Carbon Markets - The Forest Dimension © 2007

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Executive Summary

Although the cause of approximately 20% of annual global carbon emissions and with the potential to provide up to 25% of climate mitigation from now to mid-century, forests have been largely excluded from the carbon markets. This is largely the result of regulatory restrictions imposed by the European Union and the Clean Development Mechanism of the Kyoto Protocol. These restrictions no longer have any rationale as a result of significant methodological advances since their adoption.

Emerging compliance markets, including that of the United States do not impose such restrictions not least because it is now recognised that climate stabilisation cannot be achieved without a radical decline in tropical and sub-tropical deforestation and a radical increase in afforestation and reforestation. They also realise that forest-based carbon credits offer a low cost compliance option over the decades required to introduce new energy technologies on a global scale. The rapidly growing demand for forest carbon credits in the voluntary markets also reflects the recognition that unlike other climate strategies, forest-based carbon credits also provide an alternative and sustainable source of revenue to the world's poorest and most vulnerable people helping them to adapt to climate change and to restore and preserve biodiversity, fresh water and other environmental services on which all of us ultimately rely.

Growing population and rising living standards are generating growing demand for increasingly scarce timber resources most of which are generated from harvesting native forests. Reduction in such harvest, "avoided deforestation" will almost certainly be endorsed at the upcoming COP meeting in Bali. Much less appreciated is that, if achieved, this necessarily implies a shortfall in timber and wood product supply which must be made up elsewhere. Unless carbon market regulations also incentivise rapid development of new forests and the sustainable management of remaining forest areas, an increase in illegal logging will almost certainly result to address the imbalance between demand and supply.

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The Background

Until recently, the forest and rural land use dimension of the carbon equation has been largely ignored by the emerging carbon markets. This was due primarily to two regulatory restrictions. First, convinced by a few radical environmental groups that the methodology of carbon sequestration was uncertain and in an effort to force the United States to adopt stringent industrial emissions controls, the European Union decided to ban forest credits, together with nuclear energy, from the first phase of it Emissions Trading System ("EU ETS"). Second, the agreement reached by the Conference of the Parties ("COP") meeting in Marrakech in 2001 ("Marrakech Accords") and their subsequent interpretation by the Executive Board of the Clean Development Mechanism ("CDM") put such heavy restrictions on afforestation and reforestation ("A/R") projects that not a single commercial project has been approved for the crediting of Certified Emission Reductions ("CERs").[1] In the face of this, most institutions and potential industrial buyers of forest and land-use change credits naturally focused on clean energy as less controversial and more certain, even if more expensive, sources of carbon offsets and credits.

This all began to change at the COP meeting in Montreal in 2005 when, faced with a political impasse that convinced most observers that there would be no post Kyoto treaty, the Coalition for Rainforest Nations suddenly appeared with the solution which had escaped everyone else. Addressing the principal argument of the United States that it would not subscribe to any treaty unless it included emerging economies such as China and India, the Coalition made a grand proposal. Noting that much of the natural capital of the developing world was in its land and its trees, these countries proposed a mechanism that would compensate them for not releasing their land-based carbon into the atmosphere through continued deforestation. This unlocked the political door. The COP immediately instructed its Subsidiary Body for Scientific and Technological Advice ("SBSTA") to determine not if, but how, this could be accomplished and to report its findings to the COP meeting to be convened in Bali in December 2007.

The Magnitude of Forest Emissions

Important as the recognition of the political importance of forests was, the critical step was its quantification. The scientific community had known for some time that 90% of the exchange of carbon between the atmosphere and the Earth occurs through photosynthesis primarily in the world's forests.[2] The International Panel on Climate Change ("IPCC") itself had done the fundamental work in respect to the impact of deforestation on climate change some time previously, confirming that deforestation and other land-use activities account for 18% of annual greenhouse gas ("GHG") emissions. It was the Stern Report, however, which put deforestation into an economic context, pointing out that this was a larger share than

[1] For the history see Streck, Charlotte and Sebastian Scholz: "The role of forests in global climate change: whence we come and where we go" International Affairs 82: 5 (2006) 861–879, 2006 Blackwell/The Royal Institute of International Affairs

[2] J. K. Winjum, R. K. Dixon and P. E. Schroeder, 'Forest management and carbon storage: an analysis of 12 key forest nations', *Water, Air, and Soil Pollution*, 70: 1–4, 1993, pp. 239–57.

that contributed by the global transportation sector.[3] Put another way, the annual carbon emissions of the European power and energy sector is approximately 4 billion metric tonnes; the annual carbon emissions from deforestation is approximately 6 billion metric tonnes.

Soon after publication of the Stern Report, Vattenfall AB and McKinsey & Company published the results of studies that put the economics of forestry into a business context; it put forestry, and particularly tropical and sub-tropical forestry, where 90% of deforestation occurs, onto a price curve in comparison with other climate mitigation strategies. The result, anticipated by the authors of this chapter but not by many others, has been a fundamental reversal of strategy and rapidly growing awareness that mankind cannot reach its goal of climate stabilisation by mid-century without a radical reduction in deforestation and a radical increase in reforestation and afforestation, particularly in the tropics and sub-tropics.

Deforestation is by far the largest source of emissions from developing countries, contributing an amount greater than total US fossil fuel emissions.[4] Sustainable forestry management must play a crucial role in the mitigation of emissions,[5] particularly over the next few decades in which stabilisation of atmospheric CO_2 concentrations must occur if we are to avoid crossing critical thresholds.[6] In fact, it must play a larger role than any other sector over the next few decades; not something intuitively obvious to most policy makers and market participants until now.

Climate research has shown that to avoid catastrophic changes to the global climate and large-scale irreversible systemic disruption, temperatures must not increase to a threshold of 2 degrees Celsius above those in pre-industrial times.[7] A stabilisation at around 450 ppm would imply a medium likelihood of staying below this threshold.[8] Stabilizing atmospheric concentration at 450ppm would allow cumulative emissions of close to 2100 Gt CO2e between 2000 and 2100.[9] Recent analysis has shown to get on track for long-term stabilization, by 2030, emissions should not exceed 32 Gt CO_2e/yr.[10] To achieve this target requires significant emission cuts against the business as usual scenario.

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[3] Stern, Nicholas, 2006, "Stern Review: The Economics of Climate Change", November 2006: Watson, Robert et al. eds." Land Use, Land-Use Change, and Forestry. A Special Report of the IPCC", Cambridge University Press 2000.

[4] Indonesia, for example, is now the third largest emitter of greenhouse gases in the world almost entirely as a result of deforestation. See Wetlands International: http://www.wetlands.org/ckpp/publication.aspx?ID=1f64f9b5-debc-43f5-8c79- b1280f0d4b9a

[5] IPCC, 2000, Special Report of the Intergovernmental Panel on Climate Change: Land Use, Land-Use Change and Forestry, Cambridge University Press

[6] Stern, N, 2006 Stern Review: The Economics of Climate Change

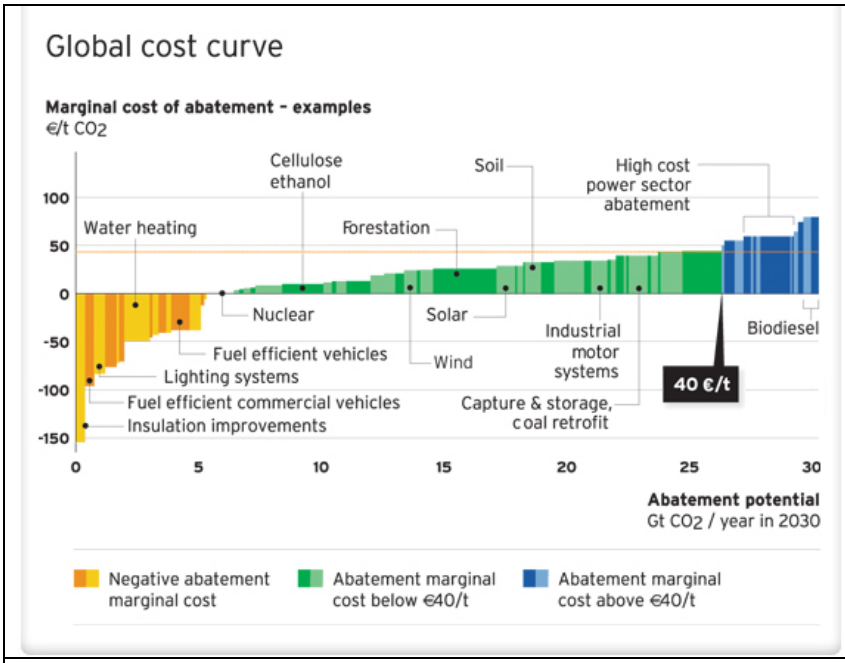
[7] European Commission Communication "Limiting Global Climate Change to 2° Celsius: The way ahead for 2020 and beyond.", Stern, N, 2006, Stern Review: The Economics of Climate Change, Meinshausen, Malte. "On the Risk of Overshooting 2°C." *Proceedings from International Symposium on Stabilisation of Greenhouse Gas Concentrations -- Avoiding Dangerous Climate Change*, Exeter, 1-3 February 2005 at www.stabilisation2005.com/programme.html.

[8] IPCC, 2001, The Scientific Basis, Cambridge University Press, Meinshausen, Malte. "On the Risk of Overshooting 2°C." *Proceedings from International Symposium on Stabilisation of Greenhouse Gas Concentrations -- Avoiding Dangerous Climate Change*, Exeter, 1-3 February 2005 at www.stabilisation2005.com/programme.html.

[9] Stern, N, 2006, Stern Review: The Economics of Climate Change

[10] A Cost Curve for Greenhouse Gas Reduction, The McKinsey Quarterly, February 2007

Reductions on this scale require the inclusion of emissions reductions from the forestry sector. Offsets from the forestry sector account for a larger share of potential reduction abatement than any other sector, including potential reductions from the power sector over that period.[11] The McKinsey study examined potential abatement scenarios for achieving the necessary emission reductions at a cost below €40/tCO2e.[12] Forestry accounts for 25% of the additional reduction potential in emissions required to achieve this target. It is clear that to achieve stabilisation at 450 ppm by 2030 requires both avoided deforestation and reforestation. The potential 2030 abatement from reducing deforestation is ~3.3 Gt CO_2e /year, and from afforestation/reforestation a further 3.5 Gt CO_2e/year (see Figure below)[13]. Without the inclusion of forestry offsets, achieving these emissions reductions targets at an acceptable cost is impossible. In other words, the alternative to achieving forest-based emissions abatement is the likely onset of irreversible climate change by 2030.



Source:Vattenfall, 2007, Global Mapping of Greenhouse Gas Abatement Opportunities up to 2030

IPCC research has demonstrated that the potential of biological mitigation options is in the order of 100 GtC (cumulative) by 2050, equivalent to about 10 to 20% of projected fossil fuel emission during that period.[14] The analysis shows that emission reductions from the forestry sector, while essential to achieving medium term abatement goals, are also biologically constrained in their ability to mitigate climate change beyond a certain point.[15]

[11] *Ibid.*
[12] *Ibid.*
[13] Vattenfall, 2007, Global Mapping of Greenhouse Gas Abatement Opportunities up to 2030
[14] IPCC, 2001, Climate Change 2001: Mitigation, Cambridge University Press

This, amongst other considerations, should dispel fears that offsets from forestry will "flood" the market and reduce incentives to technological change. Forestry carbon credits and offsets are necessary but are not, by any means, sufficient, to achieve climate stabilisation goals.

The Mandatory Markets

European Union

As mentioned above, the EU ETS currently bans forestry credits from the developing world. In contrast, both foreign and domestic forestry counts toward the European nations' Kyoto compliance obligations.[16] This anomaly is now being formally reviewed and there are indications that it will be revised for the post-2012 period.[17] If it persists in the face of acceptance of such credits in other systems, such as those emerging in the US, Australia and New Zealand and under a post-2012 Kyoto treaty, it will both impose a competitive disadvantage on European industry[18] and reduce the attractiveness of the market itself.

It will also conflict with the European Union's policy to increase renewable energy to 20% of its supply. This is because biomass, essentially timber, is a critical part of the means by which it intends to achieve that goal. In its "Biomass Action Plan," the European Commission noted:

"The EU currently meets 4% of its energy needs from biomass. If it made full use of its potential, it would more than double biomass use by 2010 (from 69 mtoe[19] in 2003 to about 185 mtoe in 2010) – while complying with good agricultural practice, safeguarding sustainable production of biomass and without significantly affecting domestic food production."[20]

The European Union has adopted policy targets that call for an increase in the use of renewable energy as part of the EU's energy mix of 12% by 2010 and 20% by 2020. As wood-based energy is a major source of renewables in the EU, it is instructive to look at the implications of this energy policy on the wood supply of the EU.

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[16] See EU ETS legislation: http://ec.europa.eu/environment/climat/emission/implementation_en.htm, and see http://unfccc.int/2860.php

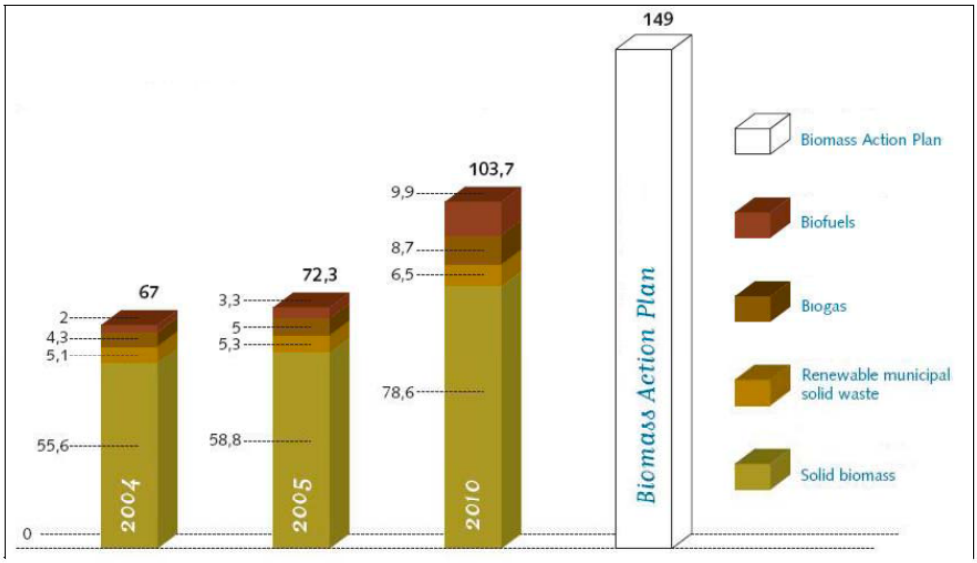
[17] European Parliament resolution of 15 November 2007 on limiting global climate change to 2 degrees Celsius – the way ahead for the Bali Conference on Climate change and beyond (COP13 and COP/MOP 3)

[18] McKinsey & Company and Ecofys, "EU ETS REVIEW: Report on International Competitiveness," December 2006

[19] million tonnes of oil equivalent

[20] European Environmental Agency, "How much biomass can Europe use without harming the environment", briefing 2/2005; see Annex 2.

Comparison between the current trend and the Biomass Action Plan scenario (in Mtoe) EurObserv'ER 2006



One can easily see that the Biomass Action Plan calls for a significant increase in the use of biomass (and a correspondingly large increase of supply from solid biomass, i.e. wood) to achieve the EU's renewables target. A recent draft study[21] by UNECE, FAO, and Hamburg University has assessed the implications of EU renewables policy on the supply of wood versus the amount of wood required to fulfill the policy objectives. The table below shows the results of the study. The "2020 75%" scenario reflects a decrease in the relative share of wood versus other renewables.

Wood supply vs wood required to fulfill EFSOS projections and policy objectives			
Year	**Total Wood Supply***	**Total Wood Demand****	**Difference**
2005	**775**	**821**	**47**
2010	**791**	**976**	**185**
2020	**825**	**1274**	**448**
2020 75%	**825**	**1156**	**321**
* direct from the forest and indirect (EFSOS forecast)			
**required to fulfill EFSOS projections and policy objectives			

In any scenario, it is evident that the EU will experience an increasing shortage of wood supply, indicating that steps must be taken to increase the supply if policy objectives are to

[21] UNECE, FAO, and University of Hamburg: 'Wood resources availability and demands – implications of renewable energy policies: A first glance at 2005, 2010 and 2020 in European countries,' October 2007

be met. Among these steps to increase the supply would include: planting on new areas (afforestation); increasing supply from existing sources (reforestation); and increasing imports. It is also worth noting that of the increase in wood demand illustrated in the Table above, the increase to the traditional wood based industries (wood-based panels, sawmilling, and pulp and paper) from 2005 to 2020 is 12% (from 478 million m^3 to 536 million m^3) while the increase to achieve EU policy goals for renewable energy is 115% (343 million m^3 to 738 million m^3).

The continuation of the EU ETS ban also conflicts with the EU's overseas development policy[22]and with the fact that European Governments are entitled and will need, to purchase forest-based credits under the CDM in order to meet their Kyoto targets.[23]

Kyoto Protocol

One of the anomalies of the Kyoto Protocol is that it credits all forms of forestry in the Annex 1 countries (both for carbon accounting and for Joint Implementation projects)[24] but restricts forest credits to afforestation and reforestation in the developing world. This creates the perverse incentive of encouraging regrowth of the northern forests and encouraging continued destruction of the southern forests. The latter not only store orders of magnitude more carbon than the former, they also harbour 50% of the world's species and are critical suppliers of fresh water, food, fuel and medicine to over 1.5 billion of the world's most vulnerable people. In the Kyoto negotiations it seems to have gotten lost, in the single minded focus on industrial emissions, that the Kyoto Protocol is a piece of subsidiary legislation to a treaty, the UNFCCC, that is dedicated to sustainable development.[25]

The CDM created by the Protocol, ironically, was specifically intended by the parties to be the mechanism by which the Protocol would contribute to just the overriding goal of sustainable development. This has been effectively frustrated by the administration of the mechanism by its Executive Board (over 2/3s of all CERs have been generated by the rapidly industrialising China, India and Brazil) and the poorest countries, those most in need of sustainable development, have generated least; for example, Africa as a whole has generated less than 3%. This is largely the result of the fact that the only meaningful form of sustainable development for such countries is in their rural areas but the rules adopted by the COP at Marrakech and their subsequent interpretation by the Executive Board has meant that virtually no CERs have yet to be generated from that source.

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[22] http://www.undg.org/archive_docs/6638-European_Union_MDG_Report_2000-2004.pdf

[23] Only the UK and Sweden will be able to deliver on their pledge to reduce greenhouse-gas emissions, according to new figures by the European Environment Agency (EEA). See: "EU off-track from Kyoto targets, says EEA," at http://www.euractiv.com/en/sustainability/eu-track-kyoto-targets-eea/article-159246

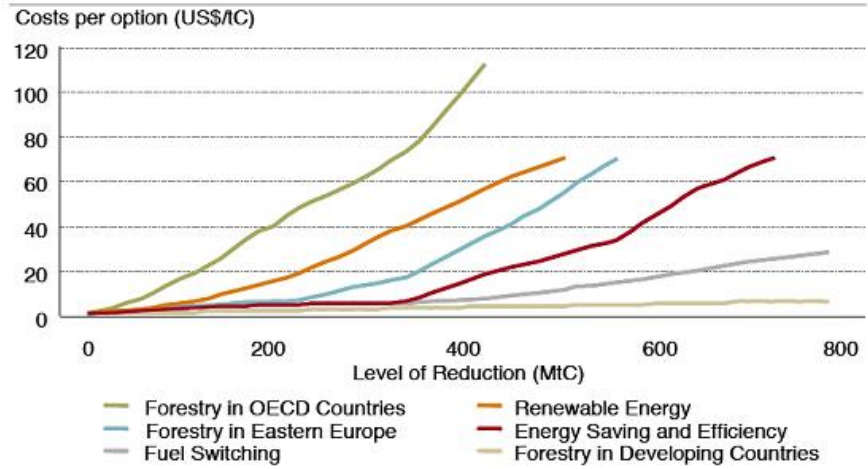
[24] See Kyoto Protocol Articles 3, 6 and 12 at http://unfccc.int/resource/docs/convkp/kpeng.pdf and Marrakech Accord Section on Land Use, Land Use Change and Forestry, at http://unfccc.int/cop7/documents/accords_draft.pdf

[25] Bettelheim and d'Origney: "The Kyoto Protocol-A Legal Analysis" in Carbon, Biodiversity, Conservation and Income: An Analysis of a Free Market Approach to Land Use Change and Forestry in Developing and Developed Countries; Royal Society Transactions, July 2002

In fact, despite approving to date some 10 methodologies for LULUCF credits, the CDM process has resulted in the registration of only one forest project to date. This project is forecast to generate only 327,000 tonnes CO_2e of emission reductions over the first commitment period,[26] or just 0.27% of the amount allowed under the Marrakech Accords (see below). In fact, it is forecast that all CDM A/R projects combined will generate only between 7 and 14 million tCO_2e reductions in the first commitment period (2.8 million tonnes CO_2e per year),[27] or about 1% of the total predicted CER market of a billion tonnes.[28]

The CDM process is also notoriously slow and resistant to input from the private sector. The results are rules and procedures that impose unnecessarily high compliance costs and which create barriers to investment on a commercial basis. Tragically, the CDM, a mechanism created to assist the developing world, in reality serves as a non-tariff barrier to carbon exports from the developing to the developed world.[29] The damage is compounded by the fact that forestry is the one sector of the carbon market in which the developing world has a substantial competitive advantage given lower land and input costs, higher growth rates and a large pool of relatively cheap but experienced labour. Any farmer can grow tress provided he has access to capital and a reliable income stream.

Relative Costs of Abatement Strategies



Source: Intergovernmental Panel on Climate Change (2001), vol.IV, ch.4.

CDM rules have effectively negated the cost competitive advantage of carbon forestry in the developing world by restrictive regulation. They have done so to the point that it is difficult to invest in the sector on commercial terms. The rules that have resulted in this are discussed below. As should also be apparent, the rationales for them, to the extent they ever existed, are now obsolete.

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[26] Project Design Document: "Facilitating Reforestation for Guangxi Watershed Management in Pearl River Basin, China."

[27] Jung, Martina, "The Role of Forestry Sinks in the CDM - Analysing the Effects of Policy Decisions on the Carbon Market", Hamburg Institute of International Economics, 2003.

[28] http://cdm.unfccc.int/Statistics/index.html

[29] Bettelheim, Eric, "The Case for Forestry Sequestration," in Environmental Finance, December 2005-January 2006.

i. 1% Rule

CDM forestry rules cap the use of A/R credits to 1% of an Annex 1's country's annual compliance requirement over the first commitment period; equivalent to a global total of 120MtCO_2 annually. The principal justification for this restriction is that the inclusion of forestry credits in the CDM would "flood" the Kyoto trading system with "cheap credits". This argument never bore real scrutiny either in theory or in fact. The theoretical upper bound of emissions offsets from LULUCF activities is 10-20% of total demand for emissions reductions and the realistic level is much lower.[30]

ii. The 1990 Rule

Restoration of land deforested since 1990 is excluded under CDM rules. The original intention of this rule was to prevent "gaming" the then new carbon system by the cutting of natural forest to plant "carbon." The result has been to exclude from the system any credit for regeneration or replanting of forests destroyed since 1990. The FAO estimates that annual deforestation since 1990 has run at a rate of 13 million hectares per year, with a net forest loss of 8.9 million hectares per year from 1990-2000, and 7.3 million hectares annually from 2000-2005.[31] Thus, 125-195 million hectares of deforested land is now ineligible for CDM forestry (an area three times the size of France) and the area is expanding (not least because of the lack of any crediting of avoided deforestation and the lack of supply from A/R projects) by an area the size of Greece every year. The major cause of deforestation is the result of "slash and burn" conversion to subsistence agricultural use by peasant farmers; they are not "gaming" the carbon trading system, they are simply trying to survive.[32]

iii. Permanence.

Forests are a long-term store of carbon. They have covered vast areas of the earth's surface for millennia and contain 60% of the carbon stored in terrestrial ecosystems.[33] Their duration exceeds any industrial facility. The CDM rules nevertheless require that A/R forest credits be either temporary (tCERs) or long term (lCERs) and that all of them be replaced at specific intervals which are unrelated to the forest harvest cycle, with a maximum duration of 60 years. This rule, intended to adjust to the possible release of carbon from forests in the future, not only reduces incentives for forest restoration but can actually encourage the liquidation of healthy forests after no more than 60 years in order to generate cash to buy replacement CERs on the open market. Forestry is thus discriminated against with regard to the issue of "permanence": there is no equivalent replacement rule

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[30] IPCC, 2001, Climate Change 2001: Mitigation, Cambridge University Press

[31] FAO, Schoene, Dieter, "Reducing Emissions from Deforestation," Rome 2006, http://www.fao.org/forestry/webview/media?mediaId=11368&langId=1

[32] FAO, 2005, The Global Forest Resources Assessment, Rome

[33] IPCC, Land use, land-use change, and forestry: a special report of the IPCC. (Cambridge & New York. Cambridge University Press, 2000)

for credits from industrial installations at the end of their much shorter life span even if, like wind power plants, they require the "back-up" of fossil fuel plants.

The attempt to address the issue by creating various "currencies"[34] has compounded the complexity thus further reducing the fungibility of forest credits. No other carbon market in the world creates a "temporary" credit in any sector, including forestry.[35] Such efforts are, in fact, unnecessary. Robust methods are available to address or account for permanence. These include: maintenance of adequate reserves or buffers to cope with unforeseen losses in carbon stocks, insurance, discount factors based on the assessed risk of carbon loss, and general strategies to reduce risk to carbon stocks such as pest control and fire management. The risk of loss from a natural event in managed forests is very small, averaging 0.04% of loss per year.[36] It is so small that most large forest enterprises self-insure.

Measurement

Various concerns over measurement of carbon bio-mass have been addressed over the intervening years between Marrakech and today. The science and technology is now both strong and coherent in accurately assessing long-term gains and losses of bio-mass carbon, and other emissions, from the forestry and land use sector. Landholders and government agencies now measure and monitor forest status and growth using a combination of techniques including direct field measurements, satellite and aerial photography and computer modelling. Many protocols for measuring and monitoring carbon project benefits exist.[37] The Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF)[38] produced by the IPCC, provides methods and guidance for estimating, measuring, monitoring and reporting on carbon stock changes and GHG emissions. It is consistent with guidance for other sectors and can be used to quantify changes in GHG from a diverse range of forestry and land-use management practices. The guide assists in the production of inventories for the sector that neither 'over' nor 'under' estimates. It supports the development of inventories that are transparent, documented, consistent over time, complete, comparable, assessed for uncertainties, subject to quality control and quality assurance, and efficient in the use of resources.

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[34] There are now three categories of Kyoto forestry credits: tCERs, lCERs, and RMUs

[35] eg. See New South Wales Greenhouse Gas Abatement Scheme: http://www.greenhousegas.nsw.gov.au/Documents/syn101.asp

[36] Hancock Timberland Investor, 2nd Quarter 2003, Risk from Natural Hazards for Timberland Investments http://www.htrg.com/research_lib

[37] Brown, S. O Maseru, J Sathaye. 2000. 'Project-based activities' in R. Watson, I Noble, and D.Verardo (eds), Land Use, Land-Use Change and Forestry; 'Special Report to the Intergovernmental Panel on Climate Change, Cambridge University Press, Chapter 5 and see The Revised 1996 IPCC Guideline for National Greenhouse Gas Inventories and MacDicken, 1997, A guide to monitoring carbon storage in forestry and agroforestry projects, Winrock International Institute for Agricultural Development

[38] IPCC, 2003, Good Practice Guidance for Land Use, Land-Use Change and Forestry, http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm

Leakage

Leakage, commonly defined as the unanticipated decrease in greenhouse gas benefits outside of a project's accounting boundary as a result of project activities,[39] has often been raised as a major challenge associated with avoided deforestation projects. Real projects have demonstrated that this can be controlled and measured when it occurs. The Noel-Kempff Climate Action Project, among others, has demonstrated that active management can reduce leakage, and that which cannot be eliminated can be quantified and deducted from the project's total carbon benefits.[40] Société Générale de Surveillance (SGS), an internationally accredited CO2 certifier and Designated Operational Entity of the UNFCCC, validated the project design, verified and certified emission reductions for the project.[41] Methodologies for control and measurement of leakage have now been approved by the Executive Board of the CDM and other practical methodologies have been adopted under various other standards.[42]

Additionality

With deforestation continuing to increase on a global scale,[43] one could argue that any reductions in deforestation through incentives offered through the carbon market are *per* se additional. Nevertheless it is important to demonstrate that deforestation is being reduced and forest cover is, in fact, additional to any reductions in deforestation or increases in forest cover that may have occurred without carbon credit payments. This can be ensured by comprehensive reporting schemes documenting the origins of finance for avoided deforestation, sustainable forestry management and tree planting initiatives. Several voluntary market standards, such as that of the Climate Community and Biodiversity Alliance "CCBA"), provide for objective, third-party verification of additionality using cost-effective techniques.[44]

Emerging National Mandatory Systems

It is interesting that the "Anglo-Saxon" carbon markets which are emerging in Australia, New Zealand and the United States, all provide explicitly for a wide range of forest-based carbon credits in contrast to the EU ETS and the CDM. Indeed, the New South Wales Greenhouse Gas Abatement Scheme ("NSW GGAS") has provided for forest credits since inception and New Zealand will soon provide for forest-based credits both in its national scheme and as an Annex 1 country under the Kyoto Protocol. The importance of forest carbon is already apparent in the State and regional schemes in the US and is being catered for in the most advanced draft US Federal legislation.

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[39] http://www.epa.gov/sequestration/leakage.html
[40] http://www.fan-bo.org/pacuk
[41] SGS. Summary, Validation and Verification Report, Programa Nacional de Cambio Climatico Noel Kempff Climate Action Project. November 27, 2005.
[42] For CDM approved methods see: http://cdm.unfccc.int/methodologies/ARmethodologies/approved_ar.html For details of forestry carbon under the Chicago Climate Exchange see http://www.chicagoclimatex.com/content.jsf?id=242
[43] *op.cit FAO*
[44] http://www.climate-standards.org/

Australia

While the Federal Government has not ratified the Kyoto Protocol, it has nonetheless committed to meeting its Kyoto Protocol targets. Forest sinks have featured as a major part of the Federal Government's strategy to deliver on this commitment. Australia has recently announced its commitment to implement a Federal Emissions Trading Scheme. The Government will set national reduction targets in 2008 and trading will commence in 2011.[45]

The State of New South Wales was, in fact, the first governmental body in the world to implement a mandatory emissions trading scheme through the State of New South Wales Electricity Supply Amendment Act (trading commenced in December 2003). The NSW GGAS places an obligation upon electricity retailers and large electricity users to meet mandatory targets to reduce the emission of greenhouse gases from electricity production and use, and imposes penalties on relevant entities which fail to meet the target in any given year. Abatement Certificates ("NGACs") can be created from carbon sequestration activities and can subsequently be used by liable entities to meet their emission reduction obligations under the Scheme.

As a result, forestry sinks are already playing a major role in Australia's climate change policy and regulatory framework. There is little doubt that it will continue to do so under the proposed federal scheme. It is a policy of the platform of the Labour Party to ratify the Protocol should the Party win the Federal elections in November, 2007.[46] Should Australia ratify the Kyoto Protocol, it will then, like New Zealand be in apposition to both encourage carbon forestry for domestic and international purposes.

New Zealand

New Zealand has enacted legislation specifically targeted at conservation forestry through carbon market incentives. The Permanent Forestry Sink Initiative ("PFSI") programme allows plantations developed in accordance with certain conditions to generate Kyoto AAU credits.[47] In addition, New Zealand has also recently announced the establishment of the New Zealand Emissions Trading Scheme, in which credits from the forestry sector will be backed by AAUs.[48] AAUs issued for its PFSI forests equal to the increased CO_2 stored in the forest for the period between 2008 and 2012, Kyoto's first commitment period.

United States

Due to opposition from the current administration, carbon market regulation in the US is not as developed as in some other areas of the world. However, where legislation or programs have been implemented, forestry credits are included. The Regional Greenhouse

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[45] See "Howard: Carbon trading system for Australia by 2011," International Herald Tribune, 16 July 2007 (http://www.iht.com/articles/ap/2007/07/17/asia/AS-GEN-Australia-Global-Warming.php)
[46] Point Carbon, "Australian Labor Promises Immediate Kyoto Ratification," 14 November 2007
[47] see: http://www.maf.govt.nz/forestry/pfsi/
[48] New Zealand Government, "The Framework for a New Zealand Emissions Trading Scheme," September 2007 and "Forestry in a New Zealand Emissions Trading Scheme – Engagement Document" September 2007

Gas Initiative ("RGGI") of the mid-Atlantic States, provides for afforestation credits.[49] The recently announced California legislation provides for the development of a cap and trade program and anticipates allowing forestry offsets, both domestic and international, into its compliance scheme.[50] Although Federal cap and trade legislation has not yet been passed by Congress, several bills in both the House and Senate, including the Warner-Lieberman bill, also provide for both domestic and international forestry and other land use credits.

The Chicago Climate Exchange (CCX), a voluntary market for credits, has provisions for forestry credits, including the ability of project developers to generate credits both from reforestation and avoided deforestation.[51] Forest projects also provide the largest part of the "off-exchange" voluntary US market.[52]

Voluntary Markets

Not least in response to the limitations of the two largest compliance markets and their failure to keep up with developments in methodology and practice, the voluntary sector has taken up the running in developing workable standards for forest-based carbon credits as well as other carbon projects. Accreditation schemes for voluntary carbon credits to ensure both integrity in the marketplace and that real, measurable and long-term emissions reductions are being offered are important to the market's continued rapid development. Such schemes include those of the CCBA,[53] the Gold Standard,[54] and the Voluntary Carbon Standard.[55] These standards, which are the result of extensive consultation with the private and non-governmental sectors, provide detailed specifications for certification of emission reductions. All of these schemes provide for forest-based carbon credits and the first of these is specific to such credits.

Data on the voluntary carbon markets are incomplete, but several trends are emerging. Growth in the voluntary markets has been rapid and such growth is forecast to continue. Between 2005 and 2006, volume in the market grew by 200% to a total of about 24 million tonnes, of which forestry credits had the greatest market share.[56] Traded volumes thus far in 2007 imply about a 75 million tonne market by the end of the year.[57] Research by leading consulting groups predict an annual market in voluntary credits of between 300-400 million tonnes by the end of the first Kyoto commitment period, if not before.[58]

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[49] see: Regional Greenhouse Gas Initiative Model Rule at http://www.rggi.org/modelrule.htm

[50] see: "Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California - Recommendations of the Market Advisory Committee to the California Air Resources Board," June 2007

[51] See http://www.chicagoclimatex.com/content.jsf?id=104

[52] See fn 54 below.

[53] http://www.climate-standards.org/

[54] http://www.cdmgoldstandard.org/

[55] http://www.theclimategroup.org

[56] Ecosystems Marketplace: "State of the Voluntary Carbon Markets 2007: Picking Up Steam"

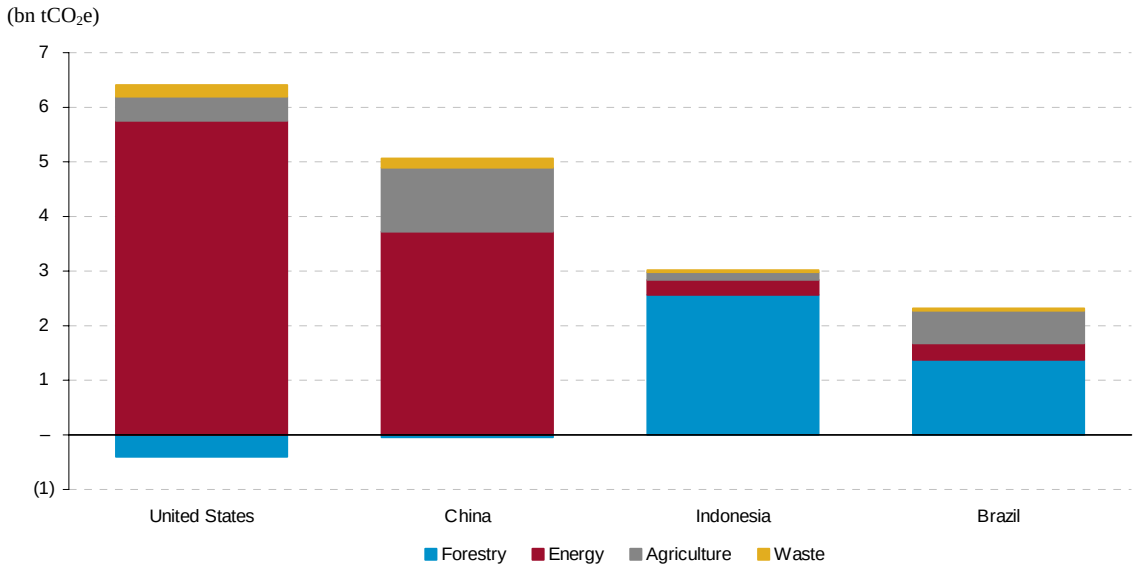
[57] Point Carbon, Carbon Market Analyst, "Voluntary Carbon Markets: Lost in Transactions?" 24 October 2007

[58] See http://www.icfi.com/newsroom/carbon-offsets-2006.asp and see Point Carbon, "Voluntary carbon market could reach 350 million tonnes in 2012: analyst," 16 October 2007

Bali and Beyond

As indicated above, the 26 developing countries in the Coalition of Rainforest Nations[59] have made it clear that either they receive compensation for the carbon sequestration services which their native forests provide to the world or they must continue to exploit them as sources of energy, wood products and agriculture.[60] The implications of the latter are illustrated in that Indonesia is now the third largest emitter of greenhouse gases in the world, almost entirely the result of continued deforestation, and Brazil is fourth for largely the same reason.[61]

World's Four Largest Greenhouse Gas Emitters



Source: World Bank/DFID - Indonesia and Climate Change: Current Status and Policies 2007

To achieve reforestation, stabilisation of arid areas, transition to low-till agricultural practices, protection of watersheds and bio-diversity and compensation for preserving existing forests in developing countries, funding must come in the form of payments for ecosystem services, particularly carbon sequestration. Indonesia has, for example, recently proposed payments of $10 per hectare in compensation for avoided deforestation.[62]

The COP convening in Bali this year will see critical decisions taken for land use and forestry in the developing world. These negotiations mark the end of a two-year consultation period on 'emission reductions from avoided deforestation', prompted by the proposal made in

[59] http://www.rainforestcoalition.org/eng/ **[Indonesia proposal of $20/ hectare]**
[60] Stilts, Joseph, "Cleaning Up Economic Growth," Project Syndicate, 2005
[61] See Wetlands International: http://www.wetlands.org/ckpp/publication.aspx?ID=1f64f9b5-debc-43f5-8c79- b1280f0d4b9a
[62] Point Carbon, October 18th 2007, Forestry CDM projects "too complex" for Indonesia: report

Montreal.[63] The Parties in Bali are confronted, given the length of time it will take to agree and ratify a follow-on, post 2012 treaty, with the need to find a political compromise which requires efforts to mitigate climate change by all countries, not just the industrialised world. To achieve this, payments for carbon sequestration are the only realistic way forward.

One measure of the resources required, opportunity cost, was the basis of a study carried out for the Stern Review. This estimated the opportunity cost for eight countries that collectively are responsible for 70 % of land-use emissions. If deforestation in these countries were to be reduced by 50%, the opportunity cost would amount to at least $5-10 billion annually (at $1-2/tCO2 on average).[64] Although there are various proposals for public sector funding, donor governments and agencies show little sign of being able to contribute funding necessary at that level.[65]

Avoided Deforestation

Avoided deforestation, or as now increasingly referred to as REDD (Reduced Emissions from Deforestation and Degradation), is a major topic for the Bali COP meetings. The SBSTA will report its findings on approaches to including such activities in the Kyoto system. If, as expected, the COP endorses the integration of REDD into the Kyoto system, detailed rules can be expected to be proposed by the Copenhagen COP in 2008 in time for incorporation in the draft terms of a post-2012 treaty to be settled in 2009.

There are a variety of approaches to crediting such activities and given the variety of historical experiences of the countries which are the intended beneficiaries, a combination of approaches is the most likely outcome but all of them will be based on non-mandatory emissions targets being adopted by such countries. A sectoral approach based on national boundaries, as opposed to the current CDM approach of project by project assessment, is attractive both because of its simplicity and its respect for sovereignty and because it eliminates many of the methodological problems, such as leakage and additionality, which have plagued development of the CDM market thus far. National forest sector targets adopted by developing countries are the most efficient way of encouraging sustainable forest management and reducing deforestation.

Timber Supply and Demand

In any assessment of the need for carbon forestry in the developing world it is critical to understand that without it the laws of supply and demand will overwhelm, as they have for decades, all other efforts to address the loss of native forests. Projected world demand for industrial round wood and sawn wood will be met partially by an increase in plantation forestry, particularly in the developed world; the balance of timber supply together with consumption of wood for fuel will, unless forest carbon offset projects are incentivised, continue to be met through the destruction of native forests. At current rates of exploitation

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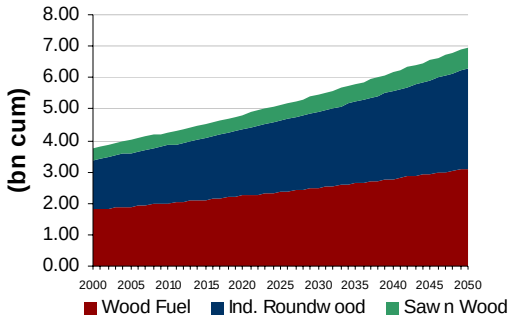
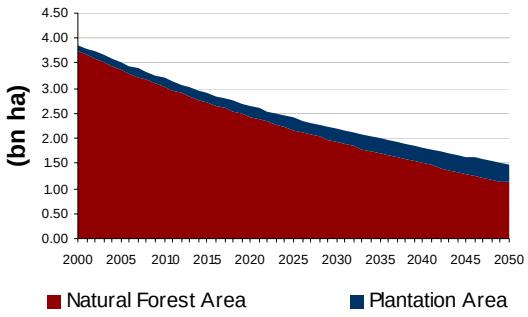
[63] UNFCCC. 2005/CP/L2, "Reducing Emissions from Deforestation in Developing Countries: Approaches To Stimulate Action". 06 December 2005.

[64] Stern, N, 2006, Stern Review: The Economics of Climate

[65] Castro, G. and I. Locker. 2000. Mapping Conservation Investments: An Assessment of Biodiversity Funding in Latin America and the Caribbean. Washington, D.C.: Biodiversity Support Program.

the tropical forests will be largely exhausted by 2050 and will have ceased to be intact eco-systems.[66]

Total Wood Consumption (World)	Total Forest Area (World)
	

Recent trends show an alarming picture of changes in the world's wood growing stock.[67] Deforestation is concentrated in the poorest areas of the world along the tropical and sub-tropical belt. As can also be seen, reforestation is growing in the temperate forests of the developed world. In other words, the world's most important forests, measured in terms of carbon sequestration, as well as other environmental services such as bio-diversity and fresh water, are being destroyed and the least important are being restored.

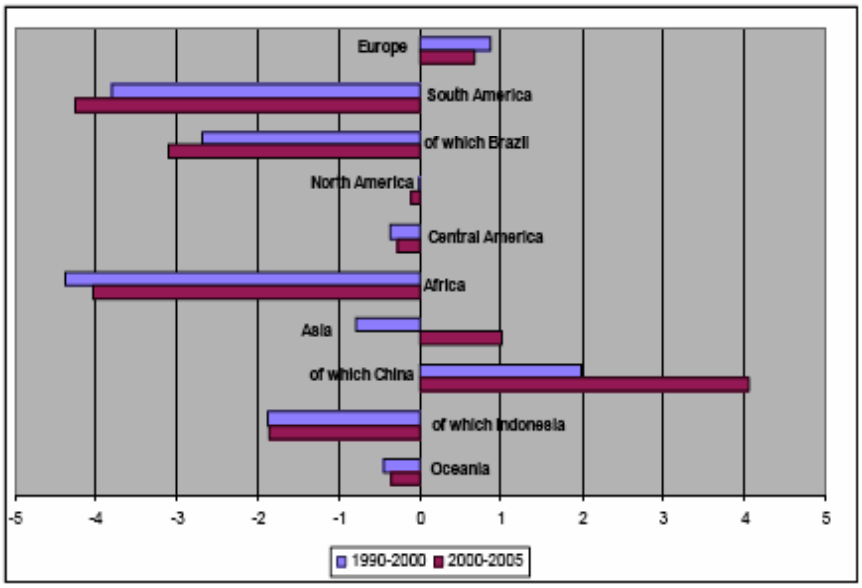
Total global forest area in 2005 was 3.95 billion hectares, just over 30% of the world's land area. Deforestation, mostly due to land conversion to agriculture, runs at nearly 13 million hectares annually. Net forest loss from 1990-2000 was 8.9 million hectares annually; from

[66] "State of the World's Forests 2005", "Global Forest Resource Assessment 2005", FAO 2006, and SFM research

[67] Kauppi, Pekka, "The Forest Identity", University of Helsinki, 2006

2000-2005 this has slowed a net loss of 7.3 million hectares per year. South America and Africa have shown the largest annual net loss of forest by far, 4.3 and 4.0 million hectares respectively.

Figure 2. Annual net change of forest area in million hectares



Source: FAO (2005)

Forest plantations are being planted at an increasing rate though they make up only about 4% of total forest area, or about 140 million hectares. About 78% of forest plantations are established for wood and fiber production (known as "productive plantations"); the other 22% have been established for water and soil conservation. From 2000-2005, productive plantations increased by 14 million hectares (about 2.8 million hectares annually). Productive plantations currently stand at about 109 million hectares or about 2.8% of the total global forest area, up from about 1.9% in 1990. Ten countries account for 73% of productive forest plantations with China, the United States, and Russia accounting for more than half of the total.[68] At 2000-2005 rates, the rate of plantation establishment would have to increase by 2.6 times in order to offset global net forest loss of 7.3 million hectares per year.

Growing Stock, Biomass, and Carbon

Total global growing stock in the world's forest areas is about 434 billion m^3, equating to an average of 110 m^3 per hectare. About 30% of the world's growing stock is found in South America. Of the total growing stock, about 202 billion m^3 or 47%, is considered commercial. 64% of the commercial growing stock is located in the United States, Europe, and Central America. Global growing stock has declined from 445 billion m^3 in 1990 to 434 billion m^3 in 2005 as a result of deforestation.

[68] Food and Agricultural Organisation of the United Nations, "Global Forest Resources Assessment 2005: Progress towards sustainable forest management," FAO Forestry Paper 147, Rome 2006.

Not surprisingly, carbon in living biomass has declined from 1990 to 2005 from 299.2 GtC to 282.7 GtC with the greatest decrease occurring in South and South East Asia over the period. This equates to an annual carbon loss of 1.1 Gt.[69] The IPCC's most recent report pegs the carbon loss from LULUCF at a higher level, 1.6 Gt annually, about 18% of global anthropogenic greenhouse gas emissions.[70] In the developing world forest loss is a function of three key activities: conversion, usually by burning, of forest land to agricultural use, illegal logging and unsustainable harvest of native forests for wood products.

Forest Loss Through Burning

A significant amount of forest is lost annually through burning. Though some naturally occurring fires are beneficial to the health of forests, it is estimated that 80-90% of wildland fires are attributable to human activities through the uncontrolled use of fire for: agriculture, maintaining grasslands for livestock, non-wood forest product extraction, industrial development and resettlement. The largest sector is conversion to agriculture.

TABLE 4.1
Average area of forest annually affected by fire 1998–2002

Region/subregion	Information availability			Area of forest affected by fire	
	Countries reporting	Forest area *(1 000 ha)*	% of total forest area	1 000 ha	% of forest area
Eastern and Southern Africa	8	62 129	26.4	483	0.8
Northern Africa	5	21 076	15.5	6 176	29.3
Western and Central Africa	7	47 558	16.7	519	1.1
Total Africa	**20**	**130 763**	**19.9**	**7 177**	**5.5**
East Asia	5	225 663	100.0	523	0.2
South and Southeast Asia	12	272 087	91.5	11 029	4.1
Western and Central Asia	16	36 994	85.0	218	0.6
Total Asia	**33**	**534 744**	**94.4**	**11 770**	**2.2**
Total Europe	**37**	**997 658**	**100.0**	**1 597**	**0.2**
Caribbean	3	3 004	52.6	13	0.4
Central America	4	12 338	51.8	130	1.1
North America	3	677 968	100.0	4 333	0.6
Total North and Central America	**10**	**693 310**	**98.0**	**4 476**	**0.6**
Total Oceania	**2**	**8 244**	**4.0**	**n.s.**	**n.s.**
Total South America	**10**	**806 483**	**94.6**	**2 719**	**0.3**
World	**112**	**3 171 203**	**79.5**	**27 740**	**0.9**

The FAO estimates that in 2000 that worldwide land area affected by vegetation fires was 350 million hectares[71] and that 27.7 million hectares of forest per year were affected by fires.

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[69] *Ibid.*

[70] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[71] Estimate made by the Joint Research Centre of the European Commission.

CO_2 emissions attributable to vegetative burning were estimated about 3.4 billion tonnes.[72] Data on area of forest burned are notoriously unreliable, but it is well documented that forest fires in relatively small geographic areas can have large effects on global greenhouse gas emissions. For example, the Indonesian forest and peat fires of 1997 were responsible for emissions of between 2.97-9.06 $GtCO_2$, equivalent to between 13-40% of the mean annual carbon emissions from fossil fuels in 1997.[73] Other data point to similar figures. The Global Fire Monitoring Center calculated that mean CO_2 emissions from forest burning in the period 1997-2005 was 8.8 $GtCO_2$ annually. [74]

Illegal Logging

Illegal logging costs developing countries worldwide around US$15 billion a year in lost revenue[75]. It also causes deforestation, environmental degradation and biodiversity loss. It damages livelihoods and is associated with corruption, organised crime and the fuelling of armed conflicts. Crediting forests with payments for carbon emission reductions provides a sustainable alternative and can reduce the incentive for illegal logging and its negative repercussions.

If the rate of tropical deforestation is to be swiftly reduced and if we are to achieve atmospheric carbon stabilization in the medium term, the rural poor of the developing world must be provided with sustainable, alternative ways of life. To accomplish this it must be based on a reliable long-term supply of compensatory payments and incentives which substitute for illegal logging as well as other lawful forms of forest degradation.

The economic and environmental consequences of illegal logging can be extensive. By definition, reliable statistics on illegal activities are difficult to gather and quantify. The Center for International Forestry Research (CIFOR) has made some estimates of the costs and volume of illegal logging activities in various countries:

- In Indonesia, as much as 50 million cubic meters of timber are estimated to be illegally cut-down each year.
- At least one-fifth of Russia's annual timber harvest is taken illegally, and illegal harvesting may account for as much as 50 percent of the total in East Asia.
- In Cambodia in 1997, the volume of illegally harvested logs was ten times that of the legal harvest.
- In Cameroon and Mozambique about half of the total annual timber harvest is illegal.
- In Brazil, an estimated 80 percent of timber extracted each year in the Amazon is removed illegally.[76]

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[72] FAO, "Fire Management – Global Assessment 2006," FAO Forestry Paper 151, Rome 2007

[73] Page, Susan et. al., "The Amount of Carbon Released from Peat and Forest Fires in Indonesia in 1997," Nature, 420, November 7, 2002.

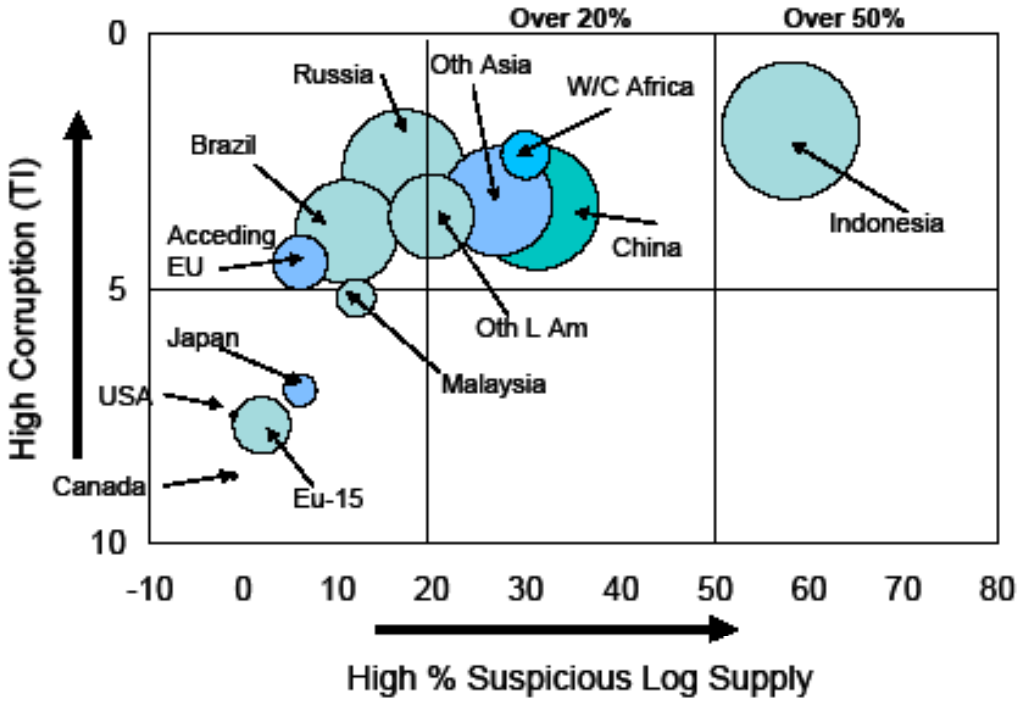
[74] The Global Fire Monitoring Center is an activity of the UN International Strategy for Disaster Reduction (see http://www.fire.uni-freiburg.de/) and see, http://ess1.ess.uci.edu/~jranders/data/GFED2/readme.pdf.

[75] World Bank: http://web.worldbank.org

[76] See http://www.cifor.cgiar.org/publications/Corporate/FactSheet/illegal_logging.htm

In 2004, the American Forest & Paper Association commissioned a study on the economic impacts of illegal logging activities which concluded that illegal logging has significant economic impacts and that its practice is widespread, particularly in the developing world.

Figure 2: Corruption and Illegal Forest Activity



Note: Size of bubbles represents volume of suspect roundwood, including imports. *Sources:* Transparency International; WRI/SCA estimates of illegal logging

In monetary terms, the estimated value associated with the production of illegal roundwood, lumber, and plywood products was $23 billion in 2002. About $5 billion of these products entered world trade, about 7% of the value of world trade in primary wood products ($69 billion). In volume terms, illegal logging represents approximately 8-10% of global wood products production. This number does not include secondary wood products, furniture, or pulp and paper; including these products would suggest that illegal logging has an even greater impact on the global forestry industry. Most illegal wood products are used domestically. In aggregate, it is estimated that 8% of the world's roundwood is illegally sourced; in export markets, estimates are that 12% of softwood roundwood, 17% of hardwood roundwood, and up to 23% of plywood are illegally sourced.[77]

[77] Seneca Creek Associates LLC and Wood Resources International LLC, "Illegal Logging and the Global Wood Markets – The Competitive Impacts on the US Wood Products Industry," prepared for American Forest & Paper Association., November 2004.

Aside from its direct economic impacts, illegal logging can affect the resource base in a way that makes future legal commercial exploitation unattractive for project developers:[78] The environmental impacts of illegal logging are also severe. Illegal logging can be responsible for a host of environmental problems, ranging from deforestation, habitat destruction, loss of biodiversity, loss of watershed protection, and carbon emissions.

The Role of Agriculture in Deforestation

Clearing land for agricultural use is a major driver of deforestation. Deforestation for agriculture occurs both on a large industrial and small subsistence scale. The relative importance of small- and large-scale agriculturalists in deforestation is debated. Much of Brazil's and Indonesia's deforestation is caused by large commercial interests such as soybean production, ranching and palm oil production, while most African and mainland Southeast Asian deforestation is carried out by smallholders.

Data about the relative global magnitudes of deforestation caused by corporate versus subsistence level agriculture are provided by the FAO's Forest Resources Assessment - Remote Sensing Survey.[79] The FAO[80] estimates that expansion of shifting cultivation into undisturbed forest represents about 5% of all pan-tropical changes in land use. Intensification of agriculture in shifting cultivation areas represents more than 20% of tropical land use change in Asia and less than 10% in Africa. Direct conversion of forest area to small-scale permanent agriculture accounted for 60% of land use change in Africa, but only a small portion elsewhere. Direct conversion of forest to large-scale permanent agriculture represents about 45% of tropical land use change in Latin America and about 30 percent in Asia.[81]

In recent years agro-industry in the Amazon has experienced explosive growth, especially beef and soybean production. Soybean production in the Brazilian Amazon states grew approximately 60% between 1998 and 2002 while the cattle herd nearly doubled from 26.2 million in 1991 to 51.6 million in 2001. This increase in production has transformed the sector into the most serious threat to the Amazon environment, becoming the main driver of deforestation in the region. Until the 1980s, soybean production in the Amazon was almost nonexistent due to the lack of varieties adapted to Amazon soils and climate. Soy expansion into the Amazon and surrounding areas began in 1997 when new soy varieties were developed that tolerated the humid, hot Amazon climate.[82]

Whatever the cause, the conversion of forests to agriculture not only releases the stored carbon it largely destroys the ability of the area to re-absorb carbon dioxide. This

[78] Nillson, Stan and Gary Bull, "Global Wood Supply Analysis," presentation to 46th Session of the FAO Advisory Committee on Paper and Wood Products, May 31, 2005, Vancouver, Canada.
[79] FAO, 2005. "Global Forest Resources Assessment 2005: Progress towards Sustainable Forest Management." Forestry Paper 147. Rome.
[80] FAO 2001 "Global Forest Resources Assessment 2000: Main Report."Forestry Paper 140. Rome.
[81] Chomitz, K, 2007, At Loggerheads? Agricultural Expanion, Poverty Reduction, and Environment in the Tropical Forests, The World Bank
[82] Woods Hole Research Center, http://www.whrc.org/southamerica/agric_expans.htm

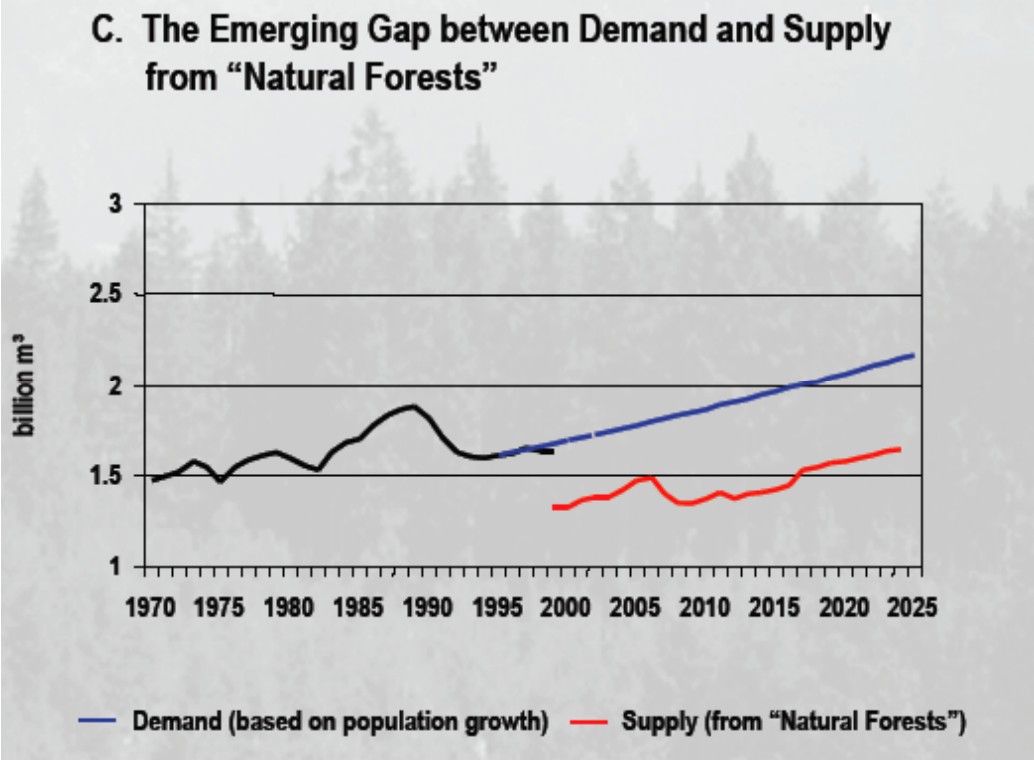
compounds the climate effect of deforestation in addition to the effects of permanent loss of biodiversity, damage to watersheds and increase in soil deterioration and erosion.

Demand for Wood Products

Consumption of wood products is dominated by the use of wood for energy, industrial uses and for sawnwood. Disparities between regions are significant; fuel for wood is the primary use is Africa while it is a relatively minor energy source in North America. The US, on the other hand, is the largest market for industrial uses of wood. On a global basis, fuelwood accounts for about 46% of overall consumption with industrial roundwood and sawnwood accounting for the other 54%. In the developing world, however, wood is the primary source of energy, constituting 87% of wood use in Africa, 68% in Asia, and 54% in Latin America and the Caribbean.[83] There is a growing disparity between demand for wood and that which can be supplied by natural forests:[84] Wood consumption is also set rise in some regions as governmental renewable energy targets kick in over the next decades.

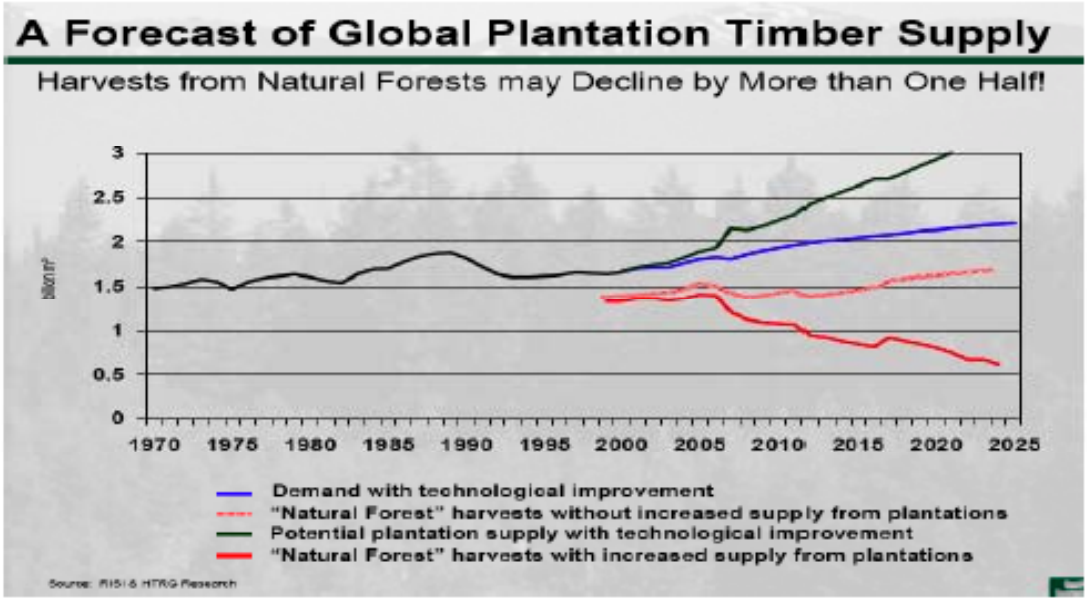
Consumption of wood products is set to increase dramatically in the developing world due to economic and population growth and rising standards of living. From 2000-2005, China's imports of logs increased by 500%, from 5 to 25 million m^3 annually; total imports of forest product increased by 300% from 1997-2004. Some predict that China will face an annual RWE (roundwood equivalent) shortage of 120 million m^3 by 2010. India's population will grow to about 1.25 billion people by 2020, 70% of whom will be between the ages of 16 and 65. By 2020, it is estimated that India will face a shortage of industrial log supply of 20-70 million m^3. Likewise, consumption of industrial roundwood in Latin America is forecast to grow from 120 million m^3 in 1990 to over 200 million m^3 by 2020.[85]

[83] Food and Agricultural Organisation of the United Nations, "State of the World's Forests 2007," FAO Rome 2007.
[84] Resource Information Systems Inc. and Hancock Timber Resource Group research, October 2000.
[85] *op. cit.* Nillson and Bull



It is clear that curbing deforestation will on one hand restrict the supply of wood flowing to the market from natural forests; it is also clear therefore, that given projections of population growth and increased global purchasing power, that the area of productive plantations must be increased to satisfy the increased demand for wood products.

The following chart shows forecasts of global timber supplies and the importance of increased plantation areas to remove pressures on native timber extraction. In simple terms, the chart shows that a significant increase in timber from plantations is needed to meet future wood demand.[86]



The market is responding to the need for an increase in wood supply from plantations. In 2000, plantations supplied about 35% of harvested roundwood, a figure forecast to grow to about 45% by 2030 and to about 50% by 2040. In volume terms, roundwood production was about 331 million m^3 in 1995 and is projected to increase to 906 million m^3 by 2045.[87] However, even with an increased supply of industrial roundwood from plantations, the FAO has concluded that present plantation development is not sufficient to offset growing consumption, deforestation and declining harvests from native forests.[88]

Like industrial roundwood, fuelwood use, especially in Africa, is forecast to grow significantly. As mentioned above, 87% of wood removals in Africa are for fuel (including for charcoal production).[89] From 1990-2005, wood removals in Africa grew from 499 million m^3 to 661 million m^3 annually[90] and are predicted to grow to 820 million m^3 by 2020. Fuelwood consumption in India is forecast to grow to 400 million m^3 by 2020 from 280 million m^3 in 2003; similarly, Latin America will experience a growth in annual consumption from 250 million m^3 in 2005 to 320 million m^3 in 2020.[91]

Charcoal consumption, a significant driver of deforestation, also shows positive growth trends. From 1975 to 2000 the consumption of charcoal doubled[92] and indications are that its growth will outstrip that of fuelwood because charcoal use tends to increase with an increase in urbanisation.[93] In addition, charcoal puts increased pressure on forests as it requires solid wood for its production. Globally, consumption of woodfuel was 1.8 billion m^3 in 2000[94] and is expected to grow by about 1.3% annually. The International Energy Association forecasts that in 2030, 2.6 billion people will rely on traditional biomass for cooking and heating, nearly all of which will be produced and consumed locally.[95]

Government policy which combines energy security and climate change concerns could also have an effect on wood demand. The European Union, for instance, has set policy targets for the use of renewables in the energy supply of 12% by 2010 and 20% by 2020. As wood is a major part of the renewables base, meeting these ambitious targets will increase the demands of the forestry sector. In fact, a wood supply deficit of 185million m^3 by 2010 and

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[87] Sampson, R. Neil et. al., Millennium Ecosystem Assessment, "Ecosystems and Human Well-Being: Current States and Trends – Chapter 9 – Timber, Fuel, and Fiber."

[88] FAO, "Role of Forest Plantations as Substitutes for Natural Forests in Wood Supply - Lessons Learned from the Asia-Pacific Region," Forest Plantations Thematic Paper Series, United Nations Food and Agriculture Organization (FAO), Rome, Italy, 2001.

[89] *op. cit.*, "State of the World's Forests 2007."

[90] *op. cit.*, "Global Forest Resources Assessment 2005."

[91] *op. cit.*, Nillson and Bull.

[92] Girard, P., "Charcoal Production and Use in Africa," *Unasylva* 53 (211), 2002.

[93] Whiteman, A., J. Broadhead and J. Bahdon, "The Revision of Wood Fuel Estimates in FAOSTAT," *Unasylva* **211**, 53: 41–45, 2004.

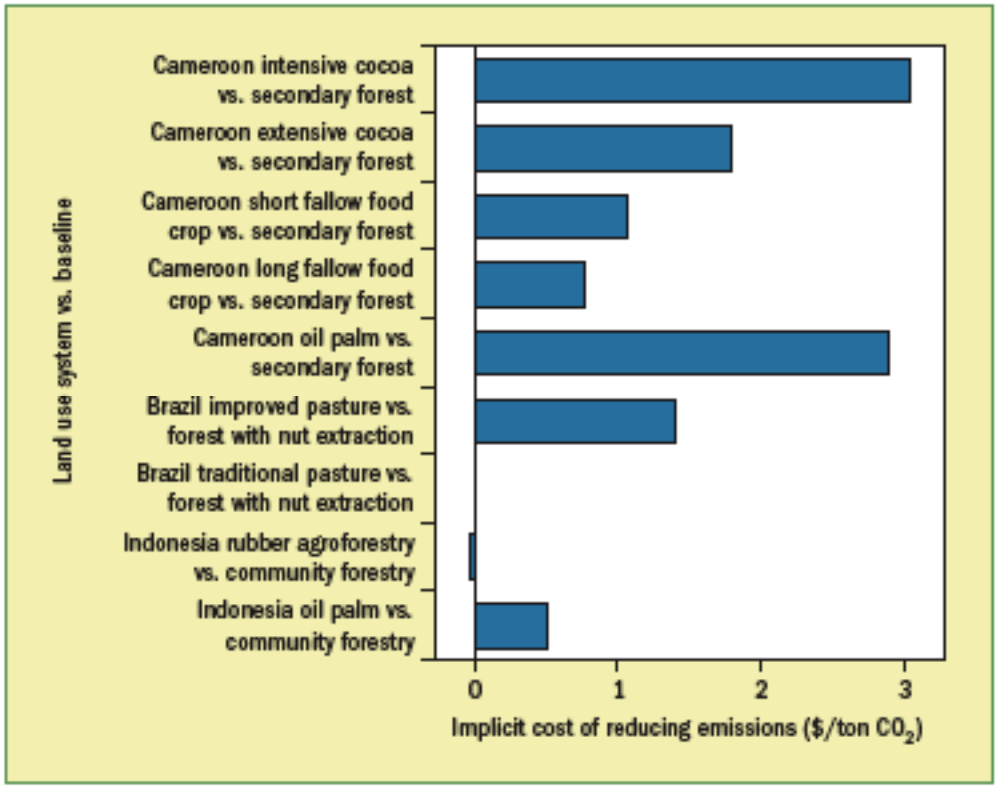
[94] FAO, 2003b: State of the World's Forests 2003, FAO, Rome, Italy.

[95] IEA (International Energy Agency), 2002a: World Energy Outlook, 2002, IEA, Paris, France.

up to 448 million m^3 by 2020 is forecast if the EU achieves the goals of its renewables policy.[96]

Carbon Credits and Deforestation

Credits from avoided deforestation allow a real commercial alternative value to be placed on tropical forests if they are integrated into carbon credit trading systems in a fungible and transparent manner. The carbon market can in many cases "tip" the balance of economics in favour of forest conservation. According to the World Bank's most recent study of the subject, the world loses annually about 12 million hectares of tropical forest; tropical forest value cleared to pasture is worth between $200-500 per hectare. Based on its average CO_2 storage per hectare of 500 tonnes, its value as a carbon store is between $1500-10,000 per hectare (@ $3-20/t$CO_2$).[97] Even at the low range of carbon prices values continued deforestation would become unprofitable in many land systems:[98]



[96] UNECE, FAO, University Hamburg, "Wood Resources Availability and Demands – Implications of Renewable Energy Policies – a first glance at 2005, 2010, and 2020 in European countries," 19 October 2007.
[97] *op. cit.* Chomitz
[98] *op. cit.* Chomitz

By way of comparison, this represents a potential transfer of private capital from the industrialised world to rural populations in the developing world of some $18 billion per annum, the equivalent of a 17% increase in global annual overseas development aid.[99]

Non-Carbon Environmental Services

Although carbon trading garners most of the attention in respect of environmental markets, there are several other markets that are developing in which it is possible to monetize what are generally known as "ecosystem services." Few observers fail to appreciate that shortages of fresh water and increasing bio-diversity loss are creating scarcities to which market mechanisms are beginning to respond.[100] These services are found in almost all tropical and sub-tropical forests.

Most of this trading is taking place in the developed world; in fact a large percentage of it occurs in the United States. The US has been at the forefront in developing markets to achieve environmental outcomes. Perhaps the best known of these markets is the Acid Rain Program run by the Environmental Protection Agency, a cap and trade regime that has delivered significant environmental benefit since its inception under amendments to the Clean Air Act in 1990 and is the precedent for the GHG emissions market.

Less well known is the development of markets for other ecosytem services that have also developed though to a smaller degree. The Table below shows the size of various markets around the world for these services. Data for these markets are often not centralised and are thus difficult to assemble. The following most likely underestimate the actual size of the various markets.

Water Markets			
Program (Start Year)	Transactions	Hectares	Value (US$)
US Wetland Banking (2000)	47	9,229	$289,660,000
No. Car. Ecosystem Enhancement (2005)	19	1092	$40,545,000
Mexico Payment for Hydrological Services(2003)	47	311,028	$23,134,000
US Water Pollutant Trading and Offset(1994)	11	8,539	$11,294,000
Costa Rica Water-based Ecosystem Services (1998)	10	20,625	$8,944,000
Source: Ecosystems Marketplace - http://ecosystemmarketplace.com/index.php			

[99] see http://www.oecd.org/dataoecd/52/18/37790990.pdf, Total ODA in 2005 was $106.7 billion, up from $80 billion in 2004.

[100] See Millennium Ecosystem Assessment http://www.millenniumassessment.org/documents/Document.798.aspx.pdf

Biodiversity Markets			
Program (Start year)	**Transactions**	**Hectares**	**Value (US$)**
US Conservation Banking (1992)	**930**	**44621**	**$40,773,590**
Australia Victoria Bush Tender (2002)	**10**	**18521**	**$3,877,531**
Voluntary US/Canada/Mexico (1987)	**57**	**5829002**	**$331,257,678**
Source: Ecosystems Marketplace - http://ecosystemmarketplace.com/index.php			

Though small by the standards of the carbon market, both the water and biodiversity markets are not insubstantial in their own right.[101] In addition, there are other ecosystem service markets that are nascent but could prove substantial in the future. Examples include nutrient trading in the US which is a market-based approach for protecting and improving water quality. These efforts are generally state or municipally based.[102] A comparable initiative is the Hunter River Salinity Trading Scheme in New South Wales which has been responsible for restoring the fresh water quality of the waters of the Hunter River and reduced water salinity to more stable and lower levels through a market based approach.[103]

Conclusion

Forest conversion and destruction, primarily in the tropics, account for the release of over 6 billion tonnes of CO_2 on an annual basis representing some 25% of annual global GHG emissions. Without a major contribution from tropical and sub-tropical forestry the mid-century goal of climate stabilisation cannot be achieved. At the same time there is a growing gap between demand and supply of wood products from natural forests. Industrial wood product demand is increasing due to population and economic growth in the developing world. Demand for fuelwood and charcoal is also increasing due to population growth and increased urbanisation.

There must be a significant reduction in tropical deforestation and a significant increase in afforestation and reforestation to mitigate climate change while meeting global demand for forest products. Most of this change must occur in the developing world where rural populations are dependent on forest and agricultural areas for survival. In the absence of real alternative financial incentives, continued conversion of forest land and illegal logging will prevent the sustainable use of tropical forests. Fortunately, even modest carbon prices

[101] It is perhaps noteworthy that as recently as 2000 the carbon market was measured in similar values.
[102] See http://www.nutrietnet.org/
[103] See http://www.environment.nsw.gov.au/licensing/hrsts/index.htm

can change the economics of forestry to promote conservation and sustainable forest management but this is largely dependent on the regulations pertaining to forest-based carbon credits in the world's carbon markets allowing the vital services which forests provide to be fully valued.