

INVESTMENT FLOWS AND FINANCE SCHEMES IN THE FORESTRY SECTOR, WITH PARTICULAR REFERENCE TO DEVELOPING COUNTRIES' NEEDS

A REPORT FOR THE SECRETARIAT OF THE UNFCCC

FINAL REPORT

CORRECTED VERSION

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Units and Conversions

1 Gg	1 Gigagramme = 10^9 gramme
1 Gt	1 Gigatonne = 10^9 tonnes = 1 Pg = 10^{15} gramme
1 Pg	Petagramme = 1 Gt
1 Mt	1 Megatonne = 1 million tonnes = 1 Tg = 10^{12} gramme
tC	Tonne carbon
1 tCO ₂	0.27 tC
1 tC	3.67 tCO ₂





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1 INTRODUCTION

1.1 Objective

- 1) This study is in support of the preparation of a technical background paper by the Secretariat that aims "to review and analyze existing and planned investment flows and finance schemes relevant to the development of an effective and appropriate international response to climate change, with particular focus on developing countries' needs" and presents:
 - ❖ A summary of net GHG emissions for the reference or business as usual scenario as well as for selected IPCC mitigation scenarios, both with as much geographic and sub-sectoral detail as possible;
 - ❖ An overview of current sources of financing (domestic, international, public private); and,
 - ❖ An estimate of financing needs towards 2030 to achieve mitigation potentials to the extent possible, also with as much geographic and sub-sectoral detail as possible.

1.2 Scope

- 2) The TORs require the consultant to cover the areas of forestation (afforestation and reforestation) and reducing deforestation. In addition, where possible and relevant, forest management is added to that list as a counter measure for deforestation and forest degradation¹. Activities such as harvesting, wood production and paper production do not need to be covered as they will be covered by a consultant working on the industry section.
- 3) In the area of emissions and removals, the elaboration of IPCC scenarios for Business as Usual (BAU) and for mitigation as reflected by Working Group III (WGIII) in the 4th Assessment Report (AR4) is the main sources of information. Other sources of information include where relevant and appropriate *inter alia*: work by the IPCC (working groups II and III reports), OECD/IEA (for example the World Energy Outlook), FAO (for example the World Forest Assessment), the World Bank (for example the Framework for Clean Energy and Development) and the Stern Review and its underlying studies.

¹ Sound forest management is a good way of conserving forest biomass whilst enhancing the long-term economic and environmental sustainability of the forest area.





2 RESULTS

2.1 Current/recent emissions and removals in the forest sector

2.1.1 Recent net emissions and removals according to AR4²

- 4) The main baseline scenarios used for the compilation of the assessments in the 4th Assessment Report of the IPCC (AR4) are the SRES B2 and A1B marker scenarios (IPCC, 2000) and the World Energy Outlook 2004 (WEO2004) (IEA, 2004). In the Forestry chapter (chapter 9) of the contribution of WGIII to AR4 (WGIII/AR4) however, little new effort was reported on the development of global baseline scenarios for land-use change and their associated carbon balance, against which mitigation options could be examined. Therefore, the agriculture and forestry sector based their mitigation potential on land-use changes deducted from various (marker) scenarios.
- 5) The Forestry chapter of WGIII/AR4 indicates that at the global scale, during the last decade of the 20th century, deforestation in the tropics and forest regrowth in temperate and parts of the boreal zone remained the major factors responsible for emissions and removals in the forestry sector, respectively. It also notes that the extent to which the loss of carbon due to tropical deforestation is offset by expanding forest areas and accumulating woody biomass in the boreal and temperate zone is the area of disagreement between land observations and estimates by top-down models. Available estimates differ in the land-use types that are included and in the use of gross fluxes versus the net C balance, among other variables, leading to the impossibility of setting a widely accepted baseline for the forestry sector globally. Instead the chapter relied on the baselines as used in each regional study separately or as used in each global study. This led to large uncertainties when trying to assess the overall mitigation potential in the forestry sector.
- 6) The Forestry chapter of WGIII/AR4 presents selected estimates of carbon exchange of forests and other terrestrial vegetation with the atmosphere in its table 9.2, but the authors stress that because of the differences in methods and scope of studies, values from different publications are not directly comparable and therefore, **the table presents samples of reported results only.**

² At the time of preparing this report, the contribution of WGIII to AR4 has not been adopted yet. Therefore, any of the information in there may still be subject to change. The version cited/used for this report is the final government draft of early 2007.

Table 9.2: Selected estimates of carbon exchange of forests and other terrestrial vegetation with the atmosphere (in MtCO₂/yr).

Regions	Annual Carbon Flux based on international statistics	Annual Carbon Flux during 1990's	
	UN-ECE, 2000	based on inversion of atmospheric transport models	based on land observations
	MtCO ₂ /yr		
OECD North America		1,833 ± 2,200 ⁹	0 ± 1,100 ²
Separately: Canada	340		
USA	610	2,090 ± 3,337 ²	293 ± 733 ¹
OECD Pacific	224		0 ± 733 ¹
Europe	316	495 ± 752 ⁶	0 ± 733 ¹ 513 ¹¹
Countries in Transition	1,726	3,777 ± 3,447 ²	1,100 ± 2,933 ⁹
Separately: Russia	1,572	4,767 ± 2,933 ⁹	1,181 ± -1,588 ⁷ 1,907 ± 469 ⁸
Northern Africa		623 ± 3,593 ²	
Sub-Saharan Africa			-576 ± 235 ³ -440 ± 110 ⁴ -1,283 ± 733 ¹
Caribbean, Central and South America		-2,310 ± 3,887 ²	-1,617 ± 972 ³ -1,577 ± 733 ⁴ -2,750 ± 1,100 ¹
Separately: Brazil			0 ± 733 ¹²
Developing Countries of South and East Asia and Middle East		-2,493 ± 2,713 ²	-3,997 ± 1,833 ¹ -1,734 ± 550 ³ -1,283 ± 550 ⁴
Separately: China		2,273 ± 2,420 ²	-110 ± 733 ¹ 128 ± 95 ¹³ 249 ¹⁴
Global total		4,767 ± 5,500 ⁹ 2,567 ± 2,933 ¹⁰ 4,913 ² 9516 ¹⁷	-7,993 ± 2,933 ¹ -3,300 ± 7,700 ⁵ -4,000 ¹⁵ -5,800 ¹⁶ -8485 ¹⁸
Annex I (excl Russia)			1300 ¹⁹

Notes: Positive values represent the sink of carbon, negative values represent source (in red). Sign "±" indicates a range of values; sign "□" indicates error term.

¹ Houghton 2003a (flux from changes in land use and land management based on land inventories);

² Gurney et al. 2002 (inversion of atmospheric transport models, estimate for Countries in Transition applies to Europe and boreal Asia; estimate for China applies to Temperate Asia);

³ Achard et al. 2004 (estimates based on remote sensing for tropical regions only);

⁴ De Fries 2002 (estimates based on remote sensing for tropical regions only);

⁵ Potter et al. 2003 (NEP estimates based on remote sensing for 1982-1998 and ecosystem modelling, the range reflects interannual variability);

⁶ Janssens et al. 2003 (combined use of inversion and land observations; includes forest, agricultural lands and peatlands between Atlantic Ocean and Ural Mountains, excludes Turkey and Mediterranean isles);

⁷ Shvidenko and Nilson, 2003 (forests only, range represents difference in calculation methods);

⁸ Nilsson et al. 2003 (includes all vegetation);



- ⁹ Ciais et al. 2000 (inversion of atmospheric transport models, estimate for Russia applies to Siberia only);
¹⁰ Plattner et al. 2002 (revised estimate for 1980's is 400-700);
¹¹ Nabuurs et al. 2003 (forests only);
¹² Houghton et al. 2000 (Brazilian Amazon only, losses from deforestation are offset by regrowth and C sink in undisturbed forests);
¹³ Fang et al. 2005;
¹⁴ Pan et al. 2004,
¹⁵ FAO 2006a (global net loss of biomass resulting from deforestation and regrowth);
¹⁶ IPCC AR4, WG I, (estimate of loss of biomass from deforestation),
¹⁷ IPCC AR4, WG I, (Residual terrestrial carbon sink),
¹⁸ EDGAR database for agriculture and forestry (see Chapter 1, Figure 1.3a/b (Olivier et al.2005)). These include emissions from bog fires and delayed emissions from soils after land use change,
¹⁹ Olivier et al.2005.

- 7) Improved spatial resolution allowed estimating the land-atmosphere C flux for some continents separately (see table 9.2 of chapter 9 WGI/AR4 reproduced above). These estimates generally suggest greater sink or smaller source than the bottom-up estimates based on analysis of forest inventories and remote sensing of change in land-cover (Houghton 2005). While the estimates of forest expansion and regrowth in the temperate and boreal zones appear relatively well constrained by available data, and consistent across published results, the rates of tropical deforestation remain uncertain and hotly debated. In general, studies based on remote sensing report lower rates of forest cover than the UNECE/FAO (2000) and lower emissions of carbon.
- 8) Chapter 11 of WG III's contribution to AR4 synthesises the **global emissions for the year 2004 as 5.8 GtCO₂-eq**. As no baseline emissions for the year 2030 from the forestry sector are reported, the baseline emissions for all GHGs adopted for **2030 are also estimated to be 5.8 GtCO₂-eq**. Both estimates exclude peat and other bog fires.

2.1.2 Recent net emissions and removals according to the WRI CAIT database³ and forest areas according to the FAO FRA 2005.

- 9) The table below combines information from the CAIT database's top 30 emitters in 2000 in the area of Land-Use Change and Forestry and the FAO FRA 2005. **It must be noted that these data sets are based on different data and therefore, are for illustration purposes only.**

³ The Climate Analysis Indicators Tool (CAIT) of the World Resources Institute in Washington uses data from: Carbon Dioxide Information Analysis Center (CDIAC), Dutch National Institute of Public Health and the Environment (RIVM), EarthTrends (WRI), Richard Houghton (Woods Hole Research Center), Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA), The World Bank, World Health Organization (WHO), United Nations Development Programme (UNDP), U.S. Environmental Protection Agency (EPA) and the U.S. Energy Information Administration.

Source	Country CAIT	MtCO ₂ in 2000* CAIT	% of global LUCF emissions in 2000* CAIT	Forest Area in 2000 (x1000 ha) FAO	Annual change rate '00-'05 (x1000 ha) FAO	Annual change rate '00-'05 (%) FAO
1	Indonesia	2,563.10	33.64%	97.852	-1.871	-2.0
2	Brazil	1,372.10	18.01%	493.213	-3.103	-0.6
3	Malaysia	698.9	9.17%	21.591	-140	-0.7
4	Myanmar	425.4	5.58%	34.554	-466	-1.4
5	Congo, Dem. Rep.	317.3	4.16%	135.207	-319	-0.2
6	Zambia	235.5	3.09%	44.676	-445	-1.0
7	Nigeria	194.8	2.56%	13.137	-410	-3.3
8	Peru	187.2	2.46%	69.213	-94	-0.1
9	Papua New Guinea	146	1.92%	30.132	-139	-0.5
10	Venezuela	144.1	1.89%	49.151	-288	-0.6
11	Nepal	123.5	1.62%	3.900	-53	-1.4
12	Colombia	106.1	1.39%	60.963	-47	-0.1
13	Mexico	96.8	1.27%	65.540	-260	-0.4
14	Philippines	94.9	1.25%	7.949	-157	-2.1
15	Cote d'Ivoire	91.1	1.20%	10.328	15	0.1
16	Bolivia	83.8	1.10%	60.091	-270	-0.5
17	Cameroon	77.1	1.01%	22.345	-220	-1.0
18	Canada	64.5	0.85%	310.134	0	0
19	Madagascar	60.2	0.79%	13.023	-37	-0.3
20	Ecuador	58.9	0.77%	11.841	-198	-1.7
21	Guatemala	56.6	0.74%	4.208	-54	-1.3
22	Cambodia	56.1	0.74%	11.541	-219	-2.0
23	Argentina	55.1	0.72%	33.770	-150	-0.4
24	Russian Federation	54.2	0.71%	809.268	-96	-
25	Nicaragua	53.7	0.70%	5.539	-70	-1.3
26	Thailand	47.6	0.63%	14.814	-59	-0.4
27	Panama	47.5	0.62%	4.307	-3	-0.1
28	Zimbabwe	47.4	0.62%	19.105	-313	-1.7
29	Liberia	39.4	0.52%	3.455	-60	-1.8
30	Uganda	39.3	0.52%	4.059	-86	-2.2
		7,638.20	100.25%			

* Source: Houghton, 2003.

10) The percentage of global LUCF emissions in 2000 exceeds 100%, even though this is a total of only the top 30 emitters. This is possible because the global total (all countries) also includes countries that are a net sink, lowering the total amount of emissions again.

11) Looking at the complete dataset from CAIT, and corresponding information from the FRA 2005, aggregated for regions, the following picture emerges.



Country Source	MtCO ₂ in 2000 CAIT	% of global LUCF emissions in 2000 CAIT	Forest Area in 2000 (x1000 ha) FAO	Annual change rate '00-'05 (x1000 ha) FAO	Annual change rate '00-'05 (%) FAO
Asia	3,957.10	51.94%	566,562	1,003	0.18
South America	2,053.90	26.96%	852,796	-4,251	-0.50
Central America & Caribbean	303.2	3.98%	29,543*	-231*	
Caribbean			5,706	54	0.9
Central America			23,837	-285	-1.2
Oceania	153.8	2.02%	208,034	-356	-0.17
Sub-Saharan Africa	1,398.80	18.36%			
Middle East & N. Africa	52.2	0.68%			
Africa			655,613	-4,040	-0.62
Europe	32.6	0.43%	998,091	661	0.07
North America	-338.3	-4.44%	677,971	-101	-
World	7,618.60	100.00%	3,988,610	-7,317	-0.18

* Calculated as the sum from the FAO regions 'Caribbean' and 'Central America'.

12) Asia is the region with by far the highest share of LUCF emissions, followed by South America and Sub-Saharan Africa. South America and Africa however, have the biggest absolute loss of forest area in the period of 2000-2005. For Asia a growth in forest area is reported in the same period. This can partially be explained by the fact that the emissions in Asia are predominantly be caused by logging, without it leading to deforestation, and the growth of plantation area. Percent-wise the loss of forest area is largest in Central America and the Caribbean. Third is Africa, followed closely by South America.

13) In addition to the groupings listed above, it is interesting to note that according to the CAIT database, the least developed countries (LDCs) together are responsible of over 20% of the emissions (1543,8 MtCO₂ in 2000) and that the OPEC countries together represent 38% of the emissions (2913.7 MtCO₂ in 2000). This offers an interesting perspective when considering a future climate regime that possibly includes a reward system for the reduction of emissions from deforestation in developing countries (REDD): both groups of countries could benefit from support to reduce these emissions and it may result in a way of economic diversification for OPEC countries.

2.1.3 Other data

14) The table below presents other data reported in various sources.

Source of Data	Period	Parameter/Source of emissions/removals	Quantity (either in ha or in net emissions)
MEA 2005	2000-2050	Forest area: industrialised countries developing countries	+ 60-230 million ha - 200-490 million ha
FAO 2006	2005	Global forest cover	3.952 million ha
	2000-2005	deforestation	12.9 million ha
	2000-2005	Net loss of forest area	7.3 million ha per year (equalling 4000 MtCO ₂ yr ⁻¹)
	1990-2000	deforestation	13.1 million ha
	1990-2000	Net loss of forest area	8.9 million ha per year
WG III / AR4 chapter 9	1990-2000	Forest degradation	2.4 million ha per year
WG III / AR4 chapter 11	2004	Global emissions from forestry (excluding peat and other bog fires)	5.8 GtCO ₂ -eq. yr ⁻¹
	2030	Global emissions from forestry (excluding peat and other bog fires). (This estimate is the same as for 2004 because no baseline emissions for 2030 from the forestry sector are reported)	5.8 GtCO ₂ -eq. yr ⁻¹

15) In general, the regions of Latin America and the Caribbean and Africa are reported to be the two regions that are losing their forests at the highest rates.

16) According to the FAO (2007), the global annual net rate of loss between 2000 and 2005 (0.51%) was higher than that of the 1990s (0.46%).

2.1.4 Comparing the data sets

17) Table 9.2 from the WGIII/AR4 provides annual fluxes in MtCO₂ yr⁻¹ from the UN-ECE for the year 2000. The CAIT database also provides MtCO₂ yr⁻¹ for 2000. In addition, the WGIII/AR4 table provides estimates for annual carbon fluxes during the 1990s based on models and on land observations.



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- 18) The dataset of the FAO for forest area and forest area lost remains the most complete data set available. No other datasets are available to compare area estimates.
- 19) The lowest level of disaggregation that can be presented and compared is on the regional level but not all regions can be compared due to different groupings of countries and / or sub-regions.
- 20) The table below presents a synthesis of data.

	WGIII/AR4		CAIT ⁴	FAO		Other sources	
Year	UN-ECE 2000	Flux in 1990s (various sources reported in WGIII/AR4)		2000	2000	('00-'05)	
Region	Unit MtCO ₂ yr ⁻¹	MtCO ₂ yr ⁻¹		MtCO ₂	Forest area (x1000 ha)	Forest area lost (x1000 ha)	Forest area lost and degradation
		Models	Land observ.				
Asia				-3957.10	566,562	1003	
South America				-2053.90	852,796	-4251	
Central America & Caribbean				-303.2	29,543	-231	
Caribbean					5,706	54	
Central America					23,837	-285	
Oceania				-153.8	208,034	-356	
Sub-Saharan Africa			-576 (+235) -440 (+110) -1283 (+733)	-1398.80			
Middle East & N. Africa				-52.2			
Africa					655,613	-4040	
Europe	316	495 (+ 752)	0 (+ 733) and 513	-32.6	998,091	661	
North America	CAN 340 USA 610	1833 (+2200)		338.3	677,971	-101	
World		4767 (+5500) 2567 (+2933) 4913 9516	-7993 (+2933) -4000 -5800 -8485	-7618.60	3,988,610 In 2005 3,952,000	-7317*	13.1 million ha in '90-'00 (net 8.9 million ha) (FAO 2006) 12.9 million ha in '00-'05 (FAO 2006) 2.4 million ha in '90-'00 forest degradation (WGIII/AR4)

* According to FAO (2005) equalling 4000 MtCO₂ yr⁻¹

⁴ Please, note the sign reversal: WGIII/AR4 indicates a sink as a positive value, whilst the CAIT tool reports emissions. For comparison reasons, the sign of the CAIT values has been changed: emissions are reported as negative values (like the WGIII/AR4 values).



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- 21) Most of the CAIT groupings differ from those used in chapter 9 from WGIII/AR4, but the estimate for sub-Saharan Africa from CAIT corresponds with the highest estimate based on land observations reported by WGIII/AR4. Most likely because both CAIT and WGIII/AR4 are using the same underlying data source from Houghton (2003).
 - 22) Values for the Caribbean and Central and South America of CAIT also correspond with the estimates of WGIII/AR4: the total for those regions corresponds to the lower estimate of inversion of atmospheric transport models and the highest estimate based on land observations.
 - 23) In general it has to be noted that the estimates vary strongly. This was concluded by the chapter 9 authors of the WGIII/AR4 as well.

2.2 Overview of existing financial flows into the forestry sector

24) According to Ian Noble from the World Bank the share of ODA going into forestry has seen a steady decline to about USD 1.75 billion per year (Noble, 2006). FDI in the forestry sector on the other hand has been characterized by an increase into developing countries. Estimates vary but all agree that private FDI considerably exceeds public ODA. According to Ole Sand, IFC Principal Investment Officer, the IFC's forest sector investments over the last 10 years have been on average USD 65-75 million per year with another USD 600 million in the pipeline. (PROFOR, 2004). According to PROFOR (2004), current levels of investment in the forest sector, both domestic and foreign, fall far short of the level necessary to realize the potential of well-managed forest resources to contribute to poverty alleviation, the protection of vital environmental services, and sustainable economic growth in developing and transition countries.

25) The table below lists information on funding and investment flows in the forest sector from various sources without claiming to be comprehensive or complete.

Funding Source	Volume	Comments
ODA	Approx. 110 million USD per yr.	See next pages. Source: Credit Reporting System (CRS), 2006, OECD Statistics.
GEF	1.25 billion USD since 1997	236 projects through 6 Operational Programmes. Leveraged co-financing 3.45 billion USD. See table below for geographic distribution and type of support. Source: GEF/C.27/14, October 12, 2005 and information directly from the GEF secretariat.
ITTO (see table below)	11.5 million USD in 2006	Conservation and sustainable management, use and trade of tropical forest resources Source: www.itto.or.jp
NFP Facility	17.3 million USD over 5 years '02-'07) of which 12.5 is committed	The Facility has programmes in approximately 50 countries, each of which receives 300.000 USD over 3 years. Committed: 1.7 million in '05, over 2 million in '06. In '06 44% of the funding went to Africa, 7.5% to Central Asia, 13% to Asia and the Pacific and 35% to Latin America and the Caribbean. Source: 2006 Progress Report. Courtesy of NFP Facility
PROFOR	8.2 million USD in 2002-2006	34 different activities. Themes include: livelihoods, governance, financing, cross-sectoral cooperation, knowledge management. 8.2 million USD over the period 2002-2006, 58% was spent on global activities, 6% in regions and 36% in countries. It has leveraged 1.3 million in co-financing Source: Savcor Indufor 2006



World Bank Global Forest Alliance	1.5-2 million USD per year	It is hoped that this fund will be growing to about 500 million USD for REDD pilots. It will be modeled after PCF/Biocarbon Fund (personal comments Bob Watson, World Bank, 2007)
FDI	Possibly 150 billion per year, 37 billion going to developing countries, on the basis of several assumptions	190 billion inward flows in 2000 of which 47.3 billion to developing countries. The categories included in these figures are: shaped wood, rail sleepers; wood manufactures; pulpwood, chips and wood waste; paper and paper board; cut paper and paper board; other wood rough, squared; and, fuel wood, charcoal. Inward flows are not equivalent to investments. If we assume IRRs on forestry of 15% on average and a commercial interest rate of 10%, the investment flow could possibly be somewhere around 150 billion with 37 billion going to developing countries. Source: UNCTAD 2007
IFC	65-75 million USD per year	Source: PROFOR, 2004
Direct Private Investments	63 billion USD per year, 15 billion per year to developing countries	63 billion USD per year in total (all countries). 15 billion per year to developing countries and EITs. Mainly domestic direct investments (over 90%) Source: Tomaselli 2006 cited in Savcor Indufor 2006
Other funds	53.8 million USD	Biocarbon fund Source: www.carbonfinance.org
New South Wales GHG Abatement Scheme (GHGAS)		6.7 million USD to date based on prices of 11.50 AUD/tCO ₂ -e for forestation and a traded volume 0.7 MtCO ₂ -e Source: Modified after Savcor Indufor 2006

26) As can be seen from the table above, most of the current financial flows into the forestry sector are not related to climate change (section 2.3 will review the application of Art.3.4 activities during the commitment period and AR project activities under Art.12 of the Kyoto Protocol). Available statistical data indicates that the vast majority of investment flows/financing to the forest sector, including sustainable forest management (SFM), is from the private sector and according to Savcor Indufor Oy (2006) over 90% of those private sector investments is domestic. But in general, there is very limited quantitative information on the cost-benefit ratios of mitigation interventions in forestry is available, irrespective whether it is related to mitigating climate change or not. In addition, the success rate of investments/funding is often not determined in terms of ha of forest established or protected, or tonnes of carbon sequestered. Therefore, it is difficult to assess the link between the magnitude of funding and the forest areas associated with it.

GEF

27) Public sector financing (domestic and ODA) has an important catalytic role. GEF, for instance, has rendered support to the forest sector since 1997 through various Operational Programmes (1 arid and semi-arid ecosystems, 2 coastal, marine, and freshwater ecosystems, 3 forest ecosystems, 4 mountain ecosystems, 12 integrated ecosystems management, and 15 sustainable land management) which has yielded 3.45 billion USD of co-financing per year. The overview of the GEF support is presented in the table below.

	Forest Conservation		Sustainable Use of Forests		SFM		Total GEF funding in US \$ (millions)
	Allocated GEF Funds in US \$ (millions)	Leveraged Co-Financing in US \$ (millions)	Allocated GEF Funds in US \$ (millions)	Leveraged Co-Financing in US \$ (millions)	Allocated GEF Funds in US \$ (millions)	Leveraged Co-Financing in US \$ (millions)	
Total Eastern and Southern Africa	69.655	351.27	15.12	43.33	69.872	255.904	154.647
Total Northern Africa	5.65	17.3			11.09	112.06	30.6
Total Western and Central Africa	80.085	191.37	5.841	119.347	41.79	180.251	127.716
Total Africa	246.775	559.94	20.961	162.677	123.752	548.355	312.963
Total East Asia	35.93	51.85			13.21	31.42	49.14
Total South and Southeast Asia	79.089	153.993	16.707	20.315	46.845	94.87	212.964
Total Western and Central Asia	31.865	33.485	5.56	59.46	11.435	25.73	48.86
Total Asia	146.884	239.328	22.267	79.775	71.49	152.02	310.964
Total Europe	27.051	27.189	8.14	36.24	37.482	52.8	72.673
Total Caribbean	2.145	11.291	0.19	0.2	0.99	0.972	3.325
Total Central America	80.83	193.686	13.4	57.525	49.26	212.112	143.49
Total North America	20.79	77.63	31.837	140.297	15.905	28.615	68.532
Total North and Central America	145.345	282.607	45.427	198.022	66.155	241.699	256.927
Total Oceania			17.55	38.75	5.09	2.2	22.64
Total South America	153.948	212.713	22.837	18.514	47.732	101.178	224.517
Global projects	1	4.61			45.04	59.96	
World	721.003	1326.387	137.182	533.978	396.741	1158.212	1254.93

(Source: GEF, 2005)



ODA

28) The summary table below presents the expenditure in terms of Official Development Assistance (ODA) according to the Credit Reporting System of the OECD. The table presents bilateral, multi lateral and other flows for 1990, 1995, 2000 and 2005. The categories that are included are:

- a) Forestry policy and administrative management;
- b) Forestry development;
- c) Fuel wood;
- d) Forestry education and training;
- e) Forestry research; and,
- f) Forestry services.

Data sheets for all these categories are contained by annex 1.

year	Total ODA in million USD; all categories			
	1990	1995	2000	2005
Africa	270	47	110	149
Annex-I parties to UNFCCC	0	0	0	0.2
Central Asia	0	0.1	2	31
Developing Asia	468	254	171	362
Latin America	35	104	48	20
Middle East	1	0	0.2	0.6
North Africa	66	0.2	39	0.4
OECD North America	0.3	3	0.4	0.3
Transition Economies	0	1	4	44
Developing Countries	774	404	328	531
+ 5 Countries	337	170	41	321

Source: Credit Reporting System (CRS), 2006, OECD Statistics.

29) The following table presents the split over bilateral, multi lateral and other flows of ODA for 1990, 1995, 2000 and 2005 for the same categories.

	Total ODA in millions USD ^a											
	1990			1995			2000			2005		
	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*
Africa,	157.44	18.43	97.19	39.16	5.28		75.65	34.76		61.02	86.68	
AI parties										0.17		
Central Asia				0.13			2.59			0.52	30.00	
Developing Asia	72.84	343.08	54.31	100.42	157.67		131.63	33.36		359.24	1.00	
Latin America	37.20	0.00	4.19	97.43	3.24		39.87	5.33		19.62		
Middle East	0.79						0.15			0.58		
North Africa		5.40	60.90	0.15			38.93			0.42		
OECD North America	0.29			3.48			0.43			0.34		
Transition Economies				0.50			4.57			6.65	37.00	
Developing Countries**	268.27	361.51	155.70	237.00	166.34		247.16	73.45		440.47	87.68	
+ 5 Countries***	37.09	300.00	0.03	84.08	90.91		32.37	3.27		320.76		

^a Categories included area: Forestry policy and administrative management; Forestry development; Fuel wood; Forestry education and training; Forestry research; and, Forestry services.

[^] Source: Credit Reporting System (CRS), 2006, OECD Statistics.

* Non-export credits; ** Africa, Developing Asia, Latin America and Middle East; *** Brazil, China, India, Mexico and South Africa

- 30) For Africa the assistance to category a) and b) has been the most important over the years (Forestry policy and administrative management and Forestry development). Developing Asia has received relatively substantial assistance in all categories with a strong emphasis in 2005 on forestry development. Latin America receives predominantly bilateral assistance in categories a) and b). The emerging economies have received substantial bilateral assistance (73% of the total) with a focus on category b) and very little over the years in c) and f) (Fuel wood and Forestry services).
- 31) Main points that can be drawn from these statistics are that in the forestry sector:
- In total ODA to developing countries for the forestry sector has declined from 774 million per year in 1990 to 531 million per year in 2005.
 - Developing Asia received most ODA in 2005 (68%); second comes Africa with less than half of that level (28%; 362 vs. 149 million per year). Latin America receives just over 3.5% (20 million per year).
 - ODA to Africa has been highest in 1990 and is now at about half that level (270 vs. 149 million per year).
 - The bilateral ODA in Asia has gone up consistently between 1990 and 2005 (72.8 million per year in 1990 vs. approx. 360 now) whilst the multilateral ODA has gone down dramatically (from 343 million down to 1 million per year).
 - The Middle East receives bilateral assistance in small volumes, most likely because forestry is not an important sector in the Middle East.
 - The emerging economies have received substantial bilateral assistance (73% of the total against 60% overall share in ODA).
 - The current bilateral aid to the emerging economies Brazil, China, India, Mexico and South Africa has increased to nearly tenfold the level of 1990 (37 vs. 320 million per year).
 - Overall the bilateral ODA in the forestry sector to developing countries has doubled in 2005 compared to 1990 whilst the multilateral assistance is currently only about a quarter of the level in 1990.

ITTO

- 32) The International Tropical Timber Organisation (ITTO) has also supported the forestry sector over the years. ITTO is an intergovernmental organization promoting the conservation and sustainable management, use and trade of tropical forest resources. It has 59 members that together represent about 80% of the world's tropical forests and 90% of the global tropical timber trade. ITTO develops internationally agreed policy documents to promote sustainable forest management and forest conservation and assists tropical member countries to adapt such policies to local circumstances and to implement them in the field through projects. In addition, ITTO collects, analyses and disseminates data on the production and trade of tropical timber and funds a range of projects and other action aimed at developing industries at both community and industrial scales.
- 33) The table below displays some of the statistics that ITTO collects from its members. In 2004 the total production by ITTO countries was about 1.6 billion m³, but as can be seen, the im- and export flows are only a small proportion of that. The total value of trade in timbers was approximately 50 billion imports and 40 billion exports in ITTO countries.

2004		production	import	export	domestic consumption
Production, Trade and Consumption of All Timber by ITTO Consumers	million m ³	1,317	243	135	1,409
Production, Trade and Consumption of All Timber by ITTO Producers	million m ³	291	14	38	268
Trade in all timbers by ITTO consumers, total	million USD		47,791	30,134	
Trade in all timbers by ITTO producers, total	million USD		2,856	9,048	

Source: <http://www.itto.or.jp/>

- 34) ITTO financially supports projects and activities, all of which are funded by voluntary contributions, mostly from consuming member countries. Since it became operational in 1987, ITTO has funded more than 700 projects, pre-projects and activities valued at more than 280 million USD. The major donors are the governments of Japan, Switzerland and the USA. The breakdown of ITTO's support is presented in the table below.

	Countries	ITTO contribution USD	Country's contribution USD	Total USD
Africa	Cameroon, DRC, Gabon and Ghana	1,441,539	488,783	1,930,422
East Asia	Japan	257,472	45,000	302,472
S&SE Asia	Cambodia, India, Indonesia and Myanmar	1,258,947	849,279	2,365,698
North America	Mexico	463,670	292,600	756,270
Oceania	PNG	138,726	24,429	163,155
South America	Colombia, Ecuador, Guyana	744,688	309,938	1,084,626
TOTAL		4,335,042	1,965,029	6,300,171

Source: www.itto.or.jp

UNCTAD Statistics

- 35) Results from the private sector in terms of investments are not easily accessible due to the confidential nature of that information. But according to Tomaselli (2006) there is a strong link between trade and investment: if investments in forestry and the forest industry go up, the trade market in that sector grows. The table below maps out the import and export flows in the wood industry for the years 1990, 1995 and 2000 as an indicator for trade in the sector. This does not include in-country investments in plantation establishment and/or forest management of course.

- 36) **Table:** Im- and exports in 1990, 1995 and 2000 around the world in the following categories: a) wood, shaped, rail sleepers; b) wood manufactures nes; c) pulpwood, chips and wood waste; d)



paper and paper board; e) paper and paper board, cut; f) other wood rough, squared; and, g) fuel wood nes, charcoal.

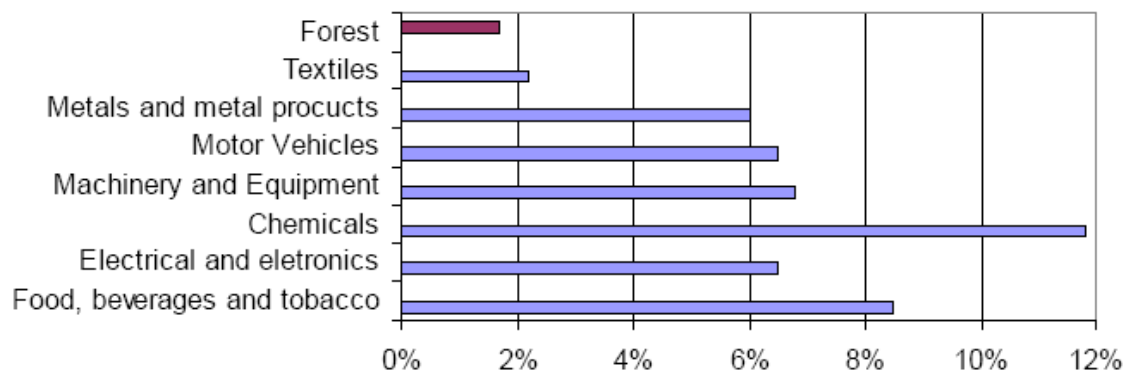
		1990	1995	2000
		Million USD	Million USD	Million USD
Developed economies	Exports	100061	146681	139260
	Imports	104904	143653	140025
Developed economies: America	Exports	33724	51738	51582
	Imports	19436	30313	39354
Developed economies: Europe	Exports	62817	89912	82470
	Imports	70406	91002	83392
Developed economies: EU 25	Exports	59629	86261	79117
	Imports	66556	86009	79039
Other developed Europe	Exports	3188	3651	3354
	Imports	3850	4993	4353
Developed economies: Asia	Exports	2145	2656	2841
	Imports	13185	19647	14359
Developed economies: Oceania	Exports	1376	2376	2367
	Imports	1877	2691	2920
Developing economies	Exports	14745	28731	32535
	Imports	22374	42786	47289
Developing economies: Africa	Exports	2034	3085	2887
	Imports	3368	4131	3697
Developing economies: America	Exports	3261	8036	8842
	Imports	3505	8718	10661
Developing economies: Asia	Exports	9293	17381	20645
	Imports	15385	29789	32763
Developing economies: Oceania	Exports	158	229	161
	Imports	116	155	168
LDCs	Exports	478	1002	716
	Imports	538	724	947
Sub-Saharan Africa	Exports	1934	2930	2735
	Imports	1416	1669	1774
World	Exports	119752	179058	177526
	Imports	129341	188998	190317

Source: UNCTAD 2007 (<http://stats.unctad.org>)

FDI

37) FDI in the forest sector is relatively small compared to other industrial segments: see figure below.

FDI BY INDUSTRIAL SEGMENTS



Source: UNCTAD, 2005

38) Looking at FDI in the primary sector (forestry/agriculture/hunting and fishing) a high concentration of investments is found in the developing countries, whilst investments in the secondary sector (forest industries) are predominantly located in the developed world. (UNCTAD 2005, cited in Tomaselli (2006))

Certification of Good Forest Management

39) A trend in the forestry sector that originates in the 1990s is the consumer-driven demand on forest managers to respect non-market benefits of forest. To demonstrate compliance certification schemes have evolved. In general certification schemes that demonstrate compliance with performance or process standards add to the transaction costs, whilst a significant price premium on certified timber has not been generated so far. This may initially lead to lower internal rate of returns (IRR) on investments, but guarantees keeping access to certain retail markets.

40) Consumer demands and NGO pressure have been instrumental in the steady increase of these forest management certification schemes and the spread of good forest management globally. For instance, certification against the Forest Stewardship Council's (FSC) Principles and Criteria, the toughest standard in terms of good forest management with broad support of environmental groups, social groups and industry, has led to 892 certificates in 75 countries, together covering nearly 88.5 million ha of forest under management world wide (last update March 2007). Some 5000 companies participate in the scheme. The table below illustrates the regional split of the certificates.



Region	No. of certificates	Hectares certified
Africa	43	2.541.093
America	383	37.954.627
Asia	50	1.643.609
Oceania	28	1.317.918
Total	892	88.431.626

For a more detailed split see www.fsc.org.

41) Whiteman (2006) argues that harvesting in primary tropical forests is still generally very profitable with value-added ranges from 500 USD ha⁻¹ of dryland forest to 3000 USD ha⁻¹ in most tropical forests. Forest management in tropical forests (i.e. actively managing natural forest as against logging and moving on) is less profitable (respectively 20 and 100 USD ha⁻¹ yr⁻¹): the care for the forest is more costly than picking up found capital. Together with the high opportunity costs for agriculture and plantations, the cost-effective management of natural forest remains a serious challenge.

2.3 Projections of GHG emissions and removals towards 2030 and other relevant data

2.3.1 Net emissions and removals for AR4 mitigation scenarios (as elaborated in the contribution of WG III)

2.3.1.a Mitigation strategies

Reducing Emissions from Deforestation

42) The available studies about mitigation options in the tropics (where virtually all of the emissions from deforestation originate) differ widely in basic assumptions regarding carbon accounting, costs, land areas, baselines, and other major parameters. A thorough comparative analysis is therefore, very difficult. In all the studies, however, future deforestation is estimated to remain high in the tropics in the short and medium term. Sathaye *et al.* (2007) estimate that deforestation rates continue in all the regions, particularly at high rates in Africa and South America, with a total of just under 600 million ha lost cumulatively by 2050. Using a spatial-explicit model coupled with demographic and economic databases, Soares-Filo *et al.*, (2006) predict that under a business-as-usual scenario, by 2050, projected deforestation trends will eliminate 40% of the current 540 million ha of Amazon forests, releasing approximately 117,000 ±30,000 MtCO₂ of carbon to the atmosphere.

Source	Indicator/parameter	Parameter value
Sathaye et al. 2007	Deforestation cumulative by 2050	600 million ha, all regions
Soares-Filo et al 2006	Deforestation by 2050	216 million ha, Amazon forest

43) Combating deforestation outside the climate convention is often an integral activity with the introduction of alternative land-use strategies, but has had only limited effect: the profitability incentives of alternative land use are simply too lucrative. In particular, options for maintaining forests on private lands in developing countries are more limited than on public lands, as governments typically have less regulatory control. Taken together, non-climate policies have had minimal impact on slowing tropical deforestation, the single largest contribution of the LUCF sector to global carbon emissions. There are examples, however, where countries with adequate resources and political will (e.g. Costa Rica) have been able to slow deforestation, raising the possibility that with sufficient institutional capacity, financial incentives, political will and sustained financial resources, it may be possible to scale up these efforts.

44) WGIII/AR4, forestry chapter, reports three major barriers to enacting effective policies to reduce forest loss are: (i) profitability incentives often run counter to forest conservation and sustainable forest management; (ii) many direct and indirect drivers of deforestation lie outside of the forest sector, especially in agricultural policies and markets; and (iii) limited regulatory and institutional capacity and insufficient resources constrain the ability of many governments to implement forest and related sectoral policies on the ground. In the face of these challenges, national forest policies designed to slow deforestation on public lands in developing countries have had mixed success:

1. In countries where institutional and regulatory capacities are insufficient, new clearing by commercial and small-scale agriculturalists responding to market signals continues to be a dominant driver of deforestation;
2. A number of national initiatives are underway to combat illegal logging. While these have increased the number of charges and convictions, it is too early to assess their impact on forest degradation and deforestation; and,
3. Legally protecting forests by designating protected areas, indigenous reserves, non-timber forest reserves and community reserves has proven an effective way to maintain forest cover in some countries, while in others, a lack of resources and personnel result in the conversion of legally protected forests to other land uses.

Bio-energy

45) Supply of bio-energy crops originate in agriculture (residues and cropping), forestry, waste supplies, as well as in biomass processing industries (e.g. paper & pulp and sugar industry). In WGIII/AR4 estimates, the supply of forest biomass for bio-energy is incorporated within the energy sector's mitigation potential.



- 46) No complete integrated studies are available for biomass supply-demand balances and biomass potential. However, in the overall estimates, bio-energy options are important for many sectors by 2030, with substantial growth potential beyond. Key preconditions for such contributions are development of biomass capacity (energy crops) in balance with investments in agricultural practices, logistic capacity, and markets, together with commercialization of second generation biofuel production. (IPCC, 2007)
- 47) Sustainable biomass production and use implies that issues are resolved in relation to competition for land and food, water resources, biodiversity and socio-economic impacts. With technical breakthroughs, biomass could make a larger future contribution to world energy needs. Such breakthroughs could also stimulate the investments required to improve biomass productivity for fuel, food and fibre.
- 48) High demand for bio-energy crops potentially poses a serious threat to the world's forests as opportunity costs for forest become higher due to the increasing demand for bio-energy crops. It has been estimated that recent agreement between the US and Brazil in the area of bio-energy, would require 22 million hectares of bio-energy crops. (Volkskrant, 2007)

Forestation

- 49) So far, afforestation and reforestation (here referred to as 'forestation') initiatives are mainly driven by the private sector when it comes to 'no regret' options (commercial plantation forestry), or governments. Incentives for plantation establishment may take the form of forestation grants, investment in transportation and roads, energy subsidies, tax exemptions for forestry investments, and tariffs against competing imports. In contrast to the conservation of existing forests, the underlying financial incentives to establish plantations may be positive. But due to the illiquidity of the investment, the high cost of capital establishment and long waiting period for financial return, the creation of many plantation estates has relied upon government support, at least in the initial stages.
- 50) CDM AR activities are still fairly limited, despite relative low costs and many possible positive side effects. This is due to a variety of barriers that can be categorised as economic, risk-related, political/bureaucratic, logistical, and capacity or political will. More about barriers can be found in section 2.4.1.

Forest management

- 51) Forest management, in particular sustainable forest management (SFM) has received ample attention over the last decades, and is both pursued by the private sector, as well as aid agencies, but in particular in a non-climate context. Forest management under article 3.4 will be used by only a few countries and is not an eligible activity under the CDM in the 1st commitment period.

52) Public forests in Annex I countries are already managed to relatively high standards, which may limit possibilities for increasing sequestration through changed management practices (e.g., by changing species mix, lengthening rotations, reducing harvest damage and or accelerating replanting rates). There may be possibilities to reduce harvest rates to increase carbon storage however, e.g. by reducing harvest rates and/or harvest damage.

53) In the year 2000 Parties were requested to provide submissions containing an assessment of net changes in carbon stocks, and changes in emissions by sources and removals by sinks, associated with the activities under Articles 3.3 and 3.4 during the 1st commitment period. The table below presents for those countries who did submit numbers, what their estimate was that forest management could contribute during the 1st commitment period.

54) Estimates of scale of Art.3.4 forest management activities during CP1* (FCCC, 2000)

	CO₂ (Gg CO ₂)	Non-CO ₂ (Gg CO ₂ e) CH₄	Non-CO ₂ (Gg CO ₂ e) N₂O
Canada	176.000	-4.000	-5.000
Finland	40.000	NR	NR
France	49.505	NR	NR
Germany	155.000	NR	NR
Japan	387.890	NR	NR
Netherlands	563	NR	NR
Sweden	83.500	NR	NR
Switzerland	5.316	NR	NR
United Kingdom**	45.000	NR	NR
United States	5.292.140	NR	NR
Total	6.234.914	-4.000	-5.000

* Numbers are a total over the entire 1st commitment period (5 years) and are provided by the countries themselves in 2000 in document FCCC/SBSTA/2000/9/Add.1.

** UK reports an additional 4.600 for bio-energy crops.

55) Proper management plans are seen as prerequisites for the development of management strategies that can include also carbon-related objectives. The lack of robust institutional and regulatory frameworks, trained personnel and secure land tenure has constrained the effectiveness of forest management in many developing countries. Africa, for example, had approximately 649 million forested hectares as of 2000 (FAO, 2001). Of this, only 5.5 million ha (0.8%) had long-term management plans, and only 0.9 million ha (0.1%) were certified to sound forestry standards.



- 56) Thus far, efforts to improve logging practices in developing countries have had limited success. For example, reduced-impact logging (RIL) would increase carbon storage over traditional logging, but has not been widely adopted by logging companies, even when they lead to cost savings. There are various plausible reasons for the lack of adopting better techniques, amongst other: staff working for firms that log-over natural forests is mainly untrained personnel and 'old habits die hard' (forestry is a traditional profession). Nevertheless, there are several examples where large investments in building technical and institutional capacity have dramatically improved forestry practices.
- 57) A recent report by the ITTO probes the state of tropical forestry in 33 countries in Asia, the Pacific, Latin America, the Caribbean and Africa. It shows that the area of sustainably managed tropical forests has expanded amongst its members from less than one million hectares in 1988 to at least 36 million hectares in 2005 (less than 5% of the 814 million ha surveyed by the report – 2/3 of all natural tropical forests in the world) also highlighting that 95% of the forests remain unprotected. In Asia and the Pacific, ITTO estimates that only 14.3 million ha of production forest in member countries are being sustainably managed, though on paper some 55 million ha are covered by management plans. In member countries in Africa, the comparable figures are 10 million under management plans versus 4.3 million actually sustainably managed, while in Latin America and the Caribbean, the gap is 31 million versus 6.5 million.
(<http://www.itto.or.jp/>)
- 58) ITTO statistics also indicate that of the 461 million ha of forests that are supposed to be protected. ITTO members (59) have developed plans for 18 million ha (3.9%), and have implemented them on about 11 million ha (2.4%). Most of the forests under active protection lie in the Asia/Pacific (5.1 million ha) and the Latin America/Caribbean regions (4.3 million ha). In Africa, ITTO found only 1.7 million ha of tropical forest with viable protection plans.
(<http://www.itto.or.jp/>)
- 59) Due to the high opportunity costs, forest management of natural tropical forests is only an attractive economic course of action in areas where other land uses are not profitable. Payments for the carbon retention function of forests can enlarge the area where that is the case. With such positive financial incentives there is some scope for the improvement of forest management and reduced impact logging (RIL) but it will require clear, strong, and continued signals from donors and/or the market to sustain such performance.
- 60) According to Whiteman (2006) the current trend of decentralisation and delegation of authority weakens the capacity to implement sound forestry management, but the first experiences with the demotion of responsibility for open access forests to local communities are very positive and do not support Whiteman's perspective. (Trines et al., 2006)
- 61) According to the Millennium Ecosystem Assessment (2005) scenarios, the forest area in the industrialised regions will increase between 2000 and 2050 by about 60 to 230 million ha, while at the same time in the developing regions forest area will decrease by about 200 to 490 million ha. Quantities of carbon stored in forests may also change due to disturbances such as forest

fires, pests (insects and diseases) or climatic events (such as drought, wind, snow, ice and floods).

2.3.1.b Models & Estimates

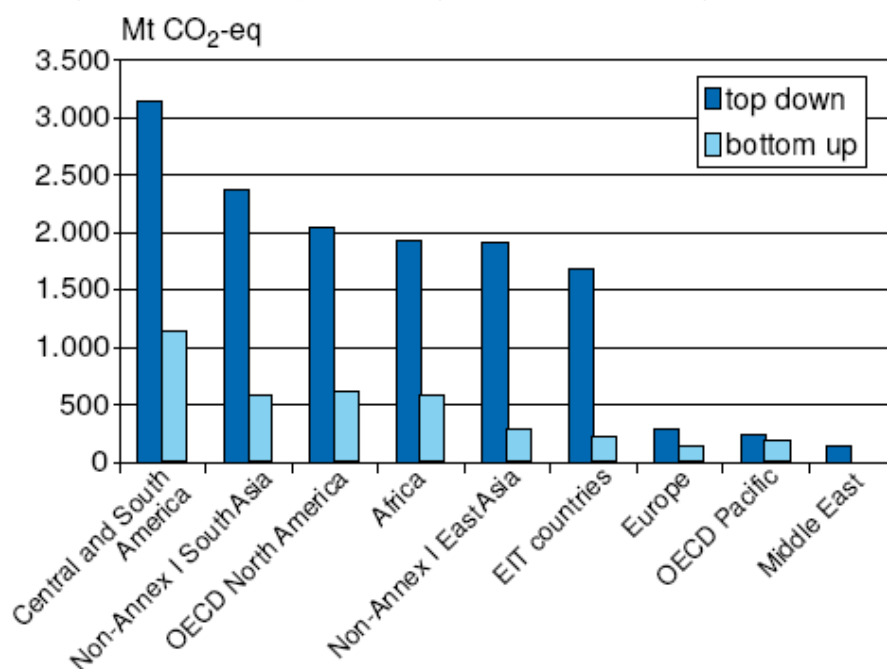
All of this section is derived from WGIII, AR4, chapter 9 and 11, unless otherwise stated.

- 62) Authors of AR4 agree that Integrated Assessment Models (IAMs) are the most appropriate for developing land-use change scenarios, and they continue to be the only available tool for global scale studies. A number of new models have emerged that provide insights into regional land-use change but they can generate very different land-use change scenarios to those generated by IAMs, often with opposing directions of change. (IPCC, WG II, chapter 2, 2007)
- 63) IAMs used to characterise the A2 marker scenario did not include land-cover change, so changes under the A1 scenario were assumed to apply also to A2. Given the differences in socio-economic drivers between A1 and A2 that can affect land use change, this assumption is not appropriate. Nor do the SRES land cover scenarios include the effect of climate change on future land cover. (IPCC, WG II, chapter 2, 2007)
- 64) A proportional approach to down-scaling the SRES land cover scenarios has been applied to global ecosystem modelling by assuming uniform rates of change everywhere within a SRES macro region. In practice, however, land-cover change is likely to be greatest where population and population growth rates are greatest. (IPCC, WG II, chapter 2, 2007)
- 65) More recent modelling based on projected deforestation and climate change in the tropics alone (IS92a, CGCM1, CSIRO, ECHAM, HadCM3) suggests an additional release of 101 to 367 PgC, adding between 29 and 129 ppm to global atmospheric CO₂ by 2100, mainly due to deforestation. (IPCC, WG II, chapter 4, 2007)
- 66) The literature still displays a large variation of mitigation estimates, partly due to the natural variability in the system, but partly due to differences in baseline assumptions, and data quality. In addition, Parties to the Convention are improving their estimates through the design of National Systems for GHG Inventories. But few major forest-based mitigation analyses have been conducted using *new* primary data. In addition, there is still hardly any integration with climate impact studies, and limited views in relation to social issues and sustainable development.
- 67) No adequate feedback models are currently available to make reliable predictions of the impacts of climate change that can affect the mitigation potential of the forestry sector by either increasing (i.e. CO₂ fertilisation) or decreasing (i.e. changes in rain patterns, etc.) the C sequestration. Likewise, the extent of adaptation in the future will impact on the mitigation potential. Overall however, the authors of WGIII/AR4 assessed the impacts on the mitigation potential to be marginal at most in comparison to changes in land use due to socio-economic drivers (which may in part be driven by climate change).
- 68) For the quantification of the economic potential of future mitigation by forests three approaches are currently available in literature: a) regional bottom up assessments per country

or continent, b) global forest sector models, and c) global multi-sectoral models. Comparing mitigation estimates between top-down and bottom-up modelling is not straightforward. Bottom-up mitigation responses are typically more detailed and derived from more constrained modelling exercises. Cost estimates are therefore, partial equilibrium in that input and output market prices are fixed, as can be key input quantities such as acreage or capital. Top-down mitigation responses consider more generic mitigation technologies and changes in outputs and inputs (e.g. shifts from food crops or forests to energy crops) as well as changes in market prices (e.g. changes in land prices with increased competition for land). In addition, top-down models currently make the optimistic assumption of simultaneous global adoption of a coordinated climate policy with an unconstrained, or almost unconstrained, set of mitigation options across sectors. Data from top-down estimates also include additional deforestation (negative mitigation potential) due to biomass energy plantations. This is not included in the bottom-up estimates.

69) In general, the bottom-up assessments also yield a lower potential consistently for every region because this type of study takes into account (to some degree) barriers for implementation. The bottom up estimate has, therefore, characteristics of a market potential study, but it is unknown to what degree. But because regional assessments are able to take into account the detailed regional specific constraints (in terms of ecological constraints, but also in terms of land owner behaviour and institutional frame), but on the other hand also vary in assumptions, e.g. in the adoption of baselines, comparing and summing up results is complex and not always possible. This is illustrated by figure 9.13 from WGIII/AR4 chapter 9.

Figure 9.13: Comparison of estimates of economic mitigation potential in the forestry sector (up to 100 US\$/tCO₂ in 2030) as based on global forest sector models (top down) versus the regional modelling results (bottom up). *Note:* figure excludes bio energy. (Source: Ch.9, WGIII, AR4)

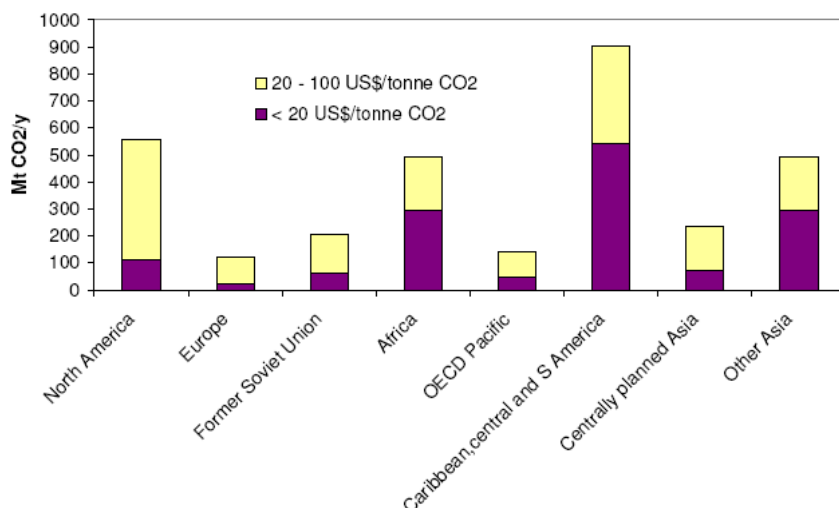


2.3.1.c Mitigation potential at different cost categories

All of this section is derived from WGIII, AR4, chapter 9 and 11, unless otherwise stated.

- 70) Forestry mitigation projections are expected to be regionally unique, while still linked across time and space by changes in global physical and economic forces. Overall, it is expected that boreal primary forests will either be sources or sinks depending on the net effect of some enhancement of growth due to climate change versus a loss of soil organic matter and emissions from increased fires. The temperate forests in USA, Europe, China and Oceania, will probably continue to be net carbon sinks, favoured also by enhanced forest growth due to climate change. In the tropical regions, the human induced land-use changes are expected to continue to drive the dynamics for decades. In the meantime, the enhanced growth of large areas of primary forests, secondary regrowth, and increasing plantation areas will also increase the sink. Beyond 2040, depending on the extent and effectiveness of forest mitigation activities within tropical areas, and very particularly on the effectiveness of policies aimed at reducing forest degradation and deforestation, tropical forest may become net sinks.
- 71) Diverse evidence indicates that carbon prices (not for the forestry sector specific) in the range 20-50 US\$/tCO₂ (US\$75-185/tC), reached globally by 2020-2030 and sustained or increased thereafter, would deliver deep emission reductions by mid century consistent with stabilisation around 550ppm CO₂-eq if implemented in a stable and predictable fashion. Such prices would deliver these emission savings by creating incentives large enough to switch ongoing investment in the world's electricity systems to low-carbon options, to promote additional energy efficiency, and to halt deforestation and reward afforestation. For the forestry sector, continuously rising carbon prices poses a problem that forest sequestration might be deferred to gain more advantage from future higher prices; from this perspective, a more rapid carbon price rise followed by period of stable carbon prices could encourage more sequestration.
- 72) At this moment forestry CDM credits are selling for \$4-5 per tC even when they have not gone through the official procedures of validation, verification, certification and issuance, while the average CDM project price has increased to \$11 per tC. (information derived from various sources at the CarboExpo 2007 in Bonn, Germany)
- 73) Figure 9.14 from WGIII/AR4 exhibits the annual economic mitigation potential in 2030 in the forestry sector by world region and cost class.

Figure 9.14: Annual economic mitigation potential in the forestry sector by world region and cost class in 2030.



74) Table 9.7 from WGIII/AR4, reproduced below, compares estimates of the economic mitigation potential by 2030 and illustrates the range of estimates present in the literature, and helps understand the uncertainty surrounding forestry mitigation potential.

Table 9.7: Comparison of estimates of economic mitigation potential by major world region and methodology (excluding biomass for bio-energy) in MtCO₂/yr in 2030, at carbon prices less or equal to 100 US\$/tCO₂.

	Regional bottom-up estimate			Global forest sector models	Global integrated assesment models
	Mean	low	high		
OECD	700	420	980	2730	
Economies in Transition	150	90	210	3600	
non OECD	1900	760	3040	7445	
Global	2750 ¹	1270	4230	13775	700

¹ Excluding bio energy. Including the emission reduction effect of the economic potential of biomass for bio energy would yield a total mean emission reduction potential (based on bottom up) of 3140 MtCO₂/yr in 2030.

75) The authors of chapter 9 WGIII/AR4 estimate that forestry mitigation options have the economic potential (at carbon prices up to 100 US\$/tCO₂) to contribute between 1270 and 4230 MtCO₂/yr in 2030 (medium confidence, medium agreement). About 50% percent of the medium estimate can be achieved at a cost under 20 US\$/ tCO₂ (= 1550 MtCO₂/yr) (see Figure 9.14 above). The combined effects of reduced deforestation and degradation, afforestation, forest management, agroforestry and bio-energy have the potential to increase gradually from the present to 2030 and beyond.



76) Table 9.3 below presents the average activity estimates reported from three global forest sector models including *GTM* (Sohngen and Sedjo 2006), *GCOMAP* (Sathaye et al., 2007), and *IIASA-DIMA* (Benitez-Ponce et al. 2007). For each of these models output for different price scenarios has been published in the literature. The original authors were asked by the authors of *WG III, AR4, chapter 9 (forestry)* to provide data of carbon supply under various carbon prices. These were summed and resulted in the total carbon supply as given in the table in the middle column. Because carbon supply was asked under various price scenarios, fractionation was possible as well.



Table 9.3: Potential of mitigation measures of global forestry activities. Global model results indicate annual amount sequestered or emissions avoided, above business as usual, in the year 2030, for carbon prices 100 US\$/tCO₂ and less.

Region	Activity	Potential at costs equal or less than 100 US\$/ton CO ₂ , in MtCO ₂ /yr in 2030 ¹⁾	Fraction in cost class: 1-20 US\$/ton CO ₂	Fraction in cost class: 20-50 US\$/ton CO ₂
USA	Afforestation	445	0.3	0.3
	Reduced Deforestation	10	0.2	0.3
	Forest Management	1,590	0.26	0.32
	TOTAL	2,045	0.26	0.31
Europe	Afforestation	115	0.31	0.24
	Reduced Deforestation	10	0.17	0.27
	Forest Management	170	0.3	0.19
	TOTAL	295	0.3	0.21
OECD Pacific	Afforestation	115	0.24	0.37
	Reduced Deforestation	30	0.48	0.25
	Forest Management	110	0.2	0.35
	TOTAL	255	0.25	0.34
Non-annex I East Asia	Afforestation	605	0.26	0.26
	Reduced Deforestation	110	0.35	0.29
	Forest Management	1,200	0.25	0.28
	TOTAL	1,915	0.26	0.27
Countries in Transition	Afforestation	545	0.35	0.3
	Reduced Deforestation	85	0.37	0.22
	Forest Management	1,055	0.32	0.27
	TOTAL	1,685	0.33	0.28
Central & South America	Afforestation	750	0.39	0.33
	Reduced Deforestation	1,845	0.47	0.37
	Forest Management	550	0.43	0.35
	TOTAL	3,145	0.44	0.36
Africa	Afforestation	665	0.7	0.16
	Reduced Deforestation	1,160	0.7	0.19
	Forest Management	100	0.65	0.19
	TOTAL	1,925	0.7	0.18
Other Asia	Afforestation	745	0.39	0.31
	Reduced Deforestation	670	0.52	0.23
	Forest Management	960	0.54	0.19
	TOTAL	2,375	0.49	0.24
Middle East	Afforestation	60	0.5	0.26
	Reduced Deforestation	30	0.78	0.11
	Forest Management	45	0.5	0.25
	TOTAL	135	0.57	0.22
TOTAL	Afforestation	4,045	0.4	0.28
	Reduced Deforestation	3,950	0.54	0.28
	Forest Management	5,780	0.34	0.28
	TOTAL	13,775	0.42	0.28

77) Central and South America has the largest potential, followed by USA, non-annex I East Asia, other Asia and Africa. These global models project the largest potential overall (in the cost class of <100 US\$/tCO₂) to be in forest management, but with the highest fraction (0.54) in the area of reduced deforestation in the cost class of 1-20 US\$/tCO₂. The mitigation strategy of reducing deforestation has the largest potential in Africa and Central and South America.

78) FAO statistics, also partly presented in the Forestry chapter of WG III/AR4, provide insight in the area currently involved in forestry and the carbon stocks contained by that land.

Table 9.1: Estimates of forest area, net changes in forest area (negative numbers indicating decrease), carbon stock in living biomass and growing stock in 1990, 2000 and 2005

Region	Forest area, mill.ha		Annual change, millha/yr		Carbon stock in living biomass, MtCO ₂			Growing stock in 2005,
	2005	1990-2000	2000-2005	1990	2000	2005	million m ³	
Africa	635412	-4.4	-4.0	241267	228067	222933	64957	
Asia	571577	-0.8	1.0	150700	130533	119533	47111	
Europe ¹⁾	1001394	0.9	0.7	154000	158033	160967	107264	
North and Central America	705849	-0.3	-0.3	150333	153633	155467	78582	
Oceania	206254	-0.4	-0.4	42533	41800	41800	7361	
South America	831.54	-3.8	-4.3	358233	345400	335500	128944	
World	3952026	-8.9	-7.3	1097067	1057467	1036200	434219	

Note 1) including whole Russian Federation

Source: FAO (2006a)

2.4 Looking ahead at finance and forestry

2.4.1 Barriers to implementation

79) Many barriers have been identified that preclude the full use of the overall mitigation potential, leading to a large discrepancy between a large theoretical potential and substantial co-benefits versus the rather low implementation rate. The longer-term prospects (beyond 2030) of mitigation within the forestry sector will be influenced by the interrelationship of a complex set of environmental, socio-economic and political factors.

80) Besides the commonly mentioned barriers (i.e. inter alia; permanence, additionality, uncertainty, leakage) others prohibit the adoption of mitigation strategies, such as, inter alia: high transaction costs, measuring and monitoring costs, and unclear property rights of land and carbon benefits. Other possible constraints or barriers to implementation include the availability of capital, the rate of capital stock turnover, the rate of penetration of bio-energy stocks into the marketplace, risk attitudes, need for new knowledge, availability of extension service-supported technology dissemination, consistency with traditional practices, pressure for competing uses of land and water, demand for agricultural products, high costs for certain



enabling technologies (e.g. soil tests before fertilization) and ease of compliance (e.g. biomass burning on site is easier than residue removal). In general, barriers can be divided into five categories, economic, risk related, political / bureaucratic, logistical and educational / societal barriers. The table below presents a further breakdown of barriers to implementation. Annex 2 provides insight in how the barriers apply to geographic regions and countries in different stages of development, and mitigation options. (Trines et al., 2006)

Broad category of barrier	Barrier
Economic	Cost of land Competing land use Continued poverty Lack of existing capacity (Low) price of carbon Population growth Transaction costs Monitoring costs
Risk-related	Delay on returns / slow system response / permanence Leakage / fire / natural variation
Political / bureaucratic	Lack of political will Slow land-use planning bureaucracy Accounting rules complex / unclear & loopholes
Logistical	Different or scattered owners / different interests Large areas unmanaged Inaccessible areas Biological unsuitability
Educational / societal	Stakeholder perception Traditional sector Sector / legislation is new

Source: Trines et al., 2006

- 81) Even though there are many and serious barriers, there are examples indicating that strong and motivated government institutions and public support are key factors in implementing effective forest policies that can lead to significant reductions in forest degradation and deforestation, in particular through partnering with communities.
- 82) According to PROFOR (2004) principal themes to get a handle on towards the future are the containment of illegal logging, forest governance, and investment safeguard policies. The first two are central to improving forest management. The third, investment safeguard policies should be put in place for all investment projects that somehow affect forests and/or the forestry sector, as drivers for deforestation and forest degradation are often located outside the forest sector. According to Claude Martin, Director General, WWF International (cited in PROFOR, 2004), all financing institutions should establish such investment policies, whether it be development banks, aid agencies, commercial banks, pensions funds, export credit agencies, or others.

2.4.2 Costs of mitigation

a. Costs of deforestation

i. Existing estimates of the costs of reducing emissions from deforestation

- 83) The biggest mitigation potential in the forestry sector is located in the tropics, as illustrated by previous sections, and can predominantly be achieved by reducing emissions from deforestation in the lower cost class. Estimates of future financial flows required to achieve mitigation potentials are scarce but some numbers are starting to surface.
- 84) The most recent estimate in the area of reducing emissions from deforestation comes from the Stern report: "...the opportunity cost of forest protection in 8 countries responsible for 70% of emissions from land use could be around \$5 billion annually, initially, although over time marginal costs would rise." The report also states that: "Compensation ... should ... take account of the opportunity costs of alternative uses of the land, the costs of administering and enforcing protection, and managing the transition." This estimate was amongst others based on the assumptions that: 1) all reductions are 100% additional; 2) there is no leakage; 3) the alternative to deforestation is conservation (not forest management); and, 4) the study has used land-use returns from other countries.
- 85) Since its publication, analyses have indicated that this estimate may be on the low side. Depending on the assumptions about alternative land use etc. this may be more in the area of 11-15 billion per year (IIED, 2006). According to the principal author on the theme in the Stern Review, Ms. M Grieg-Gran, the cost per tCO₂ avoided ranges from 2-10 USD with a central estimate of 3.5 USD per tCO₂.
- 86) An estimate by Sathaye et al. (2007), resulting from a combination of 3 global models, indicates cost of 0.4 - 1.2 billion USD per year to reduce deforestation by 10% (0.1 GtC/yr) in 2030.
- 87) Both authors, Grieg-Gran and Sathaye, provide some estimates of what Sathaye refers to as choke prices: cost per tC to arrest deforestation all together (the highest marginal price to stop 100% deforestation). The estimates of Sathaye are based on a top-down global model and gives choke prices of 39 USD per tC for the African continent, 127 for Central America, 147 for South America and 281 for Asia. These estimates exclude transaction costs. Corresponding net revenues amount to respectively 4.836, 21.590, 30.723 and 41.026 USD. (Sathaye et al., 2007)
- 88) Grieg-Gran cites payments from operational payment systems for environmental services of 64 USD per ha for conserving forest in Costa Rica and respectively 27 and 36 USD/ha for the forest protection in Mexico for forest and cloud forest. The estimate of Grieg-Gran is based on 8 countries accounting for 6.2 million ha of forest loss per year.



89) Both authors stipulate that the set of underlying assumptions determines the outcome of the analyses and especially the alternative land uses / opportunity costs are of critical importance.

ii. Estimates of the area of primary forest lost by 2030 and new estimate of the costs of avoidance

90) There is no comprehensive data or analysis available that presents the mitigation potential, area estimates and required funds/costs together. In literature it is acknowledged that current drivers for land use and land-use change may not be the same as in the future. Even stronger, drivers themselves are the resultants of all sorts of developments, including oil prices (tied to bio-energy), world trade (tied to agricultural production, trade embargos, GMOs, etc.) and economic developments in general, and are therefore, hard to model. This means that many approaches to estimates can be considered but none of them are ideal. The approach chosen here is based on the most complete data set: the FAO Forest Resource Assessment of 2005 (FRA, 2005). The methodology is outlined in annex 3.

91) FAO data originates from data provided by the countries themselves based on a questionnaire related to some 40 parameters. The figures that are submitted to the FAO are subsequently processed by the FAO and sent to the countries for verification before being published.

92) The most critical assumption in this methodology is that the area of primary forest lost, as reported in the FRA 2005, is considered to be deforestation for the purpose of this exercise. In reality this is not necessarily the case (forest can also remain as logged over, or degraded, but not be deforested), but no information is available regarding the transition of the area to other forest or land cover classes.

93) Another important assumption made is that if the trend between the two periods that are used (1990-2000 and 2000-2005) is a reduction in deforestation, the lowest percentage of area loss has been used to calculate primary forest loss up to 2030. If the trend was an increase, the higher percentage of area loss has been used. From historic data sets, however, it is known that deforestation trends vary strongly over time and a 'saw tooth' chart depicting deforestation over time is normal. The carbon emitted due to deforestation has subsequently been calculated using values for carbon content that are also presented in the FRA 2005, following the methodology as outlined in annex 3. This provides an area estimate and an emission level as presented in the following table.

94) All countries that have provided sufficient data on the basis of which this calculation could be made are included and are listed in the table below.

Table: Estimate of ha of primary forest lost and emissions (in MtC) by 2030 based on recent deforestation trends (2000-2005) and other information presented in the FRA 2005.

Countries	Total forest area in 2005 (x1000 ha) (table 3 of FRA2005)	Total Mt C in the forest in 2005 (table 14 FRA2005)	Total area of primary forest lost by 2030 (x1000)	Total MtC emitted by 2030 due to loss of primary forest	Number of countries included in the calculation	Key countries that are in- or excluded from the calculations due to lack of data
Total Eastern and Southern Africa	226,534	16,067	-905	-84	4	Kenya, Madagascar, Malawi and Reunion
Total Northern Africa	131,048	3,908	-2,679	-67	2	Burkina Faso and Sudan
Total Western and Central Africa	277,829	53,038	-459	-54	3	Congo, Nigeria and Senegal
Total Africa	635,412	73,013	-4,043	-205	9	
Total East Asia	244,862	10,147	2,733	216	2	Japan and Mongolia
Total South and Southeast Asia	283,127	33,298	-26,094	-2,008	6	Brunei, Cambodia, Indonesia, Nepal, Sri Lanka and Vietnam
Total Western and Central Asia	43,588	2,172	477	38	3	Armenia, Kyrgyzstan and Turkey
Total Asia	571,577	45,617	-22,883	-1,755	11	
Total Europe	1,001,394	206,162	-11,780	-2,913	8	Estonia, Finland, Ireland, Poland, Russian Federation, Slovenia, Spain and Sweden
Total Caribbean	5,974	774	-2	0	2	Dominica and Grenada
Total Central America	22,411	2,532	-1,485	-271	2	Guatemala and Panama
Total North America	677,464	26,296	-13,892	-463	1	USA
Total North and Central America	705,849	28,828	-15,377	-734	3	
Total Oceania	206,254	10,632	-5,552	0	1	estimate based on PNG only but no MtC value is provided
Total South America	831,540	135,428	-88,579	-10,824	6	Bolivia, Brazil, Chile, Ecuador, French Guiana and Peru
"World" (total for 40 countries)	3,952,025	500,454	-148,216	-16,430	40	

Source: calculated with data from the FAO FRA 2005

95) The table is based on data from 40 countries. Using the WRI CAIT tool these countries were responsible for over 66% of the CO₂ emissions of LUCF in the year 2000 and include 12 of the top 30 emitters.



- 96) On the basis of deforestation trends from 2000-2005, some 148 million of ha of primary forest will be lost by 2030 if the trend from 2000-2005 continues, causing 16,430 MtC of emissions or 16.4 GtC by 2030.
- 97) Using the choke prices of deforestation (highest marginal costs to stop deforestation 100%) that were reported to vary between 39 - 281 USD tC⁻¹, excluding transaction costs, to apply to the 16.4 GtC of emissions by 2030, implies a total cost of 25-185 billion per year to stop the loss of 148 million ha primary forest in those 40 countries together responsible for 66% of the CO₂ emissions of LUCF in the year 2000.
- 98) According to Sathaye et al. (2007) the land area gained by 2050 due to avoiding deforestation ranges from 122 to 501 Mha and corresponds to 8034 to 37625 MtC of emissions avoided.

b. Costs of forest management

- 99) An estimates of the scale of Art.3.4 forest management activities during the 1st commitment period on the basis of information provided by a limited amount of countries that had submitted information was presented in a previous section and amounted to:

	CO ₂ (Gg CO ₂)	CH ₄ (Gg CO ₂ e)	N ₂ O (Gg CO ₂ e)
Total	6.234.914	-4.000	-5.000

* Numbers are a total over the entire 1st commitment period (5 years) and are provided by the countries themselves in 2000 in document FCCC/SBSTA/2000/9/Add.1.

- 100) Section 2.2 provided an estimate from Whiteman (2006) regarding the costs of forest management in forests being respectively 20 and 100 USD ha⁻¹ yr⁻¹ for dryland and tropical forests. Unfortunately no estimates are available how many hectares should be under forest management by 2030 to achieve the mitigation potential in forest management presented by WGIII/AR4 (see table 9.3 in section 2.3). As a proxi for the costs again data from the FRA 2005 has been used.
- 101) Table 6 of the FRA 2005 presents the percentage of total forest area in a country that has a particular primary designated function in 2005. Functions that are distinguished are: production, protection, conservation, social services and multiple purpose. For this exercise it has been assumed that the area of production forest is the area that can potentially deliver the mitigation as estimated by WGIII/AR4 (table 9.3). It is not clear whether that area is plantation forest or natural forest but the areas per country with a primary production function can be calculated. It is also not clear whether it is dryland or tropical forest, except for those

countries where the geographic position makes it obvious (e.g. Scandinavia has no tropical forest).

	Total Forest Area (x1000 ha) Table 6, FRA2005	% of forest whose primary function is designated as production (%) Table 6, FRA2005	Area of production forest (x1000 ha)
Total Eastern and Southern Africa	226,534	19.4	43,948
Total Northern Africa	131,048	35.2	46,129
Total Western and Central Africa	277,829	44.6	123,912
Total Africa	635,412	30.3	192,530
Total East Asia	244,862	51.2	125,369
Total South and Southeast Asia	283,127	42.4	120,046
Total Western and Central Asia	43,588	22.2	9,677
Total Asia	571,577	44.7	255,495
Total Europe	1,001,394	73.1	732,019
Total Caribbean	5,974	28.1	1,679
Total Central America	22,411	14.8	3,317
Total North America	677,464	6.0	40,648
Total North and Central America	705,849	6.4	45,174
Total Oceania	206,254	11.0	22,688
Total South America	831,540	11.6	96,459
World	3,952,025	34.1	1,347,641

Source: based on FRA 2005

102) To calculate the cost of forest management, the following assumptions have been made to calculate the cost of achieving the mitigation potential:

- a) The area of production forest remains the same as in 2005;
 - b) The average costs of management of dryland and tropical forest are 60 USD ha⁻¹ yr⁻¹;
- Subsequently, combined with the estimate of avoided emissions in 2030 through forest management, presented in table 9.3, the following picture emerges.



	Area of production forest (x1000 ha in 2005)	Potential at costs equal or less than 100 USD/tC (MtC/yr in 2030)	Costs of forest management (million USD/yr)
Total Africa	192,530	27.3	11,552
Total East Asia	125,369	327.3*	7,522
Other Asia		261.8	
Total Asia	255,495		15,330
Middle East		12.3	
Total Europe	732,019	46.4	43,921
Total Caribbean	1,679		101
OECD Pacific		30	
Total Central America	3,317		199
Total North America	40,648		2,439
USA		433.6	
Total North and Central America	45,174		2,710
Total Central & South America		150	
Total Oceania	22,688		1,361
Total South America	96,459		5,788
Countries in transition		287.7	
World	1,347,641	1576.4	80,858

* non-annex I East Asia

c. Costs of forestation

- 103) Planting is the single largest cost of plantation forestry. In a recently completed assessment of the economic status of energy crops in the US, total plantation establishment costs on cropland were estimated at about 580 USD ha⁻¹. This estimate included costs for site preparation (plowing and disking), planting, and weed control (cultivation and herbicide spraying). The estimate is generally applicable for a variety of woody crops and is relatively low-cost because the land does not require clearing or extensive tillage and weed control, and there are essentially no site limitations or the need for significant quantities of soil amendments, such as fertilizers. However, when extensive site preparation and fertilization is required, establishment costs can easily exceed 1000 USD ha⁻¹. (<http://bioenergy.ornl.gov>, 2007)

- 104) For plantations in Hawaii, establishment costs approach 1400 USD ha⁻¹ because land is a combination of recently harvested sugar cane land, abandoned cane land, and waste land that is steep, poorly drained, and rocky, factor costs for clearing and weed control are high (about 55% of total establishment costs). Labour and fuel costs are also higher relative to the US mainland. (<http://bioenergy.ornl.gov>, 2007)
- 105) In Brazil, plantation establishment practices for large-scale industrial operations involve the use of disks and the construction of tree beds and check dams to prevent erosion. As in the industrialized temperate regions, weed control is critical and done at least twice each year until canopy closure occurs. These establishment practices usually involve manual labour except in larger-scaled operations where herbicides are used for weed control. The costs of plantation establishment in Northeast Brazil range from about 580 to 1170 USD ha⁻¹ with maintenance costs varying from about 140 to 860 USD ha⁻¹ over a seven-year rotation. Much of the variation in establishment costs is due to planting costs. (<http://bioenergy.ornl.gov>, 2007)
- 106) We may conclude that establishment costs ranges from 580 USD ha⁻¹ on good sites to 1400 USD ha⁻¹ on difficult sites.
- 107) The area that will be planted and the mitigation potential of forestation are linked. The drivers that will influence the adoption of this mitigation strategy vary per region and often even within one country, and predominantly originate from outside the forestry sector. Hence, accurately modeling acreage is complicated. The WGIII/AR4 report does not present hectares associated with the mitigation potential (see also table 9.3).
- 108) Sathaye et al. (2007) present the land area and carbon benefits gained across a number of scenarios relative to a reference case all the way up to 2100. For 2050 the range of land area gained is 52 - 192 Mha whilst the carbon benefits range from 4934 - 25.675 MtC.
- 109) If we assume a range of 580 - 1400 USD ha⁻¹ just for establishment costs, the start up costs of mitigating 4934 - 25.675 MtC by 2050 on 52 - 192 Mha is 30.160 - 268.800 million USD. Low range estimates for a tonne carbon (tC) are in such a case 1.17 - 6.11 USD tC⁻¹. High range estimates are 10.5 - 54.5 USD tC⁻¹.
- 110) The estimate of the IPCC of the mitigation potential of afforestation by 2030 (4045 MtCO₂ yr⁻¹ or 1103 MtC yr⁻¹) is substantially lower than the estimate of Sathaye *et al.*. If we assume a similar ratio between MtC mitigated and the required hectares for the WGIII/AR4 estimates (1618 MtCO₂ (equals 441 MtC) @ 1-20 USD/tCO₂ - 4045 MtCO₂ (equals 1103 MtC) @ 0-100 USD/tCO₂ in 2030), 4.6 -8.2 million hectares would be required. At costs of 580-1400 USD/ha establishment costs that would be 2668 - 11480 million USD. Low range estimates for a tonne carbon (tC) are in such a case 10.4 - 24.5 USD tC⁻¹. High range estimates are 24.5 - 26.1 USD tC⁻¹.

	Mitigation potential	Hectares	Plantation establishment costs
IPCC WG III/AR4	441-1103 MtC by 2030	4.6-8.2 Mha	2,7-11,5 billion USD
Sathaye et al.	4934-25675 MtC by 2050	52-192 Mha	30,1-268,8 billion USD

2.4.3 Synthesis of information

111) Bringing together the information from the previous sections, the following overview emerges

Overview of parameter values derived from section 2.4.2.

	Source	Area	Emissions Offset	Cost
Forestation	ORNL			580-1400 USD ha ⁻¹ cost for establishment
	Sathaye 2007	52-192 Mha by 2050	4934-25675 MtC by 2050	
	This study based on ORNL and Sathaye 2007	52-192 Mha by 2050	4934-25675 MtC by 2050	30160-268800 million USD
	This study based on IPCC, ORNL and Sathaye 2007	4.6 - 8.2 Mha	441-1103 MtC by 2030	2668-11480 million USD
Forest Management	Whiteman 2006			20-100 USD ha ⁻¹ yr ⁻¹
	This study based on FRA2005 and Whiteman 2006	1348 million ha in 2005	5780 MtCO ₂ in 2030 @ <100 USD tCO ₂ ⁻¹	80858 million USD yr ⁻¹
Reduced Deforestation	Stern Review		70% of emissions (emissions of 8 countries)	5 billion USD/yr
	IIED 2006		70% of emissions (emissions of 8 countries)	11-15 million USD/yr
	Sathaye 2007	122 to 501 Mha (by 2050)	8034 to 37625 MtC	Choke prices 39-281 USD/tC
	Grieg-Gran 2006			PES prices 27-64 USD/ha
	This study based on FRA2005 and choke prices of Sathaye	148 million ha of primary forest lost by 2030 in 40 countries	16430 MtC by 2030 (emissions of the 40 countries, together 66% of CO ₂ emissions of LUCF in 2000	25-185 billion per year

112) As far as possible a regional breakdown of that information yields the following table:

Region	Afforestation			Forest Management			Reduced Deforestation		
	Area (Mha)	Emissions Offset (MtC)	Cost Billion USD	Area production forest (Mha)	Emissions Avoided MtC/yr in 2030	Cost Billion USD/yr	Area lost by 2030 in BAU (Mha)	Emissions Reduced by 2030 (MtC)	Cost Billion USD/yr
Asia				255	589.1	15.3	22.9	1755	
Africa				193	27.3	11.6	4.0	205	
Europe				732	46.4	43.9	11.8	2913	
Caribbean				2		0.1	0.002	0	
North and Central America				44		2.7	15.4	734	
North America				41	433.6*	2.4			
Central America				3		0.2			
Oceania				23		1.4	5.6	0	
South America				96		5.8	88.6	10824	
World	52-192** 4.6-8.2***	4934- 25675** 441-1103***	30.2- 268.8** 2.7-11.5***	1348	1576.4	80.9	148.2	16430	25-185

* US only

** by 2050, based on ORNL (2007) and Sathaye (2007)

*** by 2030, based on IPCC (2007), ORNL (2007) and Sathaye (2007)

113) In summary, the funding required to realise the mitigation potential on the basis of this information is approximately:

Forestation*	11-270 billion USD**
Forest management	81 billion per year
Reduced deforestation	25-185 billion per year

* Establishment costs only

** Higher estimate is up to 2050 and based on acreage from Sathaye et al. 2007. Lower estimate is up to 2030 based on mitigation potential of the IPCC WGIII/AR4.



2.5 Financial /investment gap analysis between current financing levels and required future funding

- 114) It is not known how much funding is currently going to the different activities at this point in time (forestation, forest management or avoided deforestation) as financial flows are hardly ever directly exactly towards one activity. Therefore, the table below present the limited information that has been collected for the forestry sector as a whole.

Total Investment	Forestry Sector in general USD
1.0 Debt 1.1 Private 1.1.1 International (BIS, e.g., project finance from Citigroup) 1.1.2 Domestic (e.g., local bank lending) 1.2 Public 1.2.1 Multilateral (e.g., World Bank) 1.2.2 Bilateral (e.g., from the US Export-Import Bank) 1.2.3 Domestic (No data source, e.g., from the national or a sub-national government entity)	
2.0 Equity 2.1 Private 2.1.1 International (FDI) 2.1.2 Domestic (No data source, e.g., investments by individuals and domestic non-government entities) 2.2 Public 2.2.1 Multilateral (such as from the IFC) 2.2.2 Bilateral (No data source, e.g., from the US Overseas Private Investment Corporation) 2.2.2 Domestic (No data source, e.g., from the national or a sub-national government entity)	2.1.1 <u>FDI</u> : very approximately 150 billion per year of which 37 billion to developing countries ⁵ 2.2.1 <u>IFC</u> : 65-75 million per year <u>Direct Private Investments (DPI)</u> : 63 billion per year of which 15 billion to developing countries (90% domestic)
3.0 Grants 3.1 Private 3.1.1 International (No data available,	3.1.1 <u>ITTO</u> : approx. 11.5 million per year ⁶ <u>Co-financing generated through GEF funding</u> : 3.45

⁵ This is a very rough estimate based on information provided by the UNCTAD statistics database: inward flows in 2000 in 5 areas of trade in the forestry sector. Assumptions 15% IRR and 10% interest.

⁶ Based on funding level in 2006.

<p>e.g., Major charitable foundations like Gates or NGOs working on climate, particularly adaptation, issues)</p> <p>3.1.2 Domestic (No data available, e.g., local charitable organizations/NGOs)</p> <p>3.2 Public</p> <p>3.2.1 Bilateral (ODA)</p> <p>3.2.2 Multilateral (GEF, Adaptation Fund, etc.)</p> <p>3.2.3 Domestic (No data source, e.g., Various economic development/environment ministries)</p>	<p>billion per year (this may actually be other ODA)</p> <p>Co-financing generated through PROFOR funding: 0.26 million per year⁷ (this may also be other ODA)</p> <p>3.2.1</p> <p>ODA: approx. 531 million per year⁸ (overlap with 3.2.2 highly likely)</p> <p>3.2.2⁹</p> <p>GEF: approx. 125 million per year¹⁰</p> <p>FAO: NFP, 2.5 million per year¹¹</p> <p>PROFOR: 1.64 million per year¹²</p> <p>World Bank Global Forest Alliance: 1.5-2 million per year</p>
<p>4.0 Other including carbon funds and CDM,JI and others</p>	<p>Bio carbon fund: total capital 53.8 million¹³</p> <p>New South Wales GHG Abatement Scheme: 6.7 million worth of credits generated to date through sequestration.</p>

- 115) For this study the total financial flows going into forestry in developing countries is the most relevant. Therefore, only the proportion for developing countries of the values for FDI and DPI has been included in the final summation. Furthermore, co-financing has been excluded, as well as the flows from the GEF, the FAO, PROFOR, the World Bank Global Forest Alliance and the BioCarbon Fund because it is highly likely that those streams are included in the OECD CRS database providing the ODA statistics. **That brings the total value going into the forestry sector in developing countries at approximately 52.6 billion per year of which 531 million is ODA (37 billion FDI, 65 - 75 million IFC, 15 billion DPI, 11.5 million ITTO and 531 million ODA).**

⁷ PROFOR funding has generated 1.3 million in the 5 year period over which is reported, which is presented as 0.26 million per year.

⁸ This includes bilateral and multilateral ODA and other flows. To what extent this overlaps with GEF (multi lateral) is not clear.

⁹ All of the items under this section 3.2.2 may also be registered as ODA.

¹⁰ 1.25 billion as reported, divided by the 10 year in the period 1997-2007

¹¹ 12.5 million over a 5 year period equals 2.5 million per year over that period.

¹² 8.2 million over a 5 year period equals 1.64 million per year over that period.

¹³ As with section 3.2.2 in this table, support for the BioCarbon Fund may be registered as ODA as well.



- 116) Funding required in future to realise the mitigation potential is, as far as it was possible to calculate it in the previous sections, is as follows.

Forestation ¹⁴	11-270 billion USD ¹⁵
Forest management	81 billion per year
Reduced deforestation	25-185 billion per year
Total	106-266 billion per year + 11-270 billion one off and management costs thereafter for 4.6 - 192 Mha of plantations ¹⁶

- 117) The difference is 53.4 - 213.4 billion per year plus 11-270 billion one off for plantation establishment and management costs thereafter for 4.6 - 192 Mha of plantations. **Funding would therefore need to double to quadruple systematically aside from the financing of forestation activities.**
- 118) Which share can be expected to be generated by the private sector is hitherto unpredictable. It is important to note at this point that **ODA is currently providing only 0.2 - 0.5% of the financial flows going into the sector** in this calculation. This share needs to go up substantially if the international community is to be successful in achieving its mitigation potential in the forestry sector.

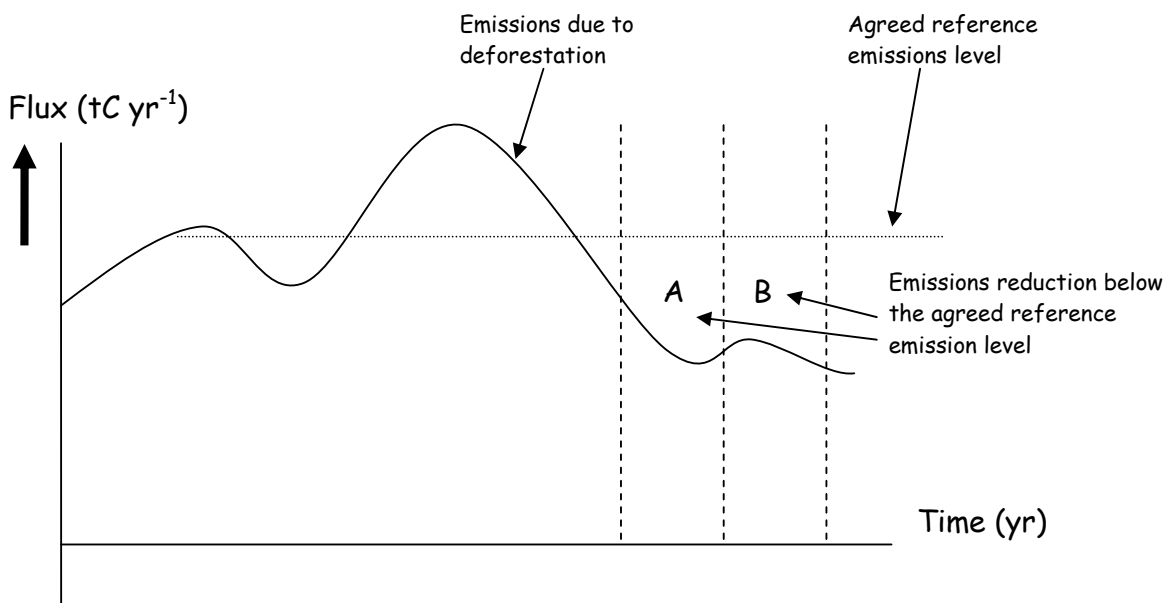
¹⁴ Establishment costs only: management costs for the associated 4.6 - 192 Mha of plantation area have not been included.

¹⁵ Higher estimate is up to 2050 and based on acreage from Sathaye et al. 2006. Lower estimate is up to 2030 based on mitigation potential of the IPCC WGIII/AR4.

¹⁶ Some of the plantation area is not in developing countries

2.6 Options to close the gap between current financing and levels required in future

- 119) The forestry sector in general can assist in achieving climate change mitigation objectives whilst reaching societal and conservation objectives at the same time. But as mentioned in previous sections, the barriers are numerous, complex and often hard to overcome. National climate policies directed towards forestry may help to incentivize engagement in the sector but more will be needed.
- 120) PROFOR (2007) proposes a portfolio approach as a potential way forward. Such an approach would mix the following major financial product and service 'types':
- a) Public funding from domestic national and sub-national budgetary allocations
 - b) ODA (bilateral and multilateral, grants and loans)
 - c) Payment for ecosystem services
 - d) Private sector investment in SFM
 - e) New financial resources from philanthropic leaders, political figures and celebrities
- PROFOR suggest that to accelerate and implement this portfolio approach the UNFF could establish a "Forest Financing Mechanism" (FFM). Such an FFM would build on existing instruments (incl. inter alia: GEF, PROFOR, NFP Facility, etc.) but be new in the sense that it would encompass various products and services and bring together competencies of governments, civil society and the private sector.
- 121) Proposals currently on the table in the context of the FCCC and its Kyoto Protocol include the agenda item "reducing emissions from deforestation in developing countries" (REDD). The basic principle is that a reference emission level is agreed for an entire country and emission reductions below that agreed reference level are rewarded ex-post. The figure below outlines the general idea.



(Source: modified after Trines et al., 2006)

- 122) There are divergent views as to whether the reference level should be based on historic emission levels or whether that level can also be determined by projections of plausible future emission scenarios.
- 123) Another area of different views is whether the reward for reducing emissions below the reference level should be financed through a dedicated fund (proposal made by Brazil) or by selling emission reduction in the carbon market (proposal supported inter alia by the Coalition for Rainforest Nations and the EU).
- 124) In general, policies have been most successful in changing forestry activities where they are consistent with underlying profitability incentives, or where there is sufficient political will, financial resources and regulatory capacity for effective implementation.
- 125) A workshop held in April 2007 at the Chatham House, to identify options for advancing negotiations on the REDD issue and to explore advantages and disadvantages of such options, attended by approximately 30 participants from governments, international organisations, NGOs and other experts, identified areas of agreement that include:
- National sovereignty over natural resources.
 - Voluntary participation.
 - Need for positive incentives.
 - Existence of substantial co-benefits.
 - Use of national reference level.

- f) Use of IPCC Good Practice Guidance (with minor modifications)
- g) Need to facilitate participation.
- h) No market access for 1st commitment period.
- i) Ex-post crediting.
- j) That gross deforestation (only accounting for emissions and not for removals) would be a simpler way forward.

Source: <http://www.chathamhouse.org.uk/pdf/research/sdp/160407workshop.pdf>

- 126) Potential sources of funding include *inter alia*: ODA, governments and NGOs, private sector, new and additional funds under the FCCC, carbon taxes, and/or existing funds under the FCCC or its Kyoto Protocol.
- 127) The most recent development is a request from both developing and industrialized countries to the World Bank to "explore a framework for piloting activities that would reduce emissions from deforestation and degradation using a system of policy approaches and performance-based payments" (www.carbonfinance.org). This 250 million USD fund, likely to be announced shortly by the Bank under the name "Forest Carbon Partnership Facility" (FCPF), would leverage private investor money and donor contributions to help countries develop strategies for avoiding forest degradation and secure payment for forest-related emissions reduction, through the creation of tradable carbon credits. (www.bicusa.org)
- 128) Another potential source of additional financing is the Payment for Environmental Service (PES) schemes that provide an incentive for the retention of forest cover. Relatively high transaction costs and insecure land and resource tenure have thus far limited applications of this approach in many countries, but significant potential may exist for developing payment schemes for restoration and retention of forest cover to provide climate mitigation and watershed protection services.
- 129) Recent studies in southern Africa for instance, have signalled the need for policy to focus on managing areas outside protected areas (*e.g.*, subsistence rangelands) in part achieved through the devolution of resource ownership and management to communities, securing community tenure rights and incentives for resource utilization. Strategic national policies could co-ordinate with communal or private land-use systems, especially when many small reserves are involved and would be particularly cost effective if they address climate change proactively.
- 130) But still typically, governments have less authority to regulate land use on private lands, and so have relied upon providing incentives to maintain forest cover, or to improve management. These incentives can take the form of tax credits, subsidies, cost sharing, contracts, technical assistance, and environmental service payments.
- 131) Numerous international policy initiatives to support countries in their efforts to reduce deforestation have also been attempted:
 - a) Forest policy processes, such as the UN Forum on Forests (www.un.org/esa/forests/), and the International Tropical Timber Organization (www.itto.or.jp/live/index.jsp) have



- provided support to national forest planning efforts but have not yet had demonstrable impacts on reducing deforestation.
- b) The World Bank has modified its lending policies to reduce the risk of direct negative impacts to forests, but they do not appear to have measurably slowed deforestation either (WBOED, 2000). (www.worldbank.org/)
 - c) The World Bank and G-8, have recently initiated the Forest Law Enforcement and Governance (FLEG) process among producer and consumer nations to combat illegal logging in Asia and Africa (World Bank, 2005). It is too early to assess the effectiveness of these initiatives on conserving forests stocks. (www.eu-flegt.org/)
 - d) The Food and Agricultural Organization's Forestry Programme (www.fao.org) has for decades provided a broad range of technical support in sustainable forest management; assessing measurable impacts has been limited by the lack of an effective monitoring program.
- 132) For forestation, forest management and forest degradation, no specific proposals are currently being put forward, be it that some countries would like the REDD proposals to apply to forest degradation as well. In that case any carbon retaining land-use strategy would become valuable and would contribute to the national level achievement of a REDD target.





3 CONCLUDING COMMENTS

- 133) There are 2 main complications for estimating costs of mitigation and required financial flows in this analysis:
- a) The mitigation potentials in the WGIII/AR4 assessment are not indicating the area on which they can be achieved. Some of the underlying studies do, but they are either global models that are coarse or regional models that are hard to scale up. Consequently, the area required to achieve the mitigation potential had to be calculated, which required several assumptions to be made; and,
 - b) Even though there are some estimates of funding that has gone into the sector to date, it is not known what the results are in terms of emissions reduced or hectares 'saved': no quantitative link can be made between money going in and forest being 'saved'. Consequently, no estimate can be made of financial flows required to achieve the mitigation potential on the basis of experience. Only calculations on the basis of various assumptions could be made.
- 134) Using the scarce but available information very liberally, the following estimates were made.
- 135) On the basis of deforestation trends from 2000-2005, some **148 million of ha of primary forest** will be lost **by 2030** in **40 countries** that together were responsible for over 66% of the CO₂ emissions of LUCF in the year 2000 and include 12 of the top 30 emitters, if the trend from 2000-2005 continues, causing **16,430 MtC of emissions or 16.4 GtC by 2030**.
- 136) Choking prices of deforestation (highest marginal price) were reported to vary between 39 - 281 USD tC⁻¹, excluding transaction costs. Applying those prices to the 16.4 GtC by 2030, implies a total cost of 25-185 billion per year to stop the deforestation of 148 million ha primary forest in those 40 countries.
- 137) According to Sathaye et al. (2007) the land area gained by 2050 due to avoiding deforestation ranges from 122 to 501 Mha and corresponds to 8034 to 37625 MtC of emissions avoided.

- 138) Funding required in future to realise the mitigation potential is, as far as it was possible to calculate it in this study, as follows.

Forestation ¹⁷	11-270 billion USD ¹⁸
Forest management	81 billion per year
Reduced deforestation	25-185 billion per year
Total	106-266 billion per year + 11-270 billion one off and management costs thereafter for 4.6 - 192 Mha of plantations ¹⁹

- 139) For this study the total financial flows going into forestry in developing countries is considered most relevant. Therefore, only the proportion for developing countries of the values for FDI and DPI has been included in the final summation. Furthermore, co-financing has been excluded, as well as the flows from the GEF, the FAO, PROFOR, the World Bank Global Forest Alliance and the BioCarbon Fund because it is highly likely that those streams are included in the OECD CRS database providing the ODA statistics. **That brings the total value going into the forestry sector in developing countries at approximately 52.6 billion per year of which 531 million is ODA (37 billion FDI, 65 - 75 million IFC, 15 billion DPI, 11.5 million ITTO and 531 million ODA).**
- 140) In total ODA to developing countries for the forestry sector has declined from 774 million per year in 1990 to 531 million per year in 2005. Overall the bilateral ODA in the forestry sector to developing countries has about doubled in 2005 compared to 1990 whilst the multilateral assistance is about $\frac{1}{4}$ of the level in 1990.
- 141) The difference between current levels of finance and what would be required in future is 53.4 - 213.4 billion per year plus 11-270 billion one off for plantation establishment and management costs thereafter for 4.6 - 192 Mha of plantations. Funding would therefore need double - quadruple systematically aside from the financing of forestation activities.
- 142) Which share can be expected to be generated by the private sector is hitherto unpredictable. It is important to note at this point that ODA is currently providing only 0.2 - 0.5% of the financial flows going into the sector in this calculation. This share needs to go up substantially if the international community is to be successful in achieving its mitigation potential in the forestry sector.

¹⁷ Establishment costs only: management costs for the associated 4.6 - 192 Mha of plantation area have not been included.

¹⁸ Higher estimate is up to 2050 and based on acreage from Sathaye et al. 2006. Lower estimate is up to 2030 based on mitigation potential of the IPCC WGIII/AR4.

¹⁹ Some of the plantation area is not in developing countries



- 143) Areas that warrant specific attention in future are the containment of illegal logging, forest governance, and investment safeguard policies.







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Annex 1 ODA FLOWS INTO THE FORESTRY SECTOR

Source: Credit
Reporting System
(CRS), 2006, OECD
Statistics

ODA in forestry policy & administrative management (million USD)

UNFCCC DATABASE Country list	1990			1995			2000			2005		
	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*
Africa, Total	82.45	2.62	80.00	3.64	4.96	0.00	38.56	31.24	0.00	28.86	51.68	0.00
Central Asia, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.52	0.00	0.00
Developing Asia, Total	18.49	0.00	0.00	17.20	113.51	0.00	15.06	29.00	0.00	21.66	1.00	0.00
Latin America, Total	9.34	0.00	0.00	16.04	0.00	0.00	14.51	1.76	0.00	6.14	0.00	0.00
Middle East, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.58	0.00	0.00
North Africa, Total	0.00	0.00	0.00	0.15	0.00	0.00	0.08	0.00	0.00	0.05	0.00	0.00
OECD North America, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.34	0.00	0.00
Transition Economies, Total	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	6.60	0.00	0.00
Annex-I parties to UNFCCC, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00
Developing Countries, Total**	110.28	2.62	80.00	36.88	118.47	0.00	68.15	62.00	0.00	57.24	52.68	0.00
+ 5 Countries, Total***	0.16	0.00	0.00	15.84	88.45	0.00	2.85	1.76	0.00	5.70	0.00	0.00

* Non-export credits

** Africa, Developing Asia, Latin America and Middle East

*** Brazil, China, India, Mexico and South Africa



**Source: Credit
Reporting System
(CRS), 2006, OECD
Statistics**

ODA in forestry development (million USD)

UNFCCC DATABASE Country list	1990			1995			2000			2005		
	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*
Africa, Total	54.02	15.62	14.50	26.83	0.00	0.00	27.77	3.52	0.00	32.17	35.00	0.00
Central Asia, Total	0.00	0.00	0.00	0.00	0.00	0.00	2.48	0.00	0.00	0.00	30.00	0.00
Developing Asia, Total	21.79	300.08	33.33	22.00	42.64	0.00	82.50	4.36	0.00	337.01	0.00	0.00
Latin America, Total	9.33	0.00	0.00	55.15	0.00	0.00	23.34	3.57	0.00	13.18	0.00	0.00
Middle East, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Africa, Total	0.00	5.40	60.90	0.00	0.00	0.00	38.66	0.00	0.00	0.37	0.00	0.00
OECD North America, Total	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transition Economies, Total	0.00	0.00	0.00	0.37	0.00	0.00	2.48	0.00	0.00	0.05	37.00	0.00
Annex-I parties to UNFCCC, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Developing Countries, Total**	85.14	315.69	47.83	103.98	42.64	0.00	133.61	11.45	0.00	382.36	35.00	0.00
+ 5 Countries, Total***	2.27	300.00	0.00	16.91	0.00	0.00	26.34	1.51	0.00	314.91	0.00	0.00

* Non-export credits; ** Africa, Developing Asia, Latin America and Middle East; *** Brazil, China, India, Mexico and South Africa



**Source: Credit
Reporting System
(CRS), 2006, OECD
Statistics**

ODA in fuel wood (million USD)

	1990			1995			2000			2005		
	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*
UNFCCC DATABASE Country list												
Africa, Total	1.10	0.00	0.00	5.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Central Asia, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Developing Asia, Total	0.00	0.00	0.00	51.80	0.00	0.00	0.50	0.00	0.00	0.02	0.00	0.00
Latin America, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
Middle East, Total	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Africa, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OECD North America, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transition Economies, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Annex-I parties to UNFCCC, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Developing Countries, Total**	1.89	0.00	0.00	57.24	0.00	0.00	0.50	0.00	0.00	0.12	0.00	0.00
+ 5 Countries, Total***	0.00	0.00	0.00	44.80	0.00	0.00	0.10	0.00	0.00	0.02	0.00	0.00

* Non-export credits; ** Africa, Developing Asia, Latin America and Middle East; *** Brazil, China, India, Mexico and South Africa



Source: Credit Reporting
System (CRS), 2006,
OECD Statistics

ODA in forestry education and training (million USD)

	1995		2000		2005	
	Bilateral	Multilateral	Bilateral	Multilateral	Bilateral	Multilateral
Africa, Total	0.47	0.00	0.05	0.00	0.95	0.00
Central Asia, Total						
Developing Asia, Total	0.06	1.50	5.56	0.00	0.72	0.00
Latin America, Total	1.95	0.00	0.00	0.00	0.32	0.00
Middle East, Total	0.00	0.00	0.00	0.00	0.00	0.00
North Africa, Total	0.00	0.00	0.00	0.00	0.00	0.00
OECD North America, Total	0.00	0.00	0.00	0.00	0.11	0.00
Transition Economies, Total	0.00	0.00	0.00	0.00	0.00	0.00
Annex-I parties to UNFCCC, Total	0.00	0.00	0.00	0.00	0.00	0.00
Developing Countries, Total*	2.47	1.50	5.61	0.00	1.99	0.00
+ 5 Countries, Total**	0.00	0.00	3.06	0.00	0.31	0.00

* Africa, Developing Asia, Latin America and Middle East; ** Brazil, China, India, Mexico and South Africa



*Source: Credit Reporting
System (CRS), 2006, OECD
Statistics*

ODA in Forestry Research (million USD)

	1990		1995		2000		2005	
	Bilateral	Multilateral	Bilateral	Multilateral	Bilateral	Multilateral	Bilateral	Multilateral
Africa, Total	1.38	0.20	2.69	0.00	0.32	0.00	0.20	0.00
Central Asia, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
Developing Asia, Total	15.06	0.00	0.98	0.00	1.52	0.00	0.77	0.00
Latin America, Total	1.28	0.00	4.19	0.00	3.24	0.00	0.00	0.00
Middle East, Total	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00
North Africa, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OECD North America, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Transition Economies, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
Annex-I parties to UNFCCC, Total								
Developing Countries, Total*	17.73	0.20	7.87	0.00	5.23	0.00	0.98	0.00
+ 5 Countries, Total**	14.28	0.00	0.03	0.00	2.46	0.00	0.30	0.00

* Africa, Developing Asia, Latin America and Middle East; ** Brazil, China, India, Mexico and South Africa



Source: Credit
Reporting System
(CRS), 2006, OECD
Statistics

ODA in forestry services (million USD)

UNFCCC DATABASE Country list	1990			1995			2000			2005		
	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*
Africa, Total	18.02	0.00	0.00	3.21	0.00	0.00	8.16	0.00	0.00	0.00	0.00	0.00
Central Asia, Total	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Developing Asia, Total	17.44	41.50	20.00	3.85	0.00	0.00	32.09	0.00	0.00	0.56	0.00	0.00
Latin America, Total	15.29	0.00	0.00	26.23	0.00	0.00	1.70	0.00	0.00	0.20	0.00	0.00
Middle East, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Africa, Total	0.00	0.00	0.00	0.00	0.00		0.18	0.00		0.00	0.00	0.00
OECD North America, Total	0.00	0.00	0.00	3.48	0.00		0.22	0.00		0.00	0.00	
Transition Economies, Total	0.00	0.00	0.00	0.13	0.00		0.00	0.00		0.00	0.00	
Annex-I parties to UNFCCC, Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Developing Countries, Total**	50.76	41.50	20.00	33.29	0.00	0.00	41.94	0.00	0.00	0.75	0.00	0.00
+ 5 Countries, Total***	20.37	0.00	0.00	3.48	0.00	0.00	2.47	0.00	0.00	0.14	0.00	0.00

* Non-export credits; ** Africa, Developing Asia, Latin America and Middle East; *** Brazil, China, India, Mexico and South Africa



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	Total ODA in millions USD											
	1990			1995			2000			2005		
	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*	Bilateral	Multi lateral	Other flows*
Africa,	157.44	18.43	97.19	39.16	5.28	0.00	75.65	34.76	0.00	61.02	86.68	0.00
AI parties	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00
Central Asia	0.00	0.00	0.00	0.13	0.00	0.00	2.59	0.00	0.00	0.52	30.00	0.00
Developing Asia	72.84	343.08	54.31	100.42	157.67	0.00	131.63	33.36	0.00	359.24	1.00	0.00
Latin America	37.20	0.00	4.19	97.43	3.24	0.00	39.87	5.33	0.00	19.62	0.00	0.00
Middle East	0.79	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.58	0.00	0.00
North Africa	0.00	5.40	60.90	0.15	0.00	0.00	38.93	0.00	0.00	0.42	0.00	0.00
OECD North America	0.29	0.00	0.00	3.48	0.00	0.00	0.43	0.00	0.00	0.34	0.00	0.00
Transition Economies	0.00	0.00	0.00	0.50	0.00	0.00	4.57	0.00	0.00	6.65	37.00	0.00
Developing Countries**	268.27	361.51	155.70	237.00	166.34	0.00	247.16	73.45	0.00	440.47	87.68	0.00
+ 5 Countries***	37.09	300.00	0.03	84.08	90.91	0.00	32.37	3.27	0.00	320.76	0.00	0.00

* Non-export credits; ** Africa, Developing Asia, Latin America and Middle East; *** Brazil, China, India, Mexico and South Africa

ANNEX 2: BARRIERS TO THE ADOPTION OF MITIGATION STRATEGIES



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Forestry mitigation measures and barriers affecting implementation for OECD countries

Activity	Practice	Applicability in Annex I countries Other management specific barriers	Economic						Risk	Political	Logistical			Educational							
			Cost of land	Competing land use	Continued poverty	Lack of existing capacity (Low) price of carbon	Population growth	Transaction costs	Monitoring costs	Delay on returns / slow system response / permanence	Leakage/fire/natural variation	Lack of political will	Accounting rules complex / unclear & loopholes	Slow land planning bureaucracy	Different or scattered owners / different interests	Large areas unmanaged	Inaccessible areas	Biological unsuitability	Stakeholder perception	Traditional sector	Sector / legislation is new
OECD NA	Afforestation	medium	x	x		x	x	x	x		x	x	x				x			x	
OECD NA	REDD	a	very small				x	x	x		x	x	x	x							
OECD NA	Forest Management	b	large				x	x	x	x	x		x	x	x	x	x	x	x	x	x
OECD NA	Bio-energy	medium		x	x		x				x	x			x	x				x	x
Europe	Afforestation	small		x	x		x	x	x	x	x	x					x			x	
Europe	REDD	a	very small				x	x	x		x	x	x	x							
Europe	Forest Management	b	small				x	x	x	x	x		x				x		x	x	x
Europe	Bio-energy	small		x	x		x				x	x		x	x					x	x
OECD Pacific	Afforestation	small		x	x		x	x	x	x	x	x					x			x	
OECD Pacific	REDD	a	small				x	x	x		x	x	x	x							
OECD Pacific	Forest Management	b	small				x	x	x	x	x		x				x		x	x	x
OECD Pacific	Bio-energy	very small		x	x		x				x	x		x	x					x	x

a deforestation is a scattered process at a fine resolution.

b the impacts of management changes are probably small, and hard to measure

Large: >500 Mt CO₂ y⁻¹, Medium: 250-500 Mt CO₂ y⁻¹, Small: 100-250 Mt CO₂ y⁻¹ by 2030, Very small: <100 Mt CO₂ y⁻¹. All by 2030.

Forestry mitigation measures and barriers affecting implementation for **non-Annex I countries**

Activity	Practice	Applicability in non-Annex I countries Other specific management barriers	Economic			Risk	Political	Logistical	Educational									
			Cost of land	Continued poverty Competing land use	Lack of existing capacity (Low) price of carbon Population growth Transaction costs Monitoring costs	Leakage / fire / natural variation Delay on returns / slow system response / permanence	Accounting rules complex / unclear & loopholes Slow land planning bureaucracy Lack of political will	Different or scattered owners / different interests Large areas unmanaged Inaccessible areas Biological unsuitability	Stakeholder perception Traditional sector Sector / legislation is new									
C&S America	Afforestation	medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
C&S America	REDD	large	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
C&S America	Forest Management	a medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
C&S America	Bio-energy	medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Africa	Afforestation	medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Africa	REDD	large	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Africa	Forest Management	a medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Africa	Bio-energy	medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other Asia	Afforestation	medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other Asia	REDD	large	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other Asia	Forest Management	a medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other Asia	Bio-energy	medium	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Middle East	Afforestation	very small	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Middle East	REDD	very small	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
e East	Forest Management	a very small	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Middle East	Bio-energy	very small	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

a Most regions are unmanaged; this hampers management changes.

Large: >500 Mt CO₂ y⁻¹ by 2030, Medium: 250-500 Mt CO₂ y⁻¹ by 2030, Small: 100-250 Mt CO₂ y⁻¹ by 2030, Very small: <100 Mt CO₂ y⁻¹ by 2030



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*Forestry mitigation measures and barriers affecting implementation for **economies in transition***

Activity	Practice	Applicability in economies in transition Other management specific barriers	Economic					Risk	Political			Logistical			Educational						
			Cost of land	Competing land use	Continued poverty	Lack of existing capacity	(Low) price of carbon	Population growth	Transaction costs	Monitoring costs	Delay on returns / slow system response / permanence	Leakage / fire / natural variation	Lack of political will	Slow land planning bureaucracy	Accounting rules complex / unclear & loopholes	Different or scattered owners / different interests	Large areas unmanaged	Inaccessible areas	Biological unsuitability	Stakeholder perception	Traditional sector
Cent. Planned Asia	Afforestation	medium	x		x	x	x	x	x	x	x	x			x	x	x			x	x
Cent. Planned Asia	REDD	<i>a</i> small				x	x			x		x					x			x	x
Cent. Planned Asia	Forest Management	medium			x	x		x	x	x	x				x	x	x		x	x	x
Cent. Planned Asia	Bio-energy	small			x	x				x	x	x		x	x	x	x			x	x
Countries in Transition	Afforestation	medium	x		x	x		x	x	x	x	x			x	x	x			x	x
Countries in Transition	REDD	<i>a</i> small			x	x				x	x	x					x			x	x
Countries in Transition	Forest Management	medium			x	x		x	x	x	x				x	x	x		x	x	x
Countries in Transition	Bio-energy	medium			x	x				x	x	x		x	x	x	x			x	x

a deforestation is a scattered process at a fine resolution
Large: >500 Mt CO₂ y⁻¹, Medium: 250-500 Mt CO₂ y⁻¹, Small: 100-250 Mt CO₂ y⁻¹ by 2030, Very small: <100 Mt CO₂ y⁻¹. All by 2030.

Annex 3 METHODOLOGY

In WGIII AR4 the mitigation potential is estimated for different cost per tonne for 2030 and/or 2040, but no indication is given what area is required to achieve those potentials. To close that gap on deforestation, the most significant mitigation option in the forest sector, the following approach has been taken:

1. Extrapolation of data from the FAO Forest Resource Assessment 2005 (FRA 2005) into the future to determine the loss of primary forest which is taken as a proxy for deforestation; and,
2. Link the resulting area estimate with the latest insights in opportunity costs without estimating knock-on effects of policies and practices on land use.

Statistics in the FAO FRA 2005 are country-based data, in some cases processed by the FAO to obtain comparable country and time series. In some instances this leads to data that are not consistent with other publications, possibly from the countries itself. A good example is the representation of deforestation in the Amazonia: the map provided by FAO 2005 flags the entire Amazonia as an area of the highest deforestation rate, whilst the assessments of Brazil of deforestation for instance narrow it down to a frontier belt leaving 83% of the Brazilian Amazonia untouched (personal comment Thelma Krug).

Even though one could argue that the methodology applied here is not ideal, the FRA remains one of the most, if not the most complete data set. To avoid countries to zoom in on 'their' country numbers, country data are not presented but left at a higher level of aggregation (mostly regional). Obviously the underlying disaggregation is available and is sent together with this draft report to the secretariat.

Detailed explanation of the use of the FRA 2005 data

The **total forest area in 2005** is provided by table 3. The **total million tonnes of carbon in the forest in 2005** is provided by table 14. Table 8 provides the **forest area in 2005** for each of the following forest types: **primary, modified natural, semi-natural, productive plantation and protective plantation**.

Assumption 1: loss of primary forest is considered deforestation, even though it may transgress to the classes modified or semi-natural.

Assumption 2: each of the forest types presented in table 8 contains the same amount of carbon. Obviously this is not true but since no forest type-specific carbon contents values are provided for each of the forest types, this is taken as the proxy.²⁰

The **annual rate of change for primary forest in ha per year** is provided by table 9 for the period 1990-2000 and 2000-2005.²¹ The ha of annual primary forest loss in the period 2000-2005,

²⁰ Please, remember the difference in carbon content between a natural forest in dry versus the humid tropics is enormous. In addition, in the 1st case plantations are likely to contain more carbon compared to natural forest and in the 2nd case less. Therefore, carbon is divided equally over the systems.

divided by the total primary forest area in 2005 (times 100), gives **the percentage of primary forest loss per year for the period 2000-2005**.

$tC\ ha^{-1}$ is calculated by dividing the total amount of carbon in the forest in 2005 (table 14: total of the 5 pools taken together) by the total number of hectares of forest in 2005 (table 3).

The area of primary forest in 2000 is back-calculated by deducting five times the annual area of forest lost in the period 2000-2005 from the forest area in 2005. The **percentage of primary forest loss per year over the period 1990-2000** is then calculated in the same way as the value for the period 2000-2005: ha of annual primary forest loss in the period 1990-2000, divided by the total primary forest area in 2000 (times 100).

ERGO: the same number of ha removed per year in the period 2000-2005 versus 1990-2000 gives a higher *percentage* of primary forest deforested because the forest area becomes smaller every year from 1990 onwards.

In cases where deforestation has gone up in the later period ('00-'05) in comparison to the earlier period, the higher percentage is applied to the future to determine deforestation by 2030. Where deforestation has gone down, the lower percentage is used to calculate deforestation by 2030.²²

Table 10 provides the area **change for plantations in the period of 1990-2000 and 2000-2005**. Comparing the values in this table with the values provided in table 8 for productive and protective plantation shows that in the greater majority of cases the value that is provided in table 10 is the same as the area listed as productive plantation in table 8, but not in all cases. Trying to extrapolate this towards 2030 is not really a useful exercise as forestation programmes never continue at a same rate for 25 years. Making assumptions about the expansion of plantation forest area can only be done on the basis of making assumptions in the agricultural and energy sectors (amount of area that will free up from food production or areas forested for the sake of bio-energy crops that would count as forest (e.g. willow or other coppice woodland)). Forestation is also unlikely to occur with financial flows like ODA or grants. Hence, no estimates are made of the amount of carbon being sequestered by forestation by 2030. Instead the estimates from AR4 can be used.

²¹ Table 4 gives the change in extent of forest and other wooded land for both periods 1990-2000 and 2000-2005 but doesn't split it over the different forest types. This prohibits detecting trends in deforestation and forestation that is required for this study.

²² Please note that drivers for deforestation are likely to change over time, changing emissions from deforestation over time as well. In addition, virtually always high inter-annual variability occurs in deforestation rates. Therefore, these estimates have to be considered as very rough proxies.