



# THE FORESTS DIALOGUE

## TFD STEERING COMMITTEE

**Mubariq Ahmad**  
World Wildlife Fund  
Indonesia

**Steve Bass**  
Department for International  
Development  
United Kingdom

**David Cassells**  
The World Bank  
United States

**James Griffiths**  
World Business Council for  
Sustainable Development  
Switzerland

**Claes Hall**  
Aracruz Celulose  
Brazil/Sweden

**Sharon Haines**  
International Paper  
United States

**Matti Karjula**  
Stora Enso  
Finland

**Tage Klingberg**  
University of Gävle  
Sweden

**Thor Lobben**  
Norske Skog  
Norway

**Stewart Maginnis**  
World Conservation Union  
(IUCN)  
Switzerland

**Cassie Phillips, TFD Co-Leader**  
Weyerhaeuser Company  
United States

**Per Rosenberg**  
Global Forest & Trade Network  
(WWF)  
Sweden

**Stephan Schenker**  
Private Forest Owners Association  
Austria

**Robert Simpson**  
American Forest Foundation  
United States

**Nigel Sizer**  
The Nature Conservancy  
Indonesia

**Roberto Smeraldi**  
Friends of the Earth  
Brazil

**Manoel Sobral**  
International Tropical Timber  
Organization  
Japan

**William Street, Jr.**  
International Federation of  
Building and Woodworkers  
Switzerland

**Gudmund Vollbrecht**  
IKEA  
Switzerland

**Scott Wallinger**  
MeadWestvaco Corporation  
United States

**Justin Ward, TFD Co-Leader**  
Conservation International  
United States

**Amelia Wright**  
Maryland Private Forest Owner  
United States

**Alexey Yaroshenko**  
Greenpeace  
Russia

**Gary Dunning**  
Executive Director  
The Forests Dialogue

## Intensively Managed Planted Forests

Professor Peter Kanowski - The Australian National University  
June 2005

*Note: In preparation for TFD's scoping dialogue on IMPF's, the Steering Committee of TFD asked Dr. Kanowski to write a brief report covering the current trends and major stakeholder perspectives on this important issue. The following is a result of his work. TFD is very grateful to Dr. Kanowski for his excellent contribution to this effort.*

### Introduction

Plantation forests - even-aged stands of a single tree species established primarily for wood production - are one of the defining features and, against many criteria, one of the successes of forestry in the past century. Plantation forest extent increased from negligible to c. 190 M ha; they currently contribute c. one third of world industrial wood supply, and are expected to contribute nearly half by 2040<sup>1</sup>. Other forms of planted forests - those established primarily for land restoration, fuelwood or amenity - are also important<sup>2</sup>, but are not the focus of this paper.

An increasing proportion - currently c. 15% - of planted forests are "intensively managed", and these forests contribute disproportionately to industrial wood supply. "Intensively managed planted forests" (IMPF) are defined here as plantation forests<sup>3</sup> of relatively high productivity, in which the owner makes a sustained investment, over the life of the forest, to optimise returns from industrial wood supply.

As WWF<sup>4</sup> notes, "well managed and appropriately located plantations can play an important role in healthy, diverse and multi-functional landscapes", and can generate substantial economic benefits. WWF also notes that plantations can impose significant environmental and social costs: the potential disbenefits of IMPF have been articulated strongly in Carrere and Lohmann's critique of short-rotation pulpwood plantations: "the results, in country after country, have been impoverishment, environmental degradation, and rural strife"<sup>5</sup>. Critics of IMPF are concerned by the consequences of large-scale land use change and wood fibre-based industrialisation, especially for the rural poor and the environment, and argue that these costs often outweigh the associated benefits.

### Intensively managed planted forests - concepts, locations, trends

Definitions of planted forests have been evolving to accommodate new forms of forestry and to clarify the blurred distinction with some forms of managed natural forest<sup>6</sup>. Both some proponents and many critics of IMPF prefer not to use of the term "forests" in describing them, favouring terms such as "tree farms" which they believe to better reflect the characteristics of these land use systems.

Contemporary forms of IMPF are distinguished from other forests by composition, scale, management and productivity. IMPF are typified by reliance on one or a few species or interspecific hybrids, established and managed as even-aged plantation stands. The

typical scale is large, from tens to hundreds of thousands of hectares in a given geographical region, with consequent appreciable local and regional impacts. Management of these planted forests is increasingly input intensive and technically sophisticated, and characterised by terminology such as "precision forestry". While the wood production threshold used to characterise IMPF is arbitrary, recent studies<sup>7</sup> use a threshold of a mean annual increment of 14 m<sup>3</sup> per hectare per year.

The first generation of IMPF, established mostly since the 1920s, are principally of temperate softwoods (mostly pines) grown primarily for solid-wood production on rotations of c. 25-45 years. Wood production rates typically range up to 20 m<sup>3</sup> per hectare per year. There are c. 13 M ha of these forests globally<sup>8</sup>, around 50% of which are in the SE USA and 50% the southern hemisphere (c. 1 M ha Africa, 2.2 M ha Australasia, 3.3 M ha S America)<sup>9</sup>. A substantial proportion<sup>10</sup> were established on sites converted directly from native vegetation. The extent of these forests is now relatively static. Many of the southern hemisphere IMPF forests were owned initially by national or sub-national governments; some still are.

The second generation of IMPF are principally of exotic temperate and tropical hardwoods (mostly acacias and eucalypts), almost all established since the 1980s, grown primarily for wood fibre production on rotations of c. 5-20 years. Wood production rates typically range from 15 - 40 m<sup>3</sup> per hectare per year. These are the "fastwood" plantations<sup>11</sup>; they total c. 11 M ha globally, and have been expanding at c. 1M ha annually<sup>12</sup>. These plantations are located principally in Asia and South America (c. 4.5 M ha Asia, 0.7 M ha Australasia, 0.5 M ha Iberian Peninsula, 5 M ha S America<sup>13</sup>), reflecting the cost of access to productive land; about half were established on sites converted directly from native vegetation<sup>14</sup>. Most of these forests are privately owned, principally by or in partnership with large corporations.

A third generation of IMPF comprises species planted originally for non-wood products, but now used (or with potential) also for wood production. These have traditionally been characterised as tropical estate crops, under both large- and small-scale private ownership. Rubberwood is currently the most important of these new resources, with a global extent of c. 10 M ha and annual harvest of c. 6.5 M m<sup>3</sup>; coconut wood has a long history of use, and both coconut and oil palm stems have potential for as fibre resources. The scale of these estate crops, c. 25 M ha in Asia alone<sup>15</sup>, offers a strong incentive for product development.

Variations on these dominant themes, such as long-rotation hardwoods or short-rotation poplars, are locally important.

## Significant trends

### *Increasing demand, international trade, comparative advantage, and concentration*

- Increasing global demand for industrial forest products (eg paper consumption is forecast to grow by 80% from 1990-2010<sup>16</sup>), increasing trade liberalisation, and the increasing cost of legal production from natural forests, will continue to favour IMPF over alternative forest resources.
- Technological change in wood products processing and manufacturing is increasingly favouring IMPF products over those of natural forests, larger- over smaller-scale operations, and advantaging products from shorter-rotation IMPF. There is increasing investment in solid-wood recovery from shorter-rotation IMPF.

- Investment in IMPF is increasingly concentrated by economies of scale, with resource expansion focused in countries with substantial existing IMPF resources<sup>17</sup>. Almost all second and third generation IMPF investment is targeted at export markets. Economic forces and opportunities have meant that most investment in IMPF in the past 25 years has been in 2<sup>nd</sup> generation IMPF in countries of the South.

#### *Private or quasi-private ownership*

- Where governments once owned IMPF assets, they have generally sold or corporatised them<sup>18</sup>. Governments worldwide now typically support IMPF by facilitating, in various ways, private investment in tree growing and wood products processing<sup>19</sup>.
- While the majority of IMPF resources remain under corporate ownership, various forms of outgrower schemes are assuming greater importance in IMPF expansion in most regions<sup>20</sup>.

#### *Impatient capital*

- Private capital, including an increasing proportion sourced from dedicated "timberland investment funds", now finances almost all IMPF.
- Most private investment favours returns on timeframes shorter than the production cycle of 1<sup>st</sup> generation IMPF; consequently, almost all recent investment has been in 2<sup>nd</sup> generation IMPF. Corporate investment in 1<sup>st</sup> generation IMPF has focused on the purchase of mature plantation estates, and - to a much lesser extent - their modest expansion to meet market demand.

#### *Opposition to IMPF expansion*

- In many places, there continues to be (often strong) opposition from other interested parties to substantial IMPF expansion. Some opposition derives from competing economic interests concerned about loss of access to land and water resources; much reflects concern about the environmental and social impacts of IMPF. Some IMPF proponents and governments have sought to engage this opposition; others have not.

### **The IMPF discourse - terms and participants**

The discourse<sup>21</sup> about IMPF has both explicit and implicit elements, and - as with forest issues more generally - is conducted in arena of varying scale and formality, ranging from direct local action and NGO coalitions to formal governmental and intergovernmental processes. Explicitly, the discourse is generally about the benefits and costs of IMPF; implicitly, to varying degrees, it is often about competing models of economic and social development, and thus founded in the value sets of proponents and opponents. Ideally, and demonstrably in many cases, the IMPF discourse helps facilitate better outcomes for all interested parties; but in the worst cases, the discourse rationalises or fails to address socially problematic and environmentally damaging policies and practices associated with IMPF.

Many of the terms of the discourse are common internationally, although the articulation and emphasis vary both over time and between particular cases<sup>22</sup>. The conventional assignment to economic, environmental and social arenas reflects much of the way in which the IMPF discourse has been framed and conducted, notwithstanding the interdependencies between arenas.

#### *Economic benefits versus economic costs*

Comprehensive independent studies of the economic benefits and costs of IMPF are rare, but many elements of the balance sheet are evident, and some are well-known:

- analyses of investment and its consequences (eg, employment, terms of trade) in tree growing and forest products processing, versus those associated with alternative land uses and industries, are confounded by factors such as processes of structural change in other primary industries - particularly traditional agriculture;
- there appears no reason to suppose that IMPF-based industries are inherently less economically desirable than alternatives; conversely, both market forces and case study analyses<sup>23</sup> suggest that IMPF investments enjoy comparative advantage in particular regions of particular countries;
- most direct and indirect economic benefits associated with IMPF are attributable to the processing industries based on them, rather than to tree growing itself<sup>24</sup>. Total employment levels associated with contemporary IMPF appear to range from 1-3 jobs/100 ha<sup>25</sup>, and are often comparable to those of industries they displace<sup>26</sup>; however, they are concentrated where processing facilities are located, rather than being more dispersed as was typically the case with traditional agriculture<sup>27</sup>.
- the economic potential of environmental service markets has yet to be realised by most IMPF owners, and are particularly difficult to access for smaller-scale owners<sup>28</sup>.
- full realisation of the economic benefits of IMPF is being constrained by the volume of trade in illegally-produced wood, which is depressing world wood prices<sup>29</sup>.

#### *Environmental benefits versus environmental costs*

Environmental benefits and costs associated with IMPF are variously location- and scale-dependent, and strongly dependent on forest practices. The principal issues are associated with IMPF impacts on:

- biodiversity. More than half IMPF globally have been established on sites converted directly from native vegetation, principally forest. Principles for biodiversity conservation at the landscape scale are now well-established, and are based on both protection of high conservation value forest, on bioregional conservation planning, and on proactive management of weediness<sup>30</sup>. Within this context, many of the adverse biodiversity impacts unavoidable at a stand level can be mitigated by good landscape-level design, and by good practice at both stand and landscape levels; well-planned and managed IMPF can help restore biodiversity in degraded landscapes<sup>31</sup>. Where these principles and practices are not followed, biodiversity impacts are reprehensibly adverse;
- natural and IMPF genepools. The principal genetic risks associated with IMPF are pollution of natural genepools, the relatively narrow genetic base of most IMPF production systems, and the suite of concerns associated with Genetically Modified Organisms. Genetic pollution risks are real in the globally-atypical cases in which IMPF species are related to the natural vegetation, where they require active management<sup>32</sup>; well-adapted and managed IMPF have been remarkably free of serious pest and disease outbreaks, but the rapidly expanding area of short-rotation IMPF may challenge this experience<sup>33</sup>, and biosecurity issues are of increasing concern worldwide<sup>34</sup>. The environmental risks and impacts associated with GM trees are more likely to be particular manifestations of those associated with IMPF more generally<sup>35</sup>, and are probably best addressed and managed as such;
- water resources and water quality. The scale and location of IMPF affects both surface and groundwater systems. While actual impacts are location-specific, soil water availability, streamflow and recharge from IMPF catchments are likely to be comparable to those from equivalent-aged regenerating natural forest, but reduced in comparison to pasture<sup>36</sup>. IMPF operational practices can significantly impact water quality<sup>37</sup>. Good understanding of catchment and groundwater hydrology, and of sediment and chemical pollution processes, is necessary to establish policies and practices which manage these

impacts to within agreed limits. There are examples of such knowledge bases, policies and practices from many IMPF regions<sup>38</sup>;

- soil fertility and properties, and soil erosion. IMPF impacts on soils and soil processes are site specific. As for biodiversity and water, good knowledge, planning and practices can mitigate potentially adverse impacts on most sites<sup>39</sup>; and where they cannot, IMPF cannot be regarded as either appropriate or sustainable;
- global change. Contrary to some early speculation, IMPF will have only minor impacts on global carbon pools and thus in addressing global change<sup>40</sup>. However, there appears to be increasing demand for carbon sequestration projects<sup>41</sup>, and thus payments for carbon sequestration may be increasingly important in economic decisions about particular IMPF projects.
- substitution for natural forest products. While IMPF resources offer the prospect of allowing societies the choice of not harvesting natural forests, and this has happened in a few particular cases (eg Australia, New Zealand), IMPF expansion has also been responsible for substantial deforestation globally. Native forest conservation and management depend much more on policy choices and forest governance, and the substitution of IMPF products more on market demand and forces, than simply on the availability of alternative resources from IMPF<sup>42</sup>. In the best case, IMPF are a necessary but insufficient condition for natural forest conservation.

#### *Social benefits versus social costs*

The social benefits and costs of IMPF depend in part on the expression of economic and environmental benefits and costs in particular cases, and in part on other societal issues. The most significant social issues associated with IMPF are:

- the general issue of the distribution of benefits and costs associated with IMPF. A fundamental concern to many critics of IMPF is that implementation, particularly in countries of the South, of the "industrial model [of IMPF] ... only serves the interests of a few against the basic needs of the majority"<sup>43</sup>. There are both political and operational dimensions to this issue; amongst the latter, strategies for benefit sharing - such as the development of various forms of company-community partnership - have been variously successful, especially where land use policies are not distorted in favour of agricultural production<sup>44</sup>;
- the more specific issue of the loss of access, to both land and its resources, to customary users - who are often marginalised or poor, and sometimes indigenous, peoples. Such displacement frequently occurs where tenure and access rights are disputed between the state and disempowered groups, and/or where governance is weak and vested interests are able to exploit others' resources;
- changes in the composition, structure and function of local communities associated with the transformation of historical land uses and associated industries to large-scale corporate forestry and forest industries. IMPF and associated processing industries are both a consequence and an agent of such transformation, which leads to different livelihood opportunities and constraints, advantaging some and disadvantaging others;
- the corporate basis of IMPF, which is new to many rural communities. Clashes of culture with variously adverse consequences are common unless IMPF proponents seek to genuinely engage with the issues of concern to those communities. For example, land use change to IMPF may impact adversely on the livelihood and land management options of neighbouring landowners, but many of these impacts can be mitigated with goodwill and collaboration;
- those associated primarily with personal and group values, such as landscape aesthetics. Rapid landscape-scale change, such as that associated with IMPF in particular regions, is generally unwelcome, especially if it has other negative connotations or is poorly planned.

### *Participants*

Participants in the IMPF discourse include proponents, critics, and commentators and knowledge brokers. They operate at scales from the very local to the global.

The proponents of IMPF commonly include:

- those associated with the forest-based industries - businesses, employees, investors, outgrowers, professionals, and service providers;
- those ministers and ministries of national and sub-national governments, and multilateral agencies, responsible for economic development or commercial forestry;
- local communities for whom IMPF-based employment and economic activity are an important elements of the local economy;
- NGOs whose focus is on conservation of natural forests and who believe IMPF can assist in realising that goal by meeting demand for wood products.

The critics of IMPF commonly include:

- some international NGOs, and their national/ local partners. The World Rainforest Movement has played the leading role in international campaigns against IMPF;
- those ministers and ministries of national and sub-national governments, and multilateral agencies, responsible for agriculture, environmental conservation, or water resources;
- indigenous and local peoples and communities who have been displaced, or who fear displacement or substantial social or environmental change, by IMPF. Social justice organizations may also speak for these peoples;
- competing primary production interests, both large and small-scale.

Other participants in the discourse, who often play the roles of commentators and knowledge brokers, include policy and research institutions, individual academics, and development agencies. Some NGOs - such as IUCN and WWF - play this role in relation to IMPF as much as they do any strong advocacy roles.

Most critics and other participants in the discourse offer qualified support to IMPF, provided that sustainability criteria are met. Many would concur with WWF's articulation of the key elements of IMPF sustainability<sup>45</sup>, as would many IMPF proponents: maintenance of high conservation forests; multifunctional forest landscapes; sound environmental management practices; respects for rights of communities and indigenous peoples; positive social impacts; proficient regulatory frameworks; and transparency.

### **Concluding comment**

As has been argued for both plantation forests generally and IMPF specifically<sup>46</sup>, these forms of forestry are neither inherently good nor bad. They are means of delivering some of the benefits of trees to societies, but they can also impose costs, and often not on those who most benefit. The balance between and the distribution of benefits and costs in any particular case depends on the context, and on the ways in which IMPF and associated activities and technologies are conceived and implemented.

## Sources and notes

- <sup>1</sup> FAO. *Forest Resources Assessment 2000*. [www.fao.org/forestry/site/10095/en](http://www.fao.org/forestry/site/10095/en); ABARE and Jaako Poyry. 1999. *Global outlook for plantations*. Paper for Intergovernmental Forum on Forests. 0
- <sup>2</sup> comprising about 50% of total planted forest area; FAO Forest Resource Assessment data - [www.fao.org/forestry/site/10049/en](http://www.fao.org/forestry/site/10049/en).
- <sup>3</sup> the definitions of "planted forests" and "plantation forests" have recently been revisited by a FAO Expert Meeting (January 2005 - [www.fao.org/forestry/site/25210/](http://www.fao.org/forestry/site/25210/)): **Planted forest**: *Forest stand in which trees have predominantly been established by planting, deliberate seeding or coppicing, where the coppicing is of previously planted trees* (this includes all stands established by planting or seeding of both native and nonnative species). **Forest Plantation**: *Forest stand in which trees have been established by planting or/and deliberate seeding or coppicing (where the coppicing is of previously planted trees) with either native species or non-native species that meet all the following criteria: 1) one or two or a few species; 2) even-aged; 3) regular spacing.*
- <sup>4</sup> WWF. 2002. *Forest plantations*. Position Paper, May 2002. [www.panda.org](http://www.panda.org)
- <sup>5</sup> Carrere and Lohmann. 1996. *Pulping the South*. [www.wrm.org.uy](http://www.wrm.org.uy) > Plantations Campaign > Information
- <sup>6</sup> FAO. 2005. *Planted forests definitions and concepts*. [www.fao.org/forestry/site/10051/en](http://www.fao.org/forestry/site/10051/en)
- <sup>7</sup> James and del Lungo. 2005. *The potential for fast-growing commercial forest plantations to supply high-value roundwood*. Planted Forests and Trees Working Paper, FAO. The use of an arbitrary figure allows unambiguous assessments, but also masks regional variability in what is considered "intensively managed". For example, a slightly lower threshold of 12 m<sup>3</sup>/hectare/year would encompass the majority of pine and eucalypt plantations in Portugal and Spain, which are excluded under the higher threshold. Data from FAO's Forest Resource Assessment 2005, currently underway, could be used to refine the crude estimates presented here. For further information, see: del Lungo & Carle. 2005. *Guidelines for national reporting tables for planted forests*. FAO Planted Forests and Trees Working Paper FP/35E.
- <sup>8</sup> definition and data - James and del Lungo, *ibid*; the global area of softwood plantation forests is estimated at c. 70 M ha (ABARE and Jaako Poyry, *ibid*).
- <sup>9</sup> estimated from James and del Lungo, *ibid*
- <sup>10</sup> the actual proportion varies between countries; for example, in Australia, almost all 1<sup>st</sup> generation IMPF were established on sites converted directly from native forest; in parts of southern Africa; most were established on sites converted directly from native grassland; in the SE USA, much of the establishment was on land previously cleared for farming, but abandoned in the 1930s.
- <sup>11</sup> Cossalter and Pye-Smith. 2003. *Fastwood forestry - myths and realities*. CIFOR. [www.cifor.cgiar.org](http://www.cifor.cgiar.org)
- <sup>12</sup> Cossalter and Pye Smith, *ibid*
- <sup>13</sup> Note that the regional IMPF area data nominated here requires further verification
- <sup>14</sup> estimated from Cossalter and Pye Smith, *ibid*; Salwood Asia Pacific, Canberra (pers. comm.)
- <sup>15</sup> FAO. 2005. Forest resources. In: *State of the world's forests 2005*. [www.fao.org/forestry/site/21407/en](http://www.fao.org/forestry/site/21407/en)
- <sup>16</sup> Cossalter and Pye-Smith, *ibid*, citing FAO
- <sup>17</sup> Carle *et al.* 2003. *The need for improved forest plantation data*. Paper to World Forestry Congress. FAO. [www.fao.org/forestry/site/5387/en](http://www.fao.org/forestry/site/5387/en)
- <sup>18</sup> Garforth and Mayers 2005. *Plantations, privatisation, poverty and power*. IIED. [www.iied.org](http://www.iied.org)
- <sup>19</sup> Garforth *et al.* 2005. Chapter 2 in Garforth and Mayers, *ibid*
- <sup>20</sup> Desmond and Race. 2000. *Global Survey and Analytical Framework for Forestry Out-grower Arrangements*. Report for FAO. ANU Forestry. [sres.anu.edu.au](http://sres.anu.edu.au); Mayers and Vermulen. 2002. *Company-community partnerships : from raw deals to mutual gains*. IIED. [www.iied.org](http://www.iied.org)

- <sup>21</sup> the term "discourse" describes "a complex entity that extends into the realms of ideology, strategy, language and practice, and is shaped by the relations between power and knowledge" (Sharp and Richardson 2001. *J. Environmental Policy and Planning* **3**: 193-209)
- <sup>22</sup> I acknowledge Jacki Schirmer's (ANU) work-in-progress in informing this topic
- <sup>23</sup> eg Australian Bureau of Rural Sciences 2004. *Plantations and water*. [www.brs.gov.au](http://www.brs.gov.au)
- <sup>24</sup> see, eg, Schirmer and Kanowski - Chapter 5 in Garforth and Mayers, *ibid*
- <sup>25</sup> Cossalter and Pye Smith, *ibid*
- <sup>26</sup> eg Pertheram et al. 2000. *Socio-economic Impact of Changing Land Use in South West Victoria*. [www.gtplantations.org](http://www.gtplantations.org) > Publications
- <sup>27</sup> Schirmer and Kanowski, *ibid*
- <sup>28</sup> Garforth *et al*, *ibid*
- <sup>29</sup> Seneca Creek Associates & Wood Resources International. 2004. *Illegal logging and global wood markets: the competitive impacts on the US wood products industry*. AFPA. [www.afandpa.org](http://www.afandpa.org)
- <sup>30</sup> eg WWF. 2002. *The landscape approach*. Position Paper. February 2002. [www.panda.org](http://www.panda.org); Kanowski et al. 1999. *International forest conservation: protected areas and beyond*. Paper for IFF.
- <sup>31</sup> eg Carnus *et al*. 2003. *Planted forests and biodiversity*. Paper to UN Forum on Forests. [www.maf.govt.nz/mafnet/unff-planted-forestry-meeting/#Programme](http://www.maf.govt.nz/mafnet/unff-planted-forestry-meeting/#Programme); Lindenmayer. 2002. *Plantation design and biodiversity conservation*. [www.rirdc.gov.au/reports/AFT/02-019sum.html](http://www.rirdc.gov.au/reports/AFT/02-019sum.html)
- <sup>32</sup> eg eucalypts in Australia, or pines in USA - see eg Potts *et al* 2003. *Australian J Botany* **51**: 1-25
- <sup>33</sup> Cossalter and Pye Smith, *ibid*
- <sup>34</sup> see, eg FAO. 2005. *State of the World's Forests 2005*. [www.fao.org/forestry/site/21407/en](http://www.fao.org/forestry/site/21407/en)
- <sup>35</sup> see Cossalter and Pye Smith, *ibid*, for background
- <sup>36</sup> see, eg: Keenan *et al*. 2004. *Plantations and Water Use: A Review*. [www.fwprdc.org.au/content/pdfs/PN04.4005%20Plantations\\_water.pdf](http://www.fwprdc.org.au/content/pdfs/PN04.4005%20Plantations_water.pdf); Cossalter and Pye-Smith, *ibid*
- <sup>37</sup> eg Australian Bureau of Rural Sciences, *ibid*
- <sup>38</sup> eg Australia: Australian Bureau of Rural Sciences, *ibid*; Brazil: Aracruz. 2005. *Watershed Project*. <http://www.aracruz.com.br/microbacia/ing/index.htm>; South Africa: Dlomo and Pitcher. 2005. Chapter 10 in Garforth and Mayers, *ibid*
- <sup>39</sup> see review by Cossalter and Pye-Smith, *ibid*
- <sup>40</sup> perhaps at most 2% of annual carbon emissions; Cossalter and Pye-Smith, *ibid*
- <sup>41</sup> J Douglas, formerly World Bank Forests Advisor. Pers. comm. June 2005
- <sup>42</sup> see review by Cossalter and Pye-Smith, *ibid*
- <sup>43</sup> World Rainforest Movement. 2005. *Plantations Campaign*. [www.wrm.org.uy](http://www.wrm.org.uy)
- <sup>44</sup> Mayers and Vermulen, *ibid*.
- <sup>45</sup> WWF. *ibid*.
- <sup>46</sup> eg Evans.1997. The sustainability of wood production in plantation forestry. In: *Proc. XI World Forestry Congress*. 3: 35-41; Kanowski. 1997. Plantation forestry for the 21st century. In: *Proc. XI World Forestry Congress*. 3: 23-34; Cossalter and Pye-Smith, *ibid*