the largest forest resource in terms of both forest area (135 million ha, 21%) and growing stock (18 Gm^3, 39%). Angola and Sudan are next largest and together have about the same forest area as RDC but only 18% of the growing stock. South Africa has the largest area of plantations (1.6 million ha, 19% of total).

Table 2. Global distribution of forest resources, year 2000

Region	Africa	Asia *incl* Middle East	Europe *incl* Russian Federation	North & Central America *incl* Caribbean	South America	Oceania	World
Forest area (Mha)	650	548	1039	549	886	197	3869
Plantation area (Mha)	8	115	32	18	10	2.8	186
Standing volume ($m^3\ ha^{-1}$)	72	63	112	123	125	55	100
Standing growing stock (Gm^3)	46.5	34.6	116.4	67.3	110.8	10.8	386

Data from FAO (2005)

Within Asia, China, Indonesia and India account for 333 million ha (61%) of forest area and 19 Gm^3 (56%) of growing stock. These three countries also have the lion's share of the plantation estate (88 million ha, 76%) but Japan's plantation estate is also significant (10.6 million ha).

Within Europe, the old Soviet Union, now represented by the Russian Federation, Ukraine and Belarus, accounts for 870 million ha (87%) of forests; the six major forested countries of Western Europe (France, Spain, Germany, Italy, Poland and UK) have 62 million ha (6%) and Scandinavia (Sweden, Norway, Finland) 56 million ha (5.8%). On the plantation front the same groupings account for 22 million ha, 5 million ha and only 0.86 million ha respectively. Clearly the Russian Federation represents by far the major forest resource in Europe with 89 Gm^3 (76%) of the growing stock; the Euro group of six has 10 million m^3 (9%) and Scandinavia 5.6 Gm^3 (4.8%).

Within North and Central America, Canada and USA have most of the forest resources, sharing roughly equally some 471 million ha (86%) with 60 Gm^3 (89%) of the growing stock. USA has the only significant plantation resource, standing at 16 million ha (93%). Canada does not invest in plantations, the remaining areas being in Mexico and Central America.

Within South America, Brazil is far and away the leader in forest area with 544 million ha (61%). A further group of four countries bordering Brazil (Venezuela, Colombia, Peru and Bolivia) share roughly equally some 217 million ha (24%). Most of this forest lies in the Amazon basin. Their share of the growing stock is 71 Gm^3 (64%) for Brazil and 22 Gm^3 (20%) for the second group. In terms of plantation resources, Brazil (5.0 million ha) and Chile (2.0 million ha) are the major investors.

Oceania is a minor contributor to global forest resources, with only three countries having significant resources — Australia, Papua New Guinea and New Zealand. Productivity of native forests is relatively low, although plantation productivity is high. Australia has 154 million ha of forest, PNG 31 million ha and New Zealand 7.9 million ha. Plantation resources are 1.04 million ha, 0.09 million ha and 1.54 million ha respectively. Growing stock is 8.5 Gm^3 for Australia and 1.0 Gm^3 each for PNG and New Zealand.

Relatively few countries account for the major proportion of global forest resources, as both native forests and plantations.

The G10 for forest resources in year 2000 measured as growing stock were the Russian Federation, Brazil, USA, Canada, D R Congo, Peru, Australia, China, Indonesia and Japan. These same countries, with the addition of India, also had the largest forest areas (Table 3). However, the level of growing stock varies by a factor of 25 from Russia to Japan. Six of these countries also feature in the G10 for plantation area, the others being India, Thailand, Ukraine and Chile. Again the range is 22 fold within this group, from 45 million ha in China to 2.0 million ha in Chile. It is not surprising that most (but not all) of these countries also feature strongly, though not exclusively, in trade in wood-based products.

Deforestation and reforestation

While many countries participate in world trade, most do so to only a small extent. Many more practise deforestation, an activity in human endeavour since the birth of agriculture.

Table 3. Country ranking of forest resources, year 2000

Country	Forest area (Mha)	Plantation area (Mha)	Productivity (m^3ha^{-1})	Standing growing stock (Gm^3)
Russian Fed	851	17.3	105	89.1
Brazil	543	5.0	131	71.2
USA	225	16.2	136	30.8
Canada	245	0.0	120	29.3
D R Congo	135	0.10	120	17.9
Peru	65.2	0.64	158	10.3
Australia	154	1.0	55	8.5
China	163	45.1	52	8.4
Indonesia	105	9.9	79	8.2
Japan	24.1	10.7	145	3.5
India	64.1	32.5	43	2.7
Chile	15.5	2.0	160	2.5
Ukraine	9.6	4.4	179	1.7
Thailand	14.8	4.9	17	0.25

Data from FAO (2005)

With a few notable exceptions, forest soils also tend to be the best agricultural soils. While clearing for agriculture is not the only cause of deforestation, it is the primary driver.

Deforestation rates have increased since the Second World War following burgeoning population growth with its rapid expansion of agriculture, urbanisation, transport infrastructure and industrial development. The consequence of this has been the estimated reduction of global forest cover by the early 1980s by 16%, a figure since modified by FAO to around 20% (WRI 2000). The net loss of forest cover over the period 1975–85 was estimated at 83 million ha (Mather 1990) and from 1990–2000 at 94 million ha (FAO 2005), representing a current annual rate of change of around 9 million ha or 0.2% of forest cover. While this may seem on the surface a low figure at the global scale, continuation at this rate would see total global deforestation halfway through this third millennium. Actual clearing of natural forests in the tropics during the 1990s has been estimated at 15 million ha annually (FAO 2005). The establishment of plantations for industrial wood, fuelwood, protection and amenity reconciles the difference between clearing and net forest loss.

At the regional level, net forest loss is greatest in Africa and South America, accounting for 95% in terms of absolute area of forest; the rate of loss continues to be high (Table 4).

Hotspots for deforestation are Brazil, Indonesia, Sudan, Zambia, the countries peripheral to the Amazon basin, Central America and Myanmar. While net forest loss is also the case for Asia, North/Central America and Oceania, the rate of loss is far lower, at least on a regional basis. Europe is the only region that shows reforestation over the period, and this is pervasive among all countries. China also shows a significant net forest gain for the decade. Rate of loss is as high as 2.4% annually in those countries that are comparatively well endowed with forest, but goes even higher in many Small Island Developing States (SIDS), e.g. 4.5% in Micronesia and 5.7% in Haiti.

Table 4. Net forest loss for period 1990–2000; major country sources

Region or country	Forest loss or gain ($k\ ha\ y^{-1}$)	Annual rate (%)	Rural population (%)
Africa	**–5262**	**–0.8**	**61.3**
Sudan	–959	–1.4	61.1
Zambia	–851	–2.4	64.3
Dem. Rep. Congo	–532	–0.4	68.4
Asia	**–364**	**–0.1**	**61.2**
Indonesia	–1312	–1.2	54.4
Myanmar	–517	–1.4	70.6
China	+1806	+1.2	61.4
Europe	**+881**	**+0.1**	**27.0**
N & C America	**–570**	**–0.1**	**24.1**
Mexico	–631	–1.1	24.5
Central America	–341	–2.0	49.2
USA	+388	+0.2	19.9
South America	**–3711**	**–0.4**	**18.9**
Brazil	–2309	–0.4	16.9
Colombia, Venezuela, Peru and Bolivia	–838	–0.4	22.0
Oceania	**–365**	**–0.2**	**26.9**
Australia	–282	–0.2	8.0
PNG	–113	–0.5	86.8
New Zealand	+39	+0.5	14.1
World	**–9382**	**–0.2**	**51.7**

Data from FAO (2005)

While a first approximation may be that countries with high rural populations are those demonstrating high deforestation rates, there is no such simple relationship, as reference to Table 4 will attest. High rates of deforestation in countries such as Brazil and Indonesia can be ascribed to increased establishment of large industrialised agriculture and commodity plantations such as oil palm. In Central America, Africa and Oceania, small-holder agricultural development is the driver, sometimes aggravated by fuelwood collection. In SIDS, urban development pressures are paramount. By contrast China, Europe and USA all show net increases in forest area over the decade, a trend possibly related to the high level of non-rural economic development as distinct of the absolute level of rural population.

We have already seen (Table 3) that only ten countries account for 148 million ha or 79% of the global plantation resource. The global net planting rate in the mid-1990s (latest data available, Brown 2000) was estimated to be around 6 million ha y^{-1}, two-thirds of which were industrial plantations and one-third for fuelwood, protection and non-wood forest products. The planting rate is insufficient (in area terms) to compensate for clearing in most countries with the exception of Europe, USA, China, New Zealand and the Middle East, all of which show a net gain in forest area. Brazil and Indonesia, which feature prominently on the deforestation table, also have large forest plantation programs, but these do not offset the rate of areal deforestation. Although limited in area, however, this reforestation may compensate in terms of wood production because of the higher productivity of plantations compared to natural forests.

The ability of the growing plantation estate to contribute to the wood resource will depend on the long-term sustainability of its productivity as an ecosystem. As Nambiar has pointed out (Nambiar 1996), this is not the same thing as sustained timber yield. Four aspects will require careful and knowledgeable management to assure long-term plantation productivity: management of pests and diseases (Speight and Wylie 2001; Old *et al*. 2003); management of forest soils, nutrition and water use (Nambiar and Brown 1997); management of species adaptation through selection and genetic improvement to compensate for any imputed climate change; and mitigation of fire and air pollution impacts. With regard to the climate change factor, planning should be initiated now, as according to some of the climate modelling, significant climate change and consequent physiological stress may be experienced by plantations already in the ground by the time they reach rotation age. Pioneering work by Trevor Booth of CSIRO on species homoclime modelling (Booth 1994) has provided a useful tool for predicting the reaction of species to possible changing climatic scenarios and the potential for species substitution.

Mention must also be made of the actual and potential contribution to the global plantation estate of the so-called 'new woods' — rubber, coconut, oil palm and bamboo. By 1999 it was estimated that there were 24 million ha of rubber, coconut and oil palm plantations in Asia alone (Durst *et al.* 2004). Oil palm and rubber are concentrated in Indonesia, Malaysia and Thailand. There are about 14 million ha of bamboo forests in India and China, possibly a quarter of which are managed intensively as plantations for construction and papermaking. These 40 million ha (approximately) of new-wood plantations are not included in FAO's forest plantation statistics as yet, but it is only a matter of time because of the increasing importance of these plantations as a wood resource, comprising as they do around 17% of the total plantation estate. Rubberwood harvest in SE Asia now exceeds 6 Mm^3 per annum and is worth around US$1.5 billion in furniture exports to Malaysia and Thailand (Durst *et al.* 2004). In passing it should be mentioned that the high deforestation figures for Indonesia, and to a lesser extent Malaysia, are caused by clearing for conversion to these industrial commodity plantations.

Production and trade in wood-based products

Total wood removals from forests in year 2002 were 3.4 Gm^3, 53% of which were fuelwood (Table 5, FAO 2005). This reflects a relatively stable position over the last 12 years as both fuelwood and industrial wood removals have declined fractionally by 0.3% in each instance, despite a global population increase of 18% in that time. However, FAO predicts a small rise (3%) in fuelwood consumption, particularly in Asia, over the 20 years to 2020 (FAO 2005).

Table 5. Production and external trade in primary forest products, year 2002 (Mm^3)

Region	Fuelwood			Industrial roundwood		
	Production	Imports	Exports	Production	Imports	Exports
Africa	546	0	0	67	0.4	5.5
Asia	782	0.3	0.02	223	51.3	8.0
Europe	107	2.0	3.3	480	57.1	71.9
North & Central America	159	0	0	615	14.2	16.0
South America	190	0	0	153	0.04	2.7
Oceania	13	0	0	50	0.12	11.4
World	1797	2.5	3.7	1588	123	116

Data from FAO (2005)

Current removals comprise 0.88% of total growing stock or 0.87 $m^3\ ha^{-1}y^{-1}$ — 1.0 $m^3\ ha^{-1}y^{-1}$ if due account is taken of conservation forests unavailable for harvest (and neglecting for the moment the widespread illegal logging that takes place in such reserves). At the highest level this is a cut that is within the capacity of global forests to sustain as annual increment is estimated at 1.5 $m^3\ ha^{-1}$ (Oliver 2005). More particularly, industrial wood will increasingly be sourced from the steadily growing plantation estate with growth rates of up to 30 times this rate of removal. This superficial analysis is of course a gross oversimplification, given that it ignores issues of land tenure and property rights, the increasing proscription in conservation forests of timber cutting, variance in productivity and intensity of cut among forests, limited practice of managed forestry and cutting cycles, badly managed logging operations often associated with illegal logging and widespread timber mining that compromise regenerative capacity and site stability, disease risk, degradation of forest and woodland environments through fuelwood collection, fire and air pollution, and of course deforestation for other land use (agriculture, urbanisation and infrastructure) that is reducing forests by some 9 million ha y^{-1}. Increasingly we can expect to see further restriction of access to natural forests for industrial forestry for all the reasons discussed earlier in this paper. The point is made, however, to illustrate that any future inhibition of the forest's capacity to provide the global community's wood resources is not so much an issue of potential sustainable productivity, rather it is one founded in ensuring an adequate forest resource under sustainable management, sound socio-economics and community cultural values.

In time, if global demand for all wood uses stabilises at around the 3–4 $Gm^3\ y^{-1}$ mark, such a wood volume might conceivably be supplied from around 350 million ha of sustained-yield plantation forests with due allowance for continued production of high-value specialty products from natural forests. Such a plantation resource would be around 10% of present total forest area and three times the current total combined industrial/commodity plantation area, or something less than the area currently devoted to global wheat production (estimated from ABARE 2005). As an indicator of moves in this direction, Australian plantations comprise only 1% of the forest resource but now provide 60% of the cut and 50% of domestic timber needs (BRS 2005; DIPNR 2005). Wood price, potential for species substitution in wood use and comparative economic advantage in supply will determine the scope and nature of future wood forms, sources and markets, and the countries which remain as significant producers and processors of forest products. The forest production sector is normally divided into several product categories for reporting purposes, reflecting the chain of production and conversion to value-added products. The main categories are fuelwood, industrial roundwood, sawnwood, panels, pulp and paper, furniture and specialty building products. However, for our purposes this paper will restrict discussion to the primary products — fuelwood and industrial roundwood — as these have greatest immediate impact on the forest. All other categories ultimately are derived from industrial roundwood.

Fuelwood

Wood-derived energy provides 5% of the world's total primary energy supply as fuelwood, charcoal or liquid fuels such as ethanol and black liquor

from pulp processing (FAO 2005). Black liquor use will increase in those countries with expanding pulp industries. Fuelwood remains the dominant source; demand is high and provides the primary energy source for over 2 billion people (WRI 2000). Although productivity is low, social and economic importance is high in least developed economies. Wood is used directly as fuel or converted to charcoal for sale in urban areas. Much fuelwood is scavenged from logging operations or clearing for agriculture, or harvested from woodlands where this practice can be a factor in land degradation. Some is sourced from plantations, but single-use fuel plantations have been shown to be uneconomic and have fallen from favour. There is practically no external trade in fuelwood except in Europe, where Russia is a significant exporter (about 1 Mm^3 or 2% of production).

Over 50% of all forest removals are as fuelwood, and these are greatest in Africa and Asia. Ethiopia, Nigeria, D. R. Congo and Uganda account for 46% of African fuelwood removals. Other heavy users, accounting among them for 20%, are Ghana, Kenya, Tanzania, Sudan, Egypt and Mozambique. India and China are by far the largest fuelwood users in the world, and with Indonesia utilise 73% of Asia's fuelwood. Brazil and USA are the largest users in the Americas (60%), being an order of magnitude greater than any other country on the two continents. Despite its huge forest resources, Canada reports comparatively little use of fuelwood. Brazil is the heaviest global user after China. The Russia Federation is by far the largest producer and user in Europe. In summary, the G11 fuelwood users are India (16.7%), China (10.6%), Brazil (7.5%), Ethiopia (5.0%), Indonesia (4.6%), USA (4.1%), D. R. Congo (3.7%), Nigeria (3.1%), Russia (2.7%), Myanmar (2.0%) and Uganda (2.0%). Among them they account for 62% of the world's fuelwood use. These countries cover the full gamut from least developed through emerging to highly industralised economies, emphasising that fuelwood is an all-pervasive and significant bio-energy source, the use of which is not restricted to poor rural communities in least developing countries.

Industrial roundwood

Of industrial wood production, 69% is centred on North America and Europe, followed by Asia (14%). Despite their significant forested areas (40% of global), South America (9.6%) and Africa (4.2%) provide together only another 14% of production. Oceania (3.1%) is a relatively minor producer on the world scene.

Within Africa, the three largest roundwood producers are South Africa, Nigeria and D. R. Congo; South African production is mainly plantation softwood, whereas the others are producing tropical hardwoods from natural forests. The export trade in roundwood is now low (8%), and has not been replaced by exports of sawnwood from local processing. Exports tend to be of high-value speciality timbers into niche markets.

Within Asia, the situation is very different. Major producers are China, Indonesia, India, Malaysia and Japan. There is a vigorous trade in logs involving all of these countries plus Myanmar. Some 23% of roundwood consumption is imported and 8% of production exported within and beyond the region. China and Japan are the processing powerhouses of the region, both with significant log imports and trade in processed products.

Within Europe, production is high and there is strong cross-border trade within the region of roundwood and processed products. The exception is the Russian Federation that exports significant quantities of roundwood to China, and in fact is now the major timber product supplier to China (Sun *et al*. 2004).

Within North and Central America, most trade is in processed products involving USA and Canada, with roundwood imports balanced by exports. Much of the roundwood trade is cross-border between these two countries.

Within South America, roundwood production is relatively low and comparatively little of it enters into trade. There is some export of speciality hardwoods such as mahogany, and of sawnwood. The large private eucalypt pulpwood plantations in Brazil are now beginning to impact on global pulp markets, with exports about half those of the level of the USA and three times those of New Zealand.

Within Oceania, Australia and New Zealand are the only major producers. Australia exports about 4% of roundwood production, whereas New Zealand exports around 34% of its production, mainly as plantation softwood. Both export processed wood products including sawnwood, pulp and paper, some of which is cross-Tasman trade.

Overall only about 7% of industrial roundwood production enters into world trade. This is a low figure compared to that for processed wood products, where 30% of sawnwood, 33% of panels, 21% of paper pulp and 30% of paper are traded. The major actors in these highly developed markets are the industrialised countries of Europe, North America with Japan plus the emerging economies of China and India, Indonesia, Malaysia, South Korea and Brazil. No African country has yet developed sufficient capacity for wood processing and value adding to enable it to enter world trade in any significant way apart from South Africa, which exports paper at around the same level as Australia (600 000 t y^{-1}). However, wood processing and value adding are important to local economies of developing countries. The forestry and forest products industries globally has consistently contributed 2% to GDP since 1990, although in year 2000 this figure fell to 1.2%; in South America it was 2.1%, Africa 1.5%, Asia 1.1%, Europe 1.2%, North America and Oceania 1.3%. This apparent decline paralleled reductions in agricultural activity as a proportion of GDP as economies have developed their industrial and service sectors and increased their productivity overall. However, the sectoral contribution has recently bounced back to 2% (Andrian *et al.* 2005).

Non-wood forest products (NWFP)

Space does not permit a comprehensive assessment of NWFP to the global forest economy. Their contribution to incomes of local communities in developing countries is important, but this is insufficient to lift communities out of subsistence. Increasingly NWFP are entering into global trade, placing pressures on the resource for income generation. Import value in 2002 was US$8 billion, an increase of 50% since 1992 (FAO 2005). Sustainability of production is problematic, as is the long-term contribution of NWFP to rural livelihoods given much harvest is uncontrolled either formally through government regulation, or socially at the community level as NWFP are often regarded as open-access resources. Many forest areas traditionally used for gathering NWFP by forest-dependent communities are being converted to other uses, e.g. commodity and industrial wood plantations in Asia, and this provides no incentive for their sustainable management as a NWFP resource. However, domestication and cultivation of NWFP on farms is growing apace, and agroforestry provides one positive strategy whereby NWFP may be produced in an economically sustainable way while fulfilling social needs and contributing to improved livelihoods.

Conclusion — can we meet the challenge?

The existing global forests are coping with the demands placed on them for wood-based products under current pricing and trading arrangements, and utilisation/processing patterns, but at a cost that they may not be able to bear in the long term. Hot spots are developing in the demand for wood-based products that are placing pressures on traditional suppliers, e.g. the recent emergence of a still-rapidly-growing China as the largest single market for industrial wood products, and the increasing global demand for paper products. These industrial pressures emanate from increasing demand and the changing nature of that demand, associated with rising populations and standards of living. Additional strong pressures continue in much of the developing world through deforestation and forest degradation, and globally through the setting aside of conservation reserves. The outcome of these combined effects is to shrink the effective size of the overall forest resource (not forgetting that fuelwood represents over half the annual forest product removals) and that available for commercial forestry. Meeting the demand for wood products from this shrinking resource has implications for the intensity of harvesting, including heavier cuts and shortened cutting cycles. This in turn has implications for maintaining the long-term productivity of the forests and their ability to provide those other critical forest goods — water, and environmental and cultural services.

It may seem somewhat paradoxical therefore that in this situation of apparently-reducing forest resource availability, wood commodity prices have remained relatively stable or have even dropped. Why hasn't the market responded to reduced forest availability by raising prices and thence putting a brake on demand? Inequitable raw material cost minimisation strategies adopted by industry are part of the answer; illegal logging depresses prices by 7–19% (Seneca Creek Associates *et al.* 2004). However, it may also lie in the lack of any simple relationship between gross forest area and wood availability, particularly now that the plantation sector is providing an increasing proportion

of industrial feedstock. That it continues to do so is fundamental to strategies to ensure the long-term supply of industrial wood and fuelwood. This will require further investment in plantations and in R&D to provide improved technologies for their management and for the processing of wood products. Another factor may be the insecure property rights attached to many forest enterprises that discourage investment and encourage a flood of cheap wood that keeps prices down and demand high. Governments seeking to ensure a continuing forest estate might start with promulgating policies aimed at securing forest tenure and providing incentives for owners and concession holders to practise improved forest management. That this may result in less wood flowing into markets at prices more equitable to growers may not necessarily be a bad thing if it also means that the overall capacity of the forest to provide non-wood services is thereby enhanced.

The challenge for the global community is to continue to be able to satisfy its wood needs while maintaining the capacity of forests to provide, in a sustainable way, the wood and other products and services expected from them. Leslie (2005) has estimated that, by 2040, the demand for environmental services may treble, while that for wood-based products will probably remain stable due to improving utilisation technologies. The key point, however, is that the value of the former might be 16 times the latter, and this relativity may eventually be translated into policy settings and funding priorities for forest management. This presupposes a sufficient forest resource functioning effectively at an adequate level of primary productivity and ecological integrity, and managed by the world's foresters for sustainable multiple outputs. As Sadanandan Nambiar (2003) has pointed out, 'sustained productivity is the foundation of sustainable forestry business, even when forestry systems are managed for environmental services because productivity drives key ecological processes'. To reiterate these multiple outputs: they include wood, NWFP, water, human livelihood, biodiversity, carbon sequestration, clean air, amenity and culture. These outputs will not necessarily be produced simultaneously in time or space on any individual forest, so part of the challenge is to meet the total global expectation from the summation of a multiplicity of segmented outputs separated in time and space. This will require a forestry that is geared to multi-purpose use and prioritisation of management objectives to ensure that the mix of products and services are provided such that they meet all community needs and expectations in an economically and socially rational way. This will also require a balance of local, national and global needs and expectations, not an easy task when these needs and economic development imperatives differ among communities that cover the spectrum of Maslow's hierarchy of needs (Maslow 1970).

A critical role of the international community, through the processes of its multilateral organisations including FAO, ITTO, the UN Conference on Environment and Development, the Convention on Biological Diversity, the Convention to Combat Desertification, the UN Forum on Forests and the Kyoto Protocol, is to recognise these differences and ensure that the normative protocols put in place for global governance have, at their core, equity among equals. The Millennium Declaration 2000 recognises that 'in addition to our separate responsibilities to our individual societies, we have a collective responsibility to uphold the principles of human dignity, equality and equity at the global level' (Art. I 2, United Nations 2000). Two of the Millennium Declaration's goals are directly relevant to global forest management — eradication of extreme poverty and ensuring environmental sustainability. UNFF-5 recently reiterated the commitment to the Millennium Declaration and extended the latter's goals into several forest-specific goals concerned with restoring forest cover, enhancing forest-based benefits, increasing the area of protected and sustainably managed forests and the products therefrom, and reversing the decline in official development assistance and mobilising new and additional finances for sustainable forest management (UNFF 2005).

The financial investment necessary to ensure the integrity and sustainable development of the world's forest will only be forthcoming when there is recognition of the real value of the products and services from the forest, including the economic value of commonly-regarded free goods such as water and clean air and of intangibles such as biodiversity, amenity and culture. Forest valuation for timber products is well developed but such is not the case for the other goods and services. The pioneering work of David Pearce *et al*. (1989) on environmental economics and followed up by him and others in the context of sustainable forest management (Adamowicz *et al.*

1996; Tacconi and Bennett 1997; Kant 2003) and locally for eucalypt plantations in Queensland by Tyron Venn (Venn 2003) has yet to bear substantial fruit in the form of concrete action by economists and policy-makers to translate appropriate techniques for forest valuation into the economic planning context. Even less have we been able to convince the polity that valuating all forest goods and services is essential to sound forest policy formulation.

Appropriate holistic forest policy settings at global and national levels, aimed at ensuring sustainable forest management and orderly and equitable provision of the benefits flowing from the utilisation of forest goods and services, will be to no avail unless there is adequate technical and professional capacity for multi-purpose sustainable forest management and for conducting the long-term strategic R&D essential to underpin that management. Furthermore 'research must continue to seek ways of improving forest management, and ways for measuring and valuing tradeoffs between different components of sustainability' (Nambiar 2003). Because traditional forestry training focussed largely on forest management for timber production, training in management for other forest products and services will need strengthening, but this will not substitute for traditional forestry training. It is also necessary to improve our ability to undertake the supporting multidisciplinary and transdisciplinary R&D. Capacity is a particular issue for developing countries, where disinvestment in training and capacity building for forest management and research has reached serious proportions (Temu *et al.* 2005). Weak institutions and forest policy, and poor governance in many instances, exacerbate the situation. Chronic budgetary shortfalls, lack of strong corporate investment in forestry as distinct from harvesting and processing, and singular lack of interest in sustainable forest management by the donor community, also contribute to a worsening situation in developing countries. Limited donor support does go to international forest research via CGIAR into CIFOR and ICRAF, and into associated centres such as INBAR, CATIE and CABI, but little of this investment tackles the issues of production forestry in its broadest sense as explained in this paper. Donor funding of forestry at the bilateral level is minimal. Donors do show some interest in the politically safe environmental issues but have very largely dodged the hard ones associated with production forestry because of green pressures on the polity. The paradox is that unless the true value of the forest is recognised and there is a real market for *all* its products and services, forest owners, including governments, will continue to liquidate their forests for capital investment in other pursuits perceived to be more lucrative.

Aid programs have an important complementary role alongside other global initiatives to improve the state of the world's forests and their productive capacity. There is a need to generate forestry assistance strategies based on a multi-pronged attack on the issues of sustainable forest management, and not resile from the challenges involved. This might be done by:

- *First*, recognise the multi-functionality of forests and place forest sustainability high on the development agenda. Despite reservations as to their effectiveness, support multilateral instruments for improving forest policy and governance, such as those of UNCED, UNCSD, UNFF and Kyoto. This support should complement much stronger government commitment to UN institutions such as FAO and UNDP, and ITTO and IUFRO.
- *Second*, recognise the legitimacy of the essential dichotomy between the forest subsistence sector providing livelihoods of forest-dependent peoples and the production forestry sector. Both are necessary elements of any global strategy for sustainable forest management. Build greater complementarity between the two, so that both can operate economically and sustainably.
- *Third*, encourage development of holistic forest policy and support management of forests for provision of multiple goods and services, funding research efforts to quantify and valuate these so that the global community has a better appreciation of the socio-economic value and utility of forests that will be translated into more realistic and defensible forest policies.
- *Fourth*, support institutional strengthening and capacity building for multiple-purpose forest management and R&D in developing countries.

The challenge of course is not only to the donor community, but also to national governments, their institutions and the private sector to raise the bar in their own approaches to forest policy and management for the benefit of their own and the global community. This includes paying more than lip service to the ideal of sustainable forest development, honesty and equity in forest-based trade arrangements, and technical cooperation and open information exchange. Most importantly, we must ensure that those charged with management of the forests are well equipped technically and professionally through their training, are adequately resourced, and operate in an appropriate holistic forest policy environment that has strong consensus support in the community.

References

ABARE 2005. *Australian Commodities Wheat Outlook.* Australian Bureau of Agricultural and Resource Economics. www.abareconomics.com

Adamowicz, W.L., Boxall, P.C., Luckert, M.K., Phillips, W.E. and White, W.A. 1996. *Forestry, Economics and the Environment*. CAB International, Wallingford, UK, 275 pp.

Andrian, G., Essmann, H.-F., Pettenalla, D. and Vantomme, P. 2005. Influence of globalisation on forests, forestry and the environment. XXII IUFRO World Congress 8–13 August, Brisbane Australia. *International Forestry Review* **7,** 293.

Booth, T.H. 1994. Determining the climatic requirements of trees suitable for agroforestry. *Climatic Change* **27,** 93–102.

Brown, C. 2000. *The Global Outlook for Future Wood Supply from Forest Plantations*. Global Forest Products Outlook Study Working Paper Series GFPOS/WP/03, FAO, Rome, 141 pp.

BRS 2004. *Australian Forests at a Glance*. Bureau of Rural Sciences, Canberra, 68 pp.

BRS 2005. *Australian Forests at a Glance*. Bureau of Rural Sciences, Canberra, 68 pp.

DIPNR 2005. *Review of the Plantations and Reafforestation Legislation*. Discussion Paper June 2005. NSW Department of Infrastructure, Planning and Resources, Sydney.

Durst, P.B., Killman, W. and Brown, C. 2004. Asia's new woods. *Journal of Forestry* **102**(4)**,** 46–53.

FAO 2005. *State of the World's Forests 2005*. FAO, Rome, Italy, 153 pp.

Kant, S. 2003. Extending the boundaries of forest economics. *Forest Policy and Economics* **5,** 39–56.

Leslie, A. 2005. What will we want from the forests? *ITTO Tropical Forest Update* **15**(1)**,** 14–16.

Maslow, A.H. 1970. *Motivation and Personality*. 2nd edition. Harper & Row, New York, USA.

Mather, A.S. 1990. *Global Forest Resources*. Belhaven Press, London, 341 pp.

Nambiar, E.K.S. 1996. Sustained productivity of plantation forests is a continuing challenge to tree improvement. In: Dieters, M.J., Matheson, A.C., Nikles, D.G., Harwood, C.E. and Walker, S.M. (eds) *Tree Improvement for Sustainable Tropical Forestry*. Proceedings QFRI-IUFRO Conference, Caloundra Queensland Australia 27 October – 1 November 1996. Queensland Forest Research Institute, pp. 6–18.

Nambiar, E.K.S. 2003. Science and technology for sustainable development of plantation forests. *Australian Forestry* **66,** 43–50.

Nambiar, E.K.S. and Brown, A.G. 1997. *Management of Soil, Nutrients and Water in Tropical Plantation Forests*. ACIAR Monograph 43, ACIAR, Canberra, 571 pp.

Old, K.M., Wingfield, M.J. and Zi Qing Yuan 2003. *A Manual of Diseases of Eucalypts in South-East Asia*. Center for International Forestry Research, Bogor, Indonesia, 98 pp.

Oliver, C.D. 2005. A working definition of sustainable forest management (SFM): means of achieving and monitoring SFM, and opportunities gained by providing it. XXII IUFRO World Congress, 8–13 August, Brisbane Australia. *International Forestry Review* **7,** 234.

Pearce, D., Markandya, A. and Barbier, E.B. 1989. *Blueprint for a Green Economy*. Report for UK Department of Environment. Earthscan Publications, London, 192 pp.

South Africa 1997. *White Paper on Water Policy*. 30 April 1997. www.polity.org.za

Seneca Creek Associates, LLC and Wood Resources International 2004. *'Illegal' Logging and Global Wood Markets: The Competitive Impacts on the U.S. Wood Products Industry*. Seneca Creek Associates, Poolesville, Maryland, USA.

Speight, M.R. and Wylie, F.R. 2001. *Insect Pests in Tropical Forestry*. CAB International, Wallingford, UK, 307 pp.

Sun Xiufang, Katsigris, E. and White, A. 2004. The China forest products trade: overview of Asia-Pacific supplying countries, impacts and implications. *International Forestry Review* **6,** 227–236.

Tacconi, L. and Bennett, J. 1997. *Protected Area Assessment and Establishment in Vanuatu: A Socioeconomic Approach*. ACIAR Monograph No. 38, ACIAR, Canberra, 180 pp.

Temu, A.B., Rudebjer, P.G., Kiyiapi, J. and van Lierop, P. 2005. *Forestry Education in Sub-Saharan Africa and Southeast Asia: Trends, Myths and Realities*. FAO, Rome, Italy, 34 pp.

UNCTAD 2005. *Kyoto Protocol.* http://r0.unctad.org/ghg/sitecurrent/carbon_mi/kyoto

UNFF 2005. *Report of the Fifth Session United Nations Forum on Forests 14–27 May*. UN Economic and Social Council Official Records, 2005 Supplement 22, 33 pp.

United Nations 2000. United Nations Millennium Declaration. General Assembly Resolution 55/2, September 2000. www.//un.org/millennium/declaration/ares552e.htm

.

Venn, T.J. 2003. Financial and economic performance of long-rotation hardwood plantation investments in Queensland, Australia. *Forest Policy and Economics* **7,** 437–454.

Watkins, C. 1998. Themes in the history of European woods and forests. In: Watkins, C. (ed.) *European Woods and Forests: Studies in Cultural History*. CAB International, Wallingford, UK, pp. 1–10.

World Bank 2005. *World Development Indicators 05*. www.worldbank.org/data/wdi2005

WRI (World Resources Institute) 2000. *World Resources 2000–2001: People and Ecosystems*. World Resources Institute, Washington, DC USA, 389 pp.

Xu Jintao, Katsigris, E. and White, T.A. 2001. *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and Policy Recommendations*. CCICED Task Force on Forest and Grasslands. China Forestry Publishing House, Beijing, China, 98 pp.