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ABSTRACT

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Forest activities in developing countries can be used to sequester carbon for gaining emission reductions within the Clean Development Mechanism of the Kyoto Protocol. This study has assessed the potentials and costs for carbon sequestration through afforestation, reforestation and deforestation activities and how these are affected when certain criteria for eligibility are applied. The criteria address issues of additionality, permanence, socio-economic and environmental sustainability, compliance and verification, which are of major importance for the successful implementation of forestry projects in the Clean Development Mechanism. Application of the criteria results in a substantial decrease in the carbon sequestration potential and an increase in the project costs.

Keywords: CDM, carbon, sink, afforestation, deforestation, additionality, permanence, leakage

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1 Executive summary

1.1 Introduction

The Clean Development Mechanism (CDM) has been defined in Article 12 of the Kyoto Protocol to promote sustainable development in non-Annex I countries (mostly developing countries) and to assist Annex I Parties to achieve compliance with their emission limitation and reduction commitments. Terrestrial sink activities may be implemented in the form of af-, reforestation and deforestation (ARD) projects or forest conservation projects. It is yet uncertain if the use of terrestrial sink projects in non-Annex 1 countries to reduce or offset carbon emissions from land use change may be included in the CDM. A decision on this issue will presumably be taken at COP6-bis in Bonn, July 2001. Allowing such terrestrial sink activities could stimulate environmental protection and forest conservation measures through private investments in developing countries and have positive effects on biodiversity, water resources, erosion control and local and regional climate. However, it is often voiced that the large potential for C-sequestration and the relatively low costs may lead to a devaluation of the Kyoto Protocol, especially for the first commitment period with it's low target reductions (5% decrease as compared to 1990 emission levels). Other objections against implementation of sink activities within the CDM to obtain CERs relate to:

- Permanence and risks of sink activities
- Uncertainties and scale: sink capacity and socio-economic processes
- Definition of baselines and additionality requirements
- Leakage across project, regional and country boundaries
- Accounting and accounting methods: monitoring and verifiability.
- Sustainable development: environmental and socio-economic,
- Capacity-building and technology transfer
- Political stability and liability factors
- Sovereignty issues

Some of the concerns surrounding these issues may be addressed by defining criteria to which sink projects need to adhere in order to become eligible. The present study defines such a set of criteria and provides information on how these criteria and conditions may affect Carbon sequestration rates and project costs. Strict application of such criteria to sink activities may provide an instrument to reduce or eliminate negative effects of the inclusion of sink activities in the CDM.

The goal of this study was:

1. to develop a set of criteria and conditions for terrestrial sink projects within the CDM, based on existing international guidelines
2. to study the effect of the adoption of such criteria on C-sequestration potentials and costs of several existing projects.

3. to estimate C-sequestration potentials and costs of sink projects in a limited number of developing countries for a number of afforestation, reforestation and forest conservation scenarios and with and without adoption of criteria.

This study deals with Afforestation, Reforestation and Deforestation (ARD) activities only. The country list includes results for 68 developing countries, as well as information on the following regions: Central America / Caribbean, Africa, Asia, South America and Oceania.

1.2 Definition of criteria and their impact on sinks and costs

Eight generic criteria were derived after studying 14 sets of guidelines and criteria used by international organisations for forestry related projects. These sets included: the United Nations Framework Convention on Climate Change, Kyoto Protocol, Center for International Forestry Research, International Tropical Timber Organisation, Forest Stewardship Council, Pan European Forest Certification, Carbon Offset Verification, Federation Internationale Pour L'Isolmente du Carbone, Montreal Process Working Group, World Wildlife Fund, Convention on Biological Diversity, Global Environment Facility, Intergovernmental Panel on Climate Change and several Dutch policy papers. The criteria are described briefly below.

1. **Project framework.** This defines a comprehensive policy, planning and institutional framework in place throughout the project lifetime. The framework includes a management plan, details on funding, project duration, team and staff composition, implementation of measuring, accounting, monitoring and verifying systems, compliance, use rights and responsibilities, etc. It also forms the basis for the implementation of other criteria.
2. **Additionality.** Additionality is a key criterion for CDM projects due to the fact that the host countries do not have emission reduction targets themselves. As such, CDM projects can create new emission allowances for Annex 1 countries, which should be balanced by reductions in the non-Annex I host country for carbon neutrality reasons. Enforcing the additionality criterion should guarantee that projects can not claim certified emission reductions unless demonstrated that the claimed project's emission reductions are indeed 'additional' to the 'business as usual' scenario in the host country. CDM projects should perhaps also be additional in financial terms to ensure that they would not have happened in the 'business as usual' scenario and to avoid subsidising commercially viable business activities.
3. **Verifiability.** The verification and monitoring of CDM sink projects requires effective monitoring and control systems. Special emphasis should be placed on the determination of leakage and the risks and uncertainties at project level (permanence issue). The verifiability criterion guarantees a successful implementation of verification and monitoring methodology that is able to measure and determine the actual sequestered carbon, uncertainties, leakage and associated impacts.

4. **Compliance.** The projects should be compliant with international, national and local regulations and treaties and should be accepted voluntarily by the host countries. This criterion may also be used to solve sovereignty issues (i.e. compliance with national laws regarding landownership).
5. **Environmental sustainability.** The project activities should be environmentally sustainable, i.e. negative impacts on the ecosystem and its functioning should be avoided. This implies that an environmental management plan should be in place (part of project framework in point 1) that ensures that the activities undertaken by the project do not cause a deterioration of the soil structure and fertility, water resources and biological activity (fauna, flora) within or outside the project area. Environmentla sustainability may also involve the use of native tree species and avoiding monocultures.
6. **Socio-economic sustainability.** The project should minimise negative effects on local communities, their activities, their resources and their cultural values. Projects should encourage employment and training of local people and promote technology/knowledge transfer and capacity building.
7. **Sustainable forest management.** Sustainable forest management aims for the protection, conservation and restoration of natural forests and sustainable management of plantations. Furthermore it should conserve or contribute to biological diversity and strive toward economic viability.
8. **Transparency.** This should guarantee reproducible results from measurement and monitoring methods and give insight into the methodology. It should also guarantee insight into project progress, project impacts and results, management and funding to the UNFCCC, the concerned parties and everyone who is interested.

The criteria deal with key project elements such as project formulation, risk reduction, knowledge transfer and capacity building, competence, infrastructure, socio-economic, political, sovereignty and environmental factors, accounting and verification methods, leakage, permanence and credit sharing. Strict adherence to these criteria by projects would therefore:

- minimise the risk of project failure
- provide guarantees relating to the permanence of the sink (e.g. through socio-economic and environmental sustainability)
- affect the scale of the sink capacity
- ensure additionality and eligibility for receiving CERs
- ensure proper project management
- provide technology transfer, training and capacity building
- minimise and account for leakage at the project level and to a lesser extend on a regional level
- resolve sovereignty issues

Two projects of the Dutch FACE Foundation in Uganda and Ecuador were selected for studying the impact of criteria on their performance and costs.

In our study, the adoption of criteria has a large impact on both the sink capacity (through the land available for sink activities) and on the costs of carbon sequestration. The criteria reduce the scale of potential forestry sector CDM projects by a magnitude of about 10. In view of the high failure rates of World Bank projects in developing countries (20-90%; Niles, 2000) we believe that adopting the presently defined set of criteria for CDM projects may reduce the risk of failure, increase the chances of projects being eligible for receiving CERs and may go a long way into providing some guarantees for the permanence of the sinks. One of the consequences of adhering to the set of criteria is that projects become more expensive. The risk of failure can be minimised further by only allowing projects that are explicitly requested by the local community.

The adoption of criteria affects both the potentially available area and project costs. For instance, the FACE Foundation has visited 14 countries to assess their potential for hosting projects. Criteria adopted for the identification of projects included additionality, cost-efficiency and social acceptability. In addition, projects had to fit in the regional planning. Only 36% of the potential projects passed these criteria and were implemented. Socio-economic factors dominate the area reduction associated with the application of criteria. For instance, land tenure appears as a major factor affecting implementation of projects because land titles are often not in the hands of people using the land. Furthermore, there are often pressures on the use of the land for food production or more profitable cash crops than trees. For af-/reforestation activities, the conditions of sustainable forest management and environmental sustainability put further constraints on the area available to projects. With the more elaborate set of criteria developed in the present study, a further reduction in the potential project area, and therefore in the Carbon sink capacity, can be expected. However, as said before, the application of these criteria will also improve upon the project failure rates, which may be as high as 90% in some of the developing countries (Niles, 2000).

Three factors determine the project costs for C sequestration, i.e. 1) the costs per hectare for af-/reforestation or forest conservation, 2) the capacity and rate of sequestration as compared to the baseline and 3) the method used for the accounting of the certified offset. If based on the maximum C sequestration capacity of the forests, the afforestation costs for the various FACE projects range from 2.2 to 25.7 US$ per tonne C. The length of the accounting period influences project costs, as shown in Table 1 for five FACE projects in The Netherlands, Czech Republic, Uganda, Ecuador and Malaysia.

Table 1. Cost assessment in US$ per tonne C of FACE sequestration forests, in relation to the length of the accounting period. (values based on reforestation achieved until the end of 1999)

	Capacity-based [A]	1991-2012	2008-2012 [B]	2001 [C]-2012
All projects	5.50	14.70	18.35	
Tropics (CDM)	3.70		33.05	9.20

[A]: Quotient of total costs over end-capacity; [B]: Commitment period; [C]: start date for CDM accountability.

Project costs include <u>Preparation cost</u> (launch of implementing body, host country and project identification, monitoring system), <u>Operational costs</u> (planting, infrastructure, project framework, research and training), Transaction costs (preparation, certification and sale) and Certification costs (monitoring, costs incurred by the certifying organisation, supervision by implementing body). The operational costs are dominated by the project framework costs, whereas the Compliance, Verification and Transparency criteria dominate the transaction costs. Certification costs are dependent on the precision level required and may vary depending on the size and homogeneity of the area.

1.3 Calculation procedures and assumptions

The CDMFSM model (Version 2.01; Waterloo et al., 2001), developed by Alterra within the scope of this study, was used to estimate the area available to projects, total carbon sequestration potentials and costs for a number of developing countries. A short overview of the procedures used is given below. A more extensive overview can be found in the manual to the CDMFSM model (Waterloo et al., 2001).

For af-/reforestation, the potential planting area for CDM af-/reforestation activities is assumed to be between 3-4% of the agricultural area (Nilsson and Schopfhauser, 1995). However, for additionality reasons CDM projects should result in an increase in the current planting rates on land available for CDM projects (*i.e.* excluding planting on land deforested after 1990 which cannot be used under the Kyoto protocol). The following assumptions were made:
- The current planting rates on for CDM available land (i.e. not including planting on land deforested after 1990) amount to 35% of the overall country planting rates (FAO, 2000).
- The biomass (and therefore carbon content) of the forest was assumed to follow an S-shaped growing curve over the period of a rotation (Cooper, 1983).
- The maximum plantation biomass was assumed to be double the country forest biomass (average 146 t ha^{-1}; FAO, 2000).
- Increase in soil carbon assumed at 30% of that in biomass (Nilsson and Schopfhauser, 1995).
- The rotation length was assumed to be 35 years.
- Harvesting at the end of the rotation would result in a return of 80% of the carbon stored to the atmosphere.
- The current country planting rate (FAO, 2000) would increase by 25% as a result of CDM activities.
- Planting would have started in 2000.

The sink value is calculated by multiplying the biomass at a certain time with a factor for conversion of dry weight to carbon (0.5: IPCC/OECD/IEA, 1996) and correcting for storage in soil and losses to the atmosphere during harvesting. The result is multiplied with a cost factor to obtain total costs. Criteria and country project success rates influence both the potential areas and costs.

Forest conservation projects in CDM should result in a lowering of local, regional and country-wide deforestation rates. The maximum area available for forest conservation projects is therefore represented by the annual deforestation rate. However, it is not realistic to assume under the present political and socio-economical conditions that the deforestation rate can be reduced to zero. We therefore assume that a certain percentage of the annualy deforested area would be available for conservation. The following options are used:

- A deforestation reduction efficiency is calculated form the GNP, the deforestation rate and the population density (see CDMFSM V2.01 user manual for details) with a maximum of 20%. The regional reductions obtained range from 0.6% for Asia to 4.7% for Oceania.
- The deforestation rate is assumed to be reduced by a fixed percentage (1% and 5% of the deforestation rate).

The sink created by reducing deforestation is calculated as the avoided loss of carbon in the biomass and soil. Both area and sink are affected by adoption of the criteria or project success rates. The starting year for CDM activities was taken as 2000.

1.4 Af-/reforestation

The total area under plantations in the selected countries amounts to 115 Mha. The current regional planting rates range between 0.01 Mha in Oceania to 3.4 Mha in Asia, with the largest planting occurring in India (1.5 Mha) and China (1.1 Mha). The combined annual planting rate for all selected countries is 4.1 Mha (worldwide=4.5 Mha yr^{-1}). This planting rate can be considered a baseline level with respect to additionality. The present study estimates that the area potentially available for afforestation is 3-4% of the agricultural area. For our 70 countries this amounts to 86 Mha without adopting any criteria and is reduced to 7 Mha when all criteria are adopted. Taking the current rate of planting into account and assuming a 25% increase of the current planting rate due to CDM, the potential area for ‘additional’ af-/reforestation is 24 Mha over a 100-year period or 10 Mha for the first 12 years. This results in a potential sink of 95 Mt C in the first commitment period with banking from 2002 onwards, or 61 Mt C without banking. This sink, however, has then to be corrected for project failures, reducing it to 45 Mt C and 29 Mt C for the first commitment period, respectively.

In the simulations, of which only the regional values are presented below, we used a maximum of 1 Mha yr^{-1} planting rate (corresponding with a 25% increase in planting) within the framework of CDM projects (no criteria selected and only until potential area is planted). Overviews of the results for several simulations are given in Table 2 – Table 8, whereas a plot of the carbon sequestration pattern over a 100-year period is shown in Figure 1.

Table 2. Regional summary of af-/reforestation simulations for three budget periods (banking from 2002 onwards) without adoption of criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	**Af-/refores-tation area**	**Seques-tration 2008-2012**	**Costs 2008-2012**	**Seques-tration 2000-2050**	**Costs 2000-2050**	**Seques-tration 2000-2100**	**Costs 2000-2100**
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	267	3	11	34	132	100	390
Africa	368	4	10	74	203	214	581
Asia	8080	64	174	541	1456	1065	2901
Oceania	19	0	0	1	2	2	6
South America	1466	25	137	365	2032	924	5247
Total	**10201**	**95**	**332**	**1014**	**3825**	**2305**	**9124**

Table 3. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) without adoption of criteria (except for additionality), but taking 'project success rates' into account. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	**Af-/refores-tation area**	**Seques-tration 2008-2012**	**Costs 2008-2012**	**Seques-tration 2000-2050**	**Costs 2000-2050**	**Seques-tration 2000-2100**	**Costs 2000-2100**
	(x 1000 ha $y^{-1)}$	*(Mt C)*	*(x 10^6 \$)*	*(Mton C)*	*(x 10^6 \$)*	*(Mton C)*	*(x 10^6 \$)*
C.America/Caribbean	100	1	11	15	152	42	419
Africa	70	1	10	14	204	42	609
Asia	4437	32	183	328	1702	664	3636
Oceania	6	0	1	0	2	1	7
South America	679	12	139	170	2190	449	5867
Total	**5291**	**45**	**343**	**527**	**4250**	**1198**	**10539**

Table 4. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	**Af-/refores-tation area**	**Seques-tration 2008-2012**	**Costs 2008-2012**	**Seques-tration 2000-2050**	**Costs 2000-2050**	**Seques-tration 2000-2100**	**Costs 2000-2100**
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	1	20	5	83	16	257
Africa	306	3	24	27	237	65	517
Asia	743	9	68	28	224	79	619
Oceania	1	0	0	0	0	0	1
South America	497	11	290	44	1093	125	3233
Total	**1680**	**24**	**402**	**105**	**1637**	**286**	**4628**

Table 5. Summary of results for af-/reforestation simulations for the three budget periods (no banking) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y-1)	*(Mt C)*	*(x 10⁶ $)*	*(Mt C)*	*(x 10⁶ $)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	133	1	13	5	83	16	257
Africa	306	2	15	27	237	65	517
Asia	743	5	42	28	224	79	619
Oceania	1	0	0	0	0	0	1
South America	497	6	167	44	1093	125	3233
Total	**1680**	**14**	**237**	**105**	**1637**	**286**	**4628**

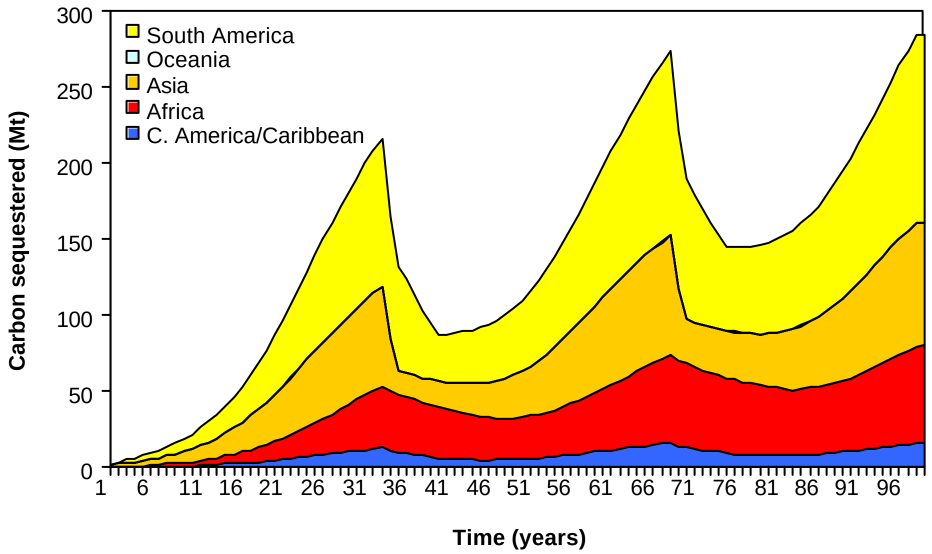

Figure 1. Carbon sequestration of af-/reforestation projects for different regions. Assuming a 25% increase in planting rates, a 35-year rotation period and all criteria adopted

Table 6. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 10% increase in current planting rate due to CDM instead of 25% and a 35-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y-1)	*(Mt C)*	*(x 10⁶ $)*	*(Mt C)*	*(x 10⁶ $)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	55	1	9	3	42	8	124
Africa	128	1	10	15	118	31	254
Asia	464	5	39	17	129	49	365
Oceania	1	0	0	0	0	0	0
South America	264	5	143	23	565	65	1697
Total	**912**	**12**	**200**	**57**	**854**	**153**	**2439**

Table 7. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM instead of 25% and a 10-year rotation period

Region	**Af-/refores-tation area**	**Seques-tration 2008-2012**	**Costs 2008-2012**	**Seques-tration 2000-2050**	**Costs 2000-2050**	**Seques-tration 2000-2100**	**Costs 2000-2100**
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	2	29	6	92	12	187
Africa	306	5	36	23	185	48	382
Asia	743	5	41	27	207	69	550
Oceania	1	0	0	0	0	0	1
South America	497	15	402	44	1145	92	2339
Total	**1680**	**27**	**508**	**100**	**1630**	**221**	**3458**

Table 8. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM instead of 25% and a 60-year rotation period

Region	**Af-/refores-tation area**	**Seques-tration 2008-2012**	**Costs 2008-2012**	**Seques-tration 2000-2050**	**Costs 2000-2050**	**Seques-tration 2000-2100**	**Costs 2000-2100**
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	1	14	15	242	15	240
Africa	306	2	17	55	423	59	441
Asia	743	5	42	71	559	76	594
Oceania	1	0	0	0	1	0	1
South America	497	7	197	112	2909	116	2978
Total	**1680**	**16**	**270**	**253**	**4134**	**265**	**4254**

From the results presented above, it becomes clear that the potential sink for af-/reforestation (Tabel 2) is reduced to a large part when project success rates (Table 3) or CDM criteria (Table 4) are taken into account (from a potential 95 Mt C to 24 Mt C for the first budget period, including banking). Taking a 10% increase in planting rates instead of 25% results in a further reduction to 8 Mt C (Table 6), whereas changing rotation lengths results in estimates between 27 Mt C (10-year rotation) to 16 Mt C (60 year rotation) for the first commitment period (Table 7, Table 8). However, the longer rotation period does lead to higher sequestration in the long-term (100 Mt C vs. 253 Mt C in 2050) and sustainable forestry will also be easier to demonstrate than for a short-rotation forest. The relatively low sequestration rates for the first commitment period reflect the slow growth of plantations during the first years after planting.

Due to the large size of their agricultural areas and their relatively high planting rates, India, Brazil, Argentina and China have the largest potentials for carbon sequestration through af-/reforestation activities. China also has a positive annual change in forest (no net deforestation within the country) and may therefore encounter less problems with accounting for leakage. As a region, Asia seems to offer the largest potential, followed by South America.

The costs range from 2.22 (Democratic Republic of Congo) – 8.76 US$ per tonne C (Argentina) (no criteria adopted) to 4.27-46.73 US$ per t C (all criteria adopted). The regional costs in the latter case range from 7.31 USD per t C for Africa to 28.25 Usd per t C in South America, respectively, using a 20% buffer.

1.5 Forest conservation

During COP6-bis the decision was made that forest conservation projects would not be eligible for inclusion in the CDM during the first commitment period. The following may therefore be less relevant to CDM at present than it was when this report was written. The annual deforestation rate is 9.5 Mha y^{-1} for the 70 developing countries selected in our study. Regional deforestation rates range between 0.1 Mha y^{-1} for Oceania to 4.7 Mha y^{-1} for Africa. Deforestation in the South American region amounts to 3.7 Mha y^{-1}, of which 2.3 Mha y^{-1} occurs in Brazil alone. The main problem with defining a sink potential for forest conservation projects is in estimating how much deforestation rates can be reduced by CDM projects. Additionality (as expressed on a country level) would imply that all CDM forest conservation projects combined would result in reduced deforestation rates for a region/country as compared to a certain baseline level (*e.g.* current deforestation rates). For countries with increasing deforestation rates (*e.g.* Brazil), this would be hard to demonstrate.

Country specific estimations of the sink and costs are presented in this report for five different forest conservation scenarios. In this summary, only the regional sink and cost estimates are given for different reductions in deforestation rates (1%, 5% and an assumed, country specific reduction rate), using forest conservation 1 scenario, which is presumably the most realistic. For the calculations it was assumed that a fixed percentage of the initial deforestation rate, and therefore a fixed forest area, is saved annually. Relative to the Business As Usual (BAU_0) scenario, *i.e.* the initial deforestation rate, the total forest area saved is linearly growing each year. This means that the area saved each year is the sum of that saved in the previous year and the fixed percentage of last year's deforestation rate. The regional country specific deforestation reduction rate values used in the calculations range from 0.56% for Asia to 4.72% for Oceania. The values used for Brazil and Indonesia, which have the highest deforestation rates, are 0.39% and 0.03%, respectively. The results of different options are given in Table 9 – Table 14.

Table 9. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. No criteria were adopted and the sink values may therefore be considered the maximum possible for the different regions. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	149	23	97	566	90	382	678	105	448
Africa	531	30	112	2373	133	499	4583	257	974
Asia	165	10	40	748	48	181	1408	86	316
Oceania	53	2	6	239	9	27	478	18	54
South America	770	76	397	3498	347	1802	6966	691	3595
Total	**1667**	**142**	**651**	**7423**	**627**	**2892**	**14113**	**1158**	**5388**

Table 10. Area, sink and cost estimates for forest conservation scenario 1using a 1% deforestation reduction. No criteria were adopted and the sink values may therefore be considered the maximum possible for the different regions. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	38	5	18	138	20	73	174	24	86
Africa	522	36	88	2083	137	337	3018	209	516
Asia	277	21	72	1257	94	326	1961	147	514
Oceania	13	0	1	60	2	7	119	4	13
South America	414	52	280	1881	238	1275	3729	472	2539
Total	**1263**	**114**	**460**	**5418**	**491**	**2018**	**9001**	**857**	**3669**

Table 11. Area, sink and cost estimates for forest conservation scenario 1 using a 5% deforestation reduction. No criteria were adopted and the sink values may therefore be considered the maximum possible for the different regions. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	188	26	91	689	102	366	868	120	430
Africa	2609	179	440	10416	684	1685	15090	1046	2581
Asia	1383	103	359	6285	469	1632	9803	734	2572
Oceania	65	2	7	298	11	33	595	22	66
South America	2069	261	1402	9402	1188	6374	18647	2360	12697
Total	**6313**	**572**	**2300**	**27090**	**2455**	**10090**	**45004**	**4283**	**18346**

Table 12. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. Project failure rates are used. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	52	8	97	202	33	382	247	40	448
Africa	181	9	112	815	39	499	1603	76	974
Asia	97	6	40	442	29	181	845	53	316
Oceania	13	1	6	61	2	27	122	5	54
South America	290	29	397	1319	131	1802	2632	262	3595
Total	**633**	**53**	**651**	**2838**	**234**	**2892**	**5449**	**435**	**5388**

Table 13. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. All criteria adopted. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	32	5	74	122	19	293	146	23	343
Africa	115	7	79	512	29	353	990	56	696
Asia	36	2	29	162	10	130	304	19	221
Oceania	11	0	3	52	2	16	103	4	32
South America	166	16	333	756	75	1515	1505	149	3023
Total	**360**	**31**	**518**	**1603**	**135**	**2307**	**3048**	**250**	**4315**

Table 14. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. All criteria adopted. The certification precision level was set at 20% (affecting costs) and no banking

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	15	2	34	122	19	293	146	23	343
Africa	52	3	36	512	29	353	990	56	696
Asia	16	1	13	162	10	130	304	19	221
Oceania	5	0	2	52	2	16	103	4	32
South America	76	7	151	756	75	1515	1505	149	3023
Total	**164**	**14**	**236**	**1603**	**135**	**2307**	**3048**	**250**	**4315**

The sink gained with Forest Conservation scenario 1 using country specific deforestation reductions and adoption of all criteria totals 31 Mt C when banking is allowed in the first commitment period and 14 Mt C when no banking occurs. The largest sinks occur in Brazil, Argentina and Guyana (3 Mt C each). The costs range from 4.01 US$ per tonne C in the Democratic Republic of Congo to 43.11 US$ per tonne C in Argentina. Regional costs range from 2.74 US$ t^{-1} C (Africa) to 6.27 US$ t^{-1} C (South America) without adoption of criteria to 6.80 US$ t^{-1} C to 26.10 US$ t^{-1} C when all criteria are adopted

Over a 100-year period a sink of 250 Gt C can be established (all criteria adopted) by protecting 3.0 Mha of forest (Table 14). It should be recognised that at present Brazil (and perhaps some other countries as well) is not likely to endorse CDM forest conservation projects and that the actual sink gained may therefore be less. Furthermore, in view of increasing deforestation rates, forest conservation projects may have problems to comply with the leakage criterion, especially in Brazil and Indonesia. Changes in deforestation rates would place heavy demands on changing the political and socio-economic fabric of the societies involved, which may be difficult and costly. As the present criteria – cost relation reflect that experienced at project level only, achieving such a change may be much more costly than our simulations indicate.

The total sink estimates for 1% and 5% deforestation reductions are 0.1 Gt C and 0.6 Gt C for the first commitment period and 0.9 Gt C and 4.2 Gt C for a 100-year period, respectively.

1.6 Conclusions

Adoption of criteria has a large impact on both the sink capacity (through the land available for sink activities) and sequestration costs. Criteria reduce the scale of potential forestry sector CDM projects by a magnitude of about 3-5. This is mainly through the need for a good project framework, socio-economic sustainability, etc. Additionality plays an important role in CDM projects. On a project level, additionality is defined as whether the project would have been implemented without the CDM or not. This is difficult to assess on a country scale. This study therefore uses current planting rates as baseline to define if projects are additional, *i.e.* all individual projects together should result in an increase in planting rates. For forest conservation on a country level, we assume that the additionality criterion is satisfied when the deforestation trend is reversed through CDM af-/reforestation or forest conservation projects. Additionality considerations therefore determine how much the planting rate is increased, or how much the deforestation rate is reduced (forest conservation). This criterion affects the areas and sink potentials to a large extent.

High failure rates of World Bank projects in developing countries (20-90%; Niles, 2000) have been reported. Adoption of the presently defined set of criteria for CDM projects may guarantee carbon neutrality to some extent, and also goes a long way to solve permanence and sovereignty issues. Furthermore, adherence to the criteria may reduce the risk of project failure, increase the chances of projects being eligible for receiving CERs and may go a long way into providing some guarantees for the permanence of the sinks. The consequence of adopting these criteria is that projects will become more expensive and that there will be less area available for the execution of such projects. The risk of failure can be minimised even more by only allowing projects that are requested by the local community.

The potentials for the first commitment period range from 24-31 Mt C (with criteria) to 95-142 Mt C (no criteria) for af-/reforestation and forest conservation (scenario 1) projects, respectively. The most optimistic forest conservation scenario (scenario 3) would yield 172–655 Mt C for this budget period.

The costs of CDM af-/reforestation projects and forest conservation projects show variation between countries but range generally between 4-10 US$ $tonne^{-1}$ C when no criteria are adopted and 8-32 US$ $tonne^{-1}$ C when criteria are enforced. The costs are lowest in African and some Asian countries, and highest in South American countries.

2 Background

In 1997, at the third Conference of the Parties of the UNFCCC, the Kyoto Protocol introduced the principle of a Clean Development Mechanism (CDM). The CDM is one of three mechanisms[1] that could contribute to the goal of the climate convention to reduce Carbon emissions and help Annex I countries achieving their commitments in a cost-effective way.

The objectives of the CDM are to support non-Annex I Parties to the UNFCCC, to promote sustainable development, and to assist Annex I Parties to achieve compliance with their emission limitation and reduction commitments under the Climate Convention. In exchange for the realised emission reductions, the Annex I Party may receive credits for CDM projects, the so-called certified emission reductions (CERs). CER units can be created at any time from the beginning of the year 2000 onwards and can be used to achieve Annex I compliance in 2008. Emission reductions from project activities conducted within the context of CDM will be certified on the basis of the items stated in article 12.5 of the Kyoto Protocol[2].

Ever since COP3, the CDM has been a subject for debate. Several issues are still under discussion and remain firmly on the policy agenda. One of these issues is the inclusion of certain potential CDM activities, with the use of so-called carbon sinks to obtain emission reductions receiving attention in particular. Such sink activities could include forest conservation or other forest based emission reduction activities (e.g. slowing down deforestation rates) and other certified sink activities (e.g. reforestation or afforestation). At present, the CDM remains largely undefined because it is not yet clear which activities may be included and which criteria will apply to CDM projects. At COP6b in 2001 (Bonn, Germany) decisions may be made about the inclusion of certain activities within the CDM.

The rate of deforestation in the tropics amounts to about 12.6 Mha y^{-1} (FAO, 1999), resulting in CO_2 emissions to the atmosphere in the order of 2.0 Gt C yr^{-1} (IPCC, 2000). These emissions form about 20% of all anthropogenic C emissions and 30% of all fossil fuel C emissions to the atmosphere in 1990 (Trexler and Haugen, 1995). To put things further into perspective, it should be noted that these emissions are over two times larger than those from fossil fuel burning in Western Europe (about 0.9 Gt C in 1996). This illustrates the importance of the contribution of deforestation in tropical regions to global carbon emissions. The emissions from deforestation in the tropics are offset by the sequestration of Carbon by terrestrial ecosystems, mainly through fertilisation processes (increased C and N deposition) and land use and management changes in the developed world (IPCC, 2000). Hence, changes in the

1 In addition to the CDM (art. 12 KP), there are the Joint Implementation (Art. 6 KP) and International Emission Trading (art. 17 KP) mechanisms.

2 These items are (a) voluntary participation approved by each Party involved, (b) real, measurable, and long-term benefits related to the mitigation of climate change and (c) reductions in emissions that are additional to any that would occur in the absence of the certified project activity. (art 15.2, Kyoto Protocol, UNFCCC 1997).

emissions from deforestation or in the sink strengths of terrestrial ecosystems are important to environmental and climate policies. The 'Noordwijk Declaration', signed by 68 environmental ministers around the world in 1989, already proposed for an increase in the global forest cover by 12 Mha yr^{-1} for climate change mitigation purposes. This contrasts sharply with the current deforestation rate, which is of similar magnitude.

Terrestrial sink activities under CDM remain controversial. Article 12 of the Kyoto Protocol does not explicitly include carbon sequestration projects as eligible CDM projects. The main argument against including sink activities in the CDM is that their permanence cannot be guaranteed. In contrast to other potential CDM activities (e.g. energy projects), it is inherent to sink activities that the carbon sequestered can potentially be released again by destruction of the carbon stock through fire, disease and pests, extreme climatic events or socio-economic pressures (e.g. illegal logging). This could be a legitimate reason to exclude forest sink activities from the CDM. On the other hand, sink activities are already permitted in Article 3, through which Annex 1 Parties may meet their emission reduction targets. Several Annex I countries favour the inclusion of Carbon sink projects within the CDM. In their view, accepting sink activities within CDM would extend the use of Article 3 measures for Annex 1 countries to non-Annex I countries. Furthermore, well-designed forestry projects may benefit developing countries in many ways, including the protection of their biotic wealth, protection of the soil and water resources and by providing a continuous supply of forest products (Trexler and Haugen, 1995). The main objections against the implementation of sink activities within the CDM to obtain CERs are summarised below[3]:

- Permanence and risks: project duration and responsibility issues
- Baselines and additionality
- Leakage across project, regional and national boundaries
- Accounting and accounting methods: monitoring and verifiability.
- Sustainable development: environmentally and socio-economic,
- Capacity-building and technology transfer
- Uncertainties and scale: sink capacity and socio-economic factors
- Political stability and liability
- Sovereignty issues

The inclusion of Carbon sink activities within the CDM has also been perceived to be a favourable option by Annex 1 countries due to the large potential for Carbon sequestration in non-Annex 1 countries and the favourable cost-effectiveness. However, for more or less the same reasons, it can been argued that the acceptance of low-cost Carbon sequestration projects (with their large potential of C sequestration) within the CDM may lead to a decreased commitment of developed countries to implement more expensive C-emission reduction measures in their own country. In view of the low emission reduction targets set for the first commitment period (i.e. 8% reduction for the European Union), inclusion of sinks into the CDM

3 To a large extent also mentioned by the IPCC as technical issues in the LULUCF Special Report (2000)

is perceived to undermine the core principle of the Kyoto Protocol. In addition, some of the developing countries are reluctant to approve the use of Carbon sequestration projects as these may withdraw focus from renewable sources and cutting-edge technology-oriented CDM projects. A better insight into the objections against sinks in the CDM outlined above is required to assess which criteria and conditions should be posed on sink activities to allow inclusion within the CDM, and how these criteria and conditions affect C-sequestration rates and project costs. Strict application of certain criteria and guidelines to sink activities may provide an instrument to reduce or eliminate negative effects of the inclusion of sink activities in the CDM.

In January 2000, a first, orientating study was carried out by Alterra, at the request of the Dutch Ministry of Agriculture, Nature Management and Fisheries (LNV). The subject of this study was to assess the potential for C-sequestration through af-, reforestation and forest conservation projects in a limited number of developing countries short-listed to receive aid from the Dutch government (Waterloo et al., 2000). The C-sequestration and cost-effectiveness estimates in this report contain large uncertainty margins. These are due to lack of reliable data on available areas for sink projects, storage capacity in biomass and soil, project costs, etc. Furthermore, any criteria or conditions that may be posed on sink activities in the CDM do not affect the estimates given in this report. This leads to very high potential sequestration rates and low cost estimates. Sink projects implemented under the 'Activities Implemented Jointly' (AIJ) may provide better insight into criteria used to set-up sink projects in developing countries and problems encountered in the projects. This insight should result in the development of a set of criteria, conditions and responsibility guaranties to ensure the eligibility of sink projects for receiving CERs within the CDM. The set of criteria should also include criteria set by the UNFCCC Climate Convention and Kyoto Protocol, forestry institutes and other (non-forestry) institutes. These criteria and conditions should therefore aim to address the uncertainties and objections to sink activities in the CDM listed above.

The aim of this study is threefold:
1) to develop a set of criteria and conditions for sink projects within the CDM.
2) to study the effect of the adoption of such criteria on C-sequestration potentials and costs of several JI/AIJ projects.
3) to estimate C-sequestration potentials and costs of sink projects for 70 developing countries using a number of afforestation, reforestation and forest conservation scenarios with and without adoption of criteria.

Most of the criteria and conditions presented in this report may also be applied to sink projects within Joint Implementation (JI), or to non-sink activities within the CDM. However, discussion of this topic falls outside the scope of this project. The same applies for the application of sink projects for 'adaptation' measures in developing countries. This study deals with Afforestation, Reforestation and Deforestation (ARD) activities only and is restricted to 70 developing countries in five regions.

3 Methods and data sources

Alterra developed the Clean Development Mechanism Forest Sink Model (CDMFSM Ver. 2.01; Waterloo et al., 2001) at the request of the Dutch Ministries of Agriculture, Nature and the Environment (LNV) and of Housing, Spatial Planning and the Environment (VROM). The model was developed to assess different sink activities (e.g. afforestation/reforestation and forest conservation) in terms of their potential C sequestration over different budget periods and the costs associated to these activities. Both the sink capacities and costs are influenced by the adoption of criteria.

Version 2.01 of the model has an extended country list (69 developing countries included) as compared to Version 1.0 and provides regional overviews for Central America/Caribbean, Africa, Asia, Oceania and South America. In addition, the country information has been updated, the af-reforestation calculations now use a growth model and a 'project success rate' factor has been incorporated to estimate potentials and costs taking into account that a certain percentage of projects will fail. Schematic overviews of the model calculation procedures are given in Figure 3 and Figure 7.

3.1 Definitions

For the purpose of this study, forests are defined in the sense of their biomass (FAO, 1999). Values for the average biomass of forests for each country have been published by the FAO (1995, 1999, 2001). It is assumed that deforestation involves a complete removal of the forest biomass (i.e. conversion to pasture or some other low-biomass vegetation cover). Afforestation or reforestation is defined as a gradual change from pasture (or some other form of low-biomass vegetation type) to forest on land that has been without forest prior to 1990. Forest conservation projects are defined as projects, which protect existing natural forest from deforestation, thus keeping the biomass at a level equal to that of undisturbed forest. This implies that there is no timber extraction from these forests (e.g. National Park status).

In reality, afforestation/reforestation can occur on land that already has a significant tree cover and the intensity of deforestation may range from low impact activities (shifting cultivation) to high impact activities such as permanent conversion to pasture.

Hence, with the definitions presently used, the estimates given for carbon sequestration must be considered as high impact changes (i.e. conversion to pasture or reforestation of pasture). The actual sink capacity must therefore be considered lower, depending on the type of deforestation and the biomass of the vegetation on deforested lands.

The definition of agro-forestry includes a change from an agricultural practise to a combination of agriculture and forestry. If we ignore the changes in carbon stocks caused by changes in the agricultural crop management practises in this system, it may be viewed as 'very low intensity' plantation forestry, with associated low biomass accumulation rates.

3.2 Area assumptions for the calculation of Carbon fixation.

The forest carbon sink potential of a country is strongly dependent on the land area that is available for af-/reforestation projects, or on the natural forest area for conservation projects. As such there is a need for realistic estimates of the area available to projects for a proper estimation of the carbon sequestration potentials. CDMFSM V2.0 was developed to calculate the sink potential, as well as 'actual' sequestration rates, by CDM projects using different sets of criteria. A schematic diagram of how potential and actual project available areas are assessed in this spreadsheet model is given in Figure 3.

3.2.1 Af-/reforestation projects

At present, forest plantations cover about 112 Mha globally, which is about 2.3% of the global agricultural area (4,938 Mha). There is no information readiliy available for the current selection of countries on the actual area being available (and physically) suitable for *af-/reforestation* projects. As such, we followed the assumptions of Nilsson and Schopfhauser (1995) that 3-4% of the agricultural land (source: FAOSTAT database) would be potentially available and physically suitable for such projects. The actual percentages used for countries in different regions are given in Table 1.

Table 15. Fraction of agricultural land in tropical regions that would be available and physically suitable for afforestation or reforestation projects (Nilsson and Schopfhauser, 1995)

Region	Available and suitable land / total agricultural land
Tropical Latin America	0.030
Tropical Africa	0.036
Tropical Asia	0.040

The potential area (85.7 Mha) is affected by the selection of criteria (Figure 3), with the exception of the additionality criterion. Additionality requires that a project needs to demonstrate that it is additional to the 'business as usual' in order to receive credits. To account for this criterion, it is assumed that the current planting rate (FAO, 2001) may be taken as a baseline value (i.e. 4.1 Mha yr^{-1}). However, a significant part of the current planting is on land that was deforested after 1990. In view of the fact that such land cannot be used for CDM af-/reforest projects, this area should not be taken fully into account in the baseline. The model therefore defines a factor ($0<F_a<1$) by which the current country annual planting rate is multiplied to define the baseline planting rate on the area available for CDM projects. At present, this value is set to 0.35 as a default.

The potential area to be reforested annually, taking additionality into account, can be expressed as a percentage of the current annual planting rate. For instance, if the percentage is set at 100%, the planting rate becomes double the current annual planting rate. The sum of the area planted annually is checked against the potential available area for af-/reforestation and cannot exceed this area. If the potential area is fully planted, the annual planting rates for CDM projects are set to zero. A plot of the total area planted over 100 years is shown in Figure 2.

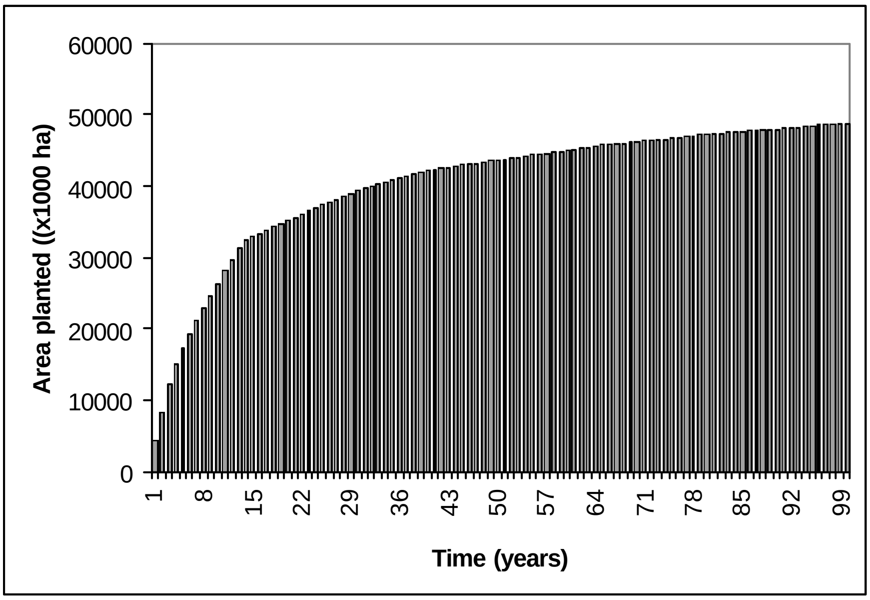

Figure 2. Plot of the total area planted assuming a 100% increase in the current planting rate due to CDM projects and no criteria applied

3.2.2 Forest conservation projects

In principle, the maximum area available for *forest conservation* projects could be represented by the area presently under forest cover (FAO, 2001). However, conservation projects should be aiming at reducing ongoing deforestation for additionality reasons. This implies that the area for such conservation projects is actually limited to current deforestation rates, assuming that this represents a maximum that could be used in (future) baseline scenarios. To arrive at an estimation for the obtainable reduction in the deforestation rate, we made the assumption that the reduction would be dependent on the country's Gross National Product (***GNP***), the deforestation rate (***DFR***) and the population density (***PD***, defining pressures on the land). The assumed potential reduction (in % of deforestation rate) was calculated according to:

$$\frac{GNP * 100}{DFR * PD}$$

and set to a maximum of 20%. An overview of the countries, their GNP, deforestation rates, population density and the calculated efficiency of slowing down deforestation is given in Table 16. The baseline scenarios are described in the next section.

Table 16. Country's GNP (FAO, 2001), Annual deforestation rates (between 1990 and 2000; FAO, 2001), population density (FAO, 2001) and assumptions on the efficiency of slowing down deforestation in a CDM programme

Country/region	GNP (US$)	Deforestation (x 1000 ha yr^{-1})	Pop. Density (km^{-2})	Assumed reduction (%)
C. America/Caribbean	1902	-313	85	0.9
Africa Developing	732	-4746	59	3.2
Asia Developing	1000	-601	185	0.6
Oceania Developing	1392	-119	20	4.7
South America	4995	-3711	18	1.8
Total/average	**2004**	**-9490**	**74**	**2.2**
Angola	1409	-124	10	4.5
Argentina	8755	-285	13	9.2
Bangladesh	352	17	975	0.0
Belize	2547	-36	10	20.0
Benin	381	-70	53	0.4
Bhutan	420	0	40	0.0
Bolivia	912	-161	8	3.0
Botswana	3307	-118	3	20.0
Brazil	4514	-2309	20	0.4
Burundi	141	-15	256	0.1
Cambodia	303	-56	62	0.3
Cameroon	587	-222	32	0.3
Central African Republic	341	-30	6	8.0
Chile	4478	-20	20	20.0
China	668	1806	137	0.0
Colombia	1910	-190	36	1.1
Congo	633	-17	8	17.7
Costa Rica	2610	-16	71	9.3
Cote d'Ivore	727	-265	46	0.2
Cuba	1500	28	102	0.0
Democratic Republic of Congo	114	-532	22	0.0
Ecuador	1390	-137	43	0.9
El Salvador	1684	-7	297	3.2
Equatorial Guinea	892	-11	16	20.0
Fiji	2340	-2	44	20.0
French Guyana	27437	0	2	0.0
Gabon	3985	-10	5	20.0
Gambia	342	4	127	0.0
Ghana	384	-120	87	0.1
Guatemala	1350	-54	103	1.0
Guinea	552	-35	30	2.1
Guinea Bissau	232	-22	42	1.0
Guyana	766	-49	4	14.5
Honduras	723	-59	56	0.9
India	392	38	336	0.0
Indonesia	1096	-1312	116	0.0
Kenya	330	-93	52	0.3
Laos	414	-53	23	1.4
Madagascar	229	-117	27	0.3

Country/region	GNP (US$)	Deforestation (x 1000 ha yr-1)	Pop. Density (km-2)	Assumed reduction (%)
Macedonia	1053	0	79	0.0
Malawi	163	-71	113	0.1
Malaysia	4469	-237	66	1.1
Mexico	3304	0	51	0.0
Mongolia	391	-60	2	15.3
Mozambique	131	-64	25	0.3
Myanmar	1000	-517	69	0.1
Nepal	200	-78	158	0.1
New Caledonia	1500	0	12	0.0
Nicaragua	408	-117	41	0.3
Nigeria	239	-398	120	0.0
Panama	2993	-52	38	6.1
Papua New Guinea	931	-113	10	3.2
Paraguay	1946	-123	14	4.7
Peru	2310	-269	19	1.8
Philippines	1170	-89	250	0.2
Rwanda	207	-15	293	0.2
Senegal	554	-45	48	1.0
Sierra Leone	150	-36	66	0.3
Solomon Islands	797	-4	15	20.0
South Africa	3377	-8	33	20.0
Sudan	255	-959	12	0.1
Surinam	940	0	3	0.0
Thailand	2821	-112	119	0.8
Tanzania	183	-91	37	0.2
Uganda	326	-91	106	0.1
Uruguay	6076	50	19	0.0
Venezuela	3499	-218	30	2.2
Vietnam	299	52	242	0.0
Zambia	387	-851	12	0.2
Zimbabwe	656	-320	30	0.3
Total/average	**1715**	**-135.5**	**68**	**3.8**

3.2.3 Forest conservation scenarios

There are many possibilities for formulating combinations of baseline scenarios and project implementation schemes for forest conservation simulation studies and it is difficult to say which would be the most realistic. We have composed five more or less realistic scenarios. To explain the differences between the five scenarios, we added two figures (see end of section) and a description of their characteristics. Figure 4 shows the annual forest area conserved for the five scenarios, whereas the total forest area saved is displayed in Figure 5 for the 5 scenarios. The scenarios are described below and examples of their implementation are included for further illustration. The case of Angola will be used as an example for each scenario. The 1990-2000 deforestation rate is used as the Business as Usual (BAU_0) baseline for Angola (FAO, 2001) and amounts to 124,000 ha yr^{-1}. The deforestation rate reduction target for this country is set to 4.5% of BAU_0 (see Table 16). All calculations cover a period of 100 years maximum.

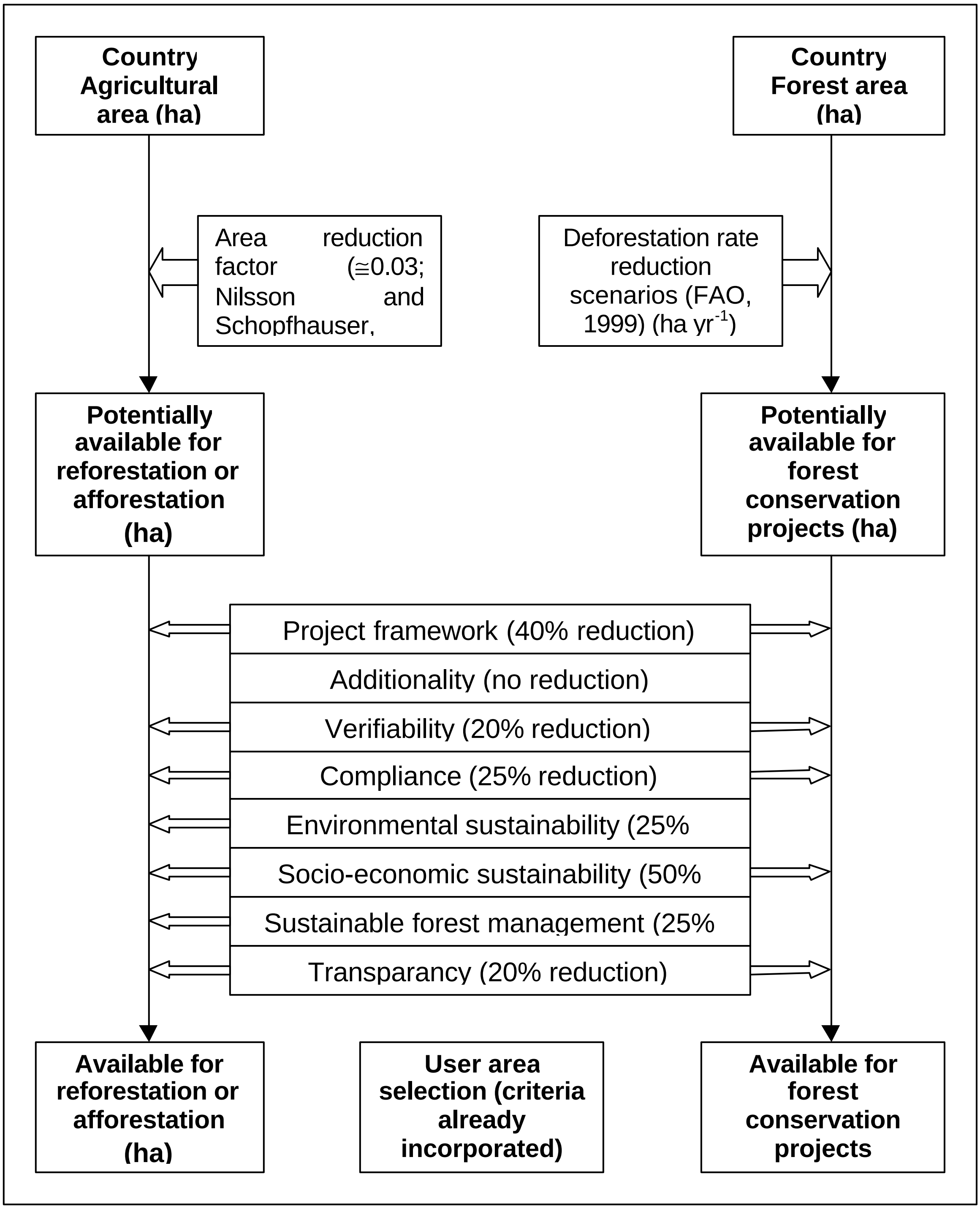

Figure 3. Schematic overview of the assessment procedure in CDMFSM for determining the potential area available to projects and the influence of criteria on the area

Forest conservation 1:
In this scenario, a fixed percentage of the initial deforestation rate (i.e. the 1990-1995 deforestation rate; FAO, 1999), and therefore a fixed forest area, is conserved each year relative to the BAU_0 baseline assumption. The accumulated forest area conserved shows a linear increase in time. The conservation target is set to zero

when there is no additional forest left to conserve anymore due to progressing deforestation in a country. Inclusion of project criteria results in lower annual conservation rates. The green lines in Figure 4 and Figure 5 display the area conserved in this scenario.

For Angola, the cumulative area conserved by conservation projects amounts to 5,600 ha in the first year, 11,200 ha in the second year, etc. The baseline remains at 124,000 ha yr^{-1}, but goes to zero when deforestation has progressed such that there is no forest left to deforest/protect in the country anymore.

Forest conservation 2:
This scenario is basically the same as Forest conservation 1, but with a single forest conservation activity in the first year and no additional conservation activities in consecutive years. As such, this scenario simulates a typical project activity, in which a certain area is selected for conservation in the first year and protected in consecutive years without adding new conservation areas. The forest area conserved drops to zero after the first year and the total forest area saved remains constant in time. This scenario is displayed by the turquoise lines in Figure 4 and Figure 5.

In the case of Angola, there would be a single forest conservation activity in the first year, protecting 5,600 ha of forest over the 100-year period.

Forest conservation 3:
This scenario is the most ambitious scenario, in that it aims toward a maximum reduction in the deforestation rates in time. In this scenario the actual deforestation rate decreases by a fixed percentage each year relative to the BAU_0 baseline scenario. The forest area protected increases on an annual basis until the deforestation rate becomes zero. The total forest area protected increases almost exponentially relative to the BAU_0 scenario, but will eventually become linear. This scenario is displayed by the blue lines in Figure 4 and Figure 5.

In the case of Angola, the area protected amounts to 5,600 ha in the first year. After the first year, the deforestation rate has been reduced by 5,600 ha yr^{-1} and equals 124,000-5,600=118,400 ha. In the second year, an area the size of another 5,600 ha plus the 4.5% of the remaining deforestation rate has to be protected (i.e. 5,600+0.045*118,400=5,328 ha), in addition to the 5,600 ha protected in the first year. The baseline is kept constant at BAU_0 (124,000 ha yr^{-1}).

Forest conservation 4:
In this scenario the actual deforestation rate decreases by a fixed percentage each year, but the BAU scenario is redefined every year. Relative to the BAU_x scenario (where BAU_x is the deforestation rate of the previous year), the forest area saved per year decreases each year. The total forest area saved relative to the BAU_x scenario increases, but is levelling (becomes constant) in time, because the forest area saved per year approaches zero. This scenario is displayed by the brown lines in Figure 4 and Figure 5.

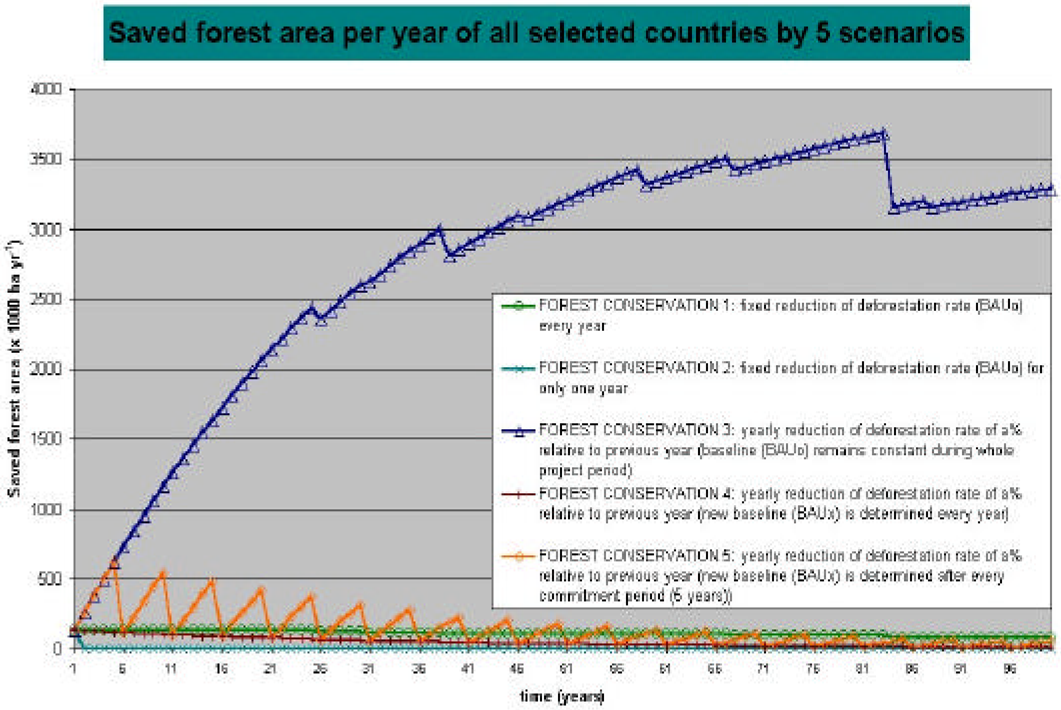

Figure 4. Annual forest area conserved over a 100-year period for the five scenarios

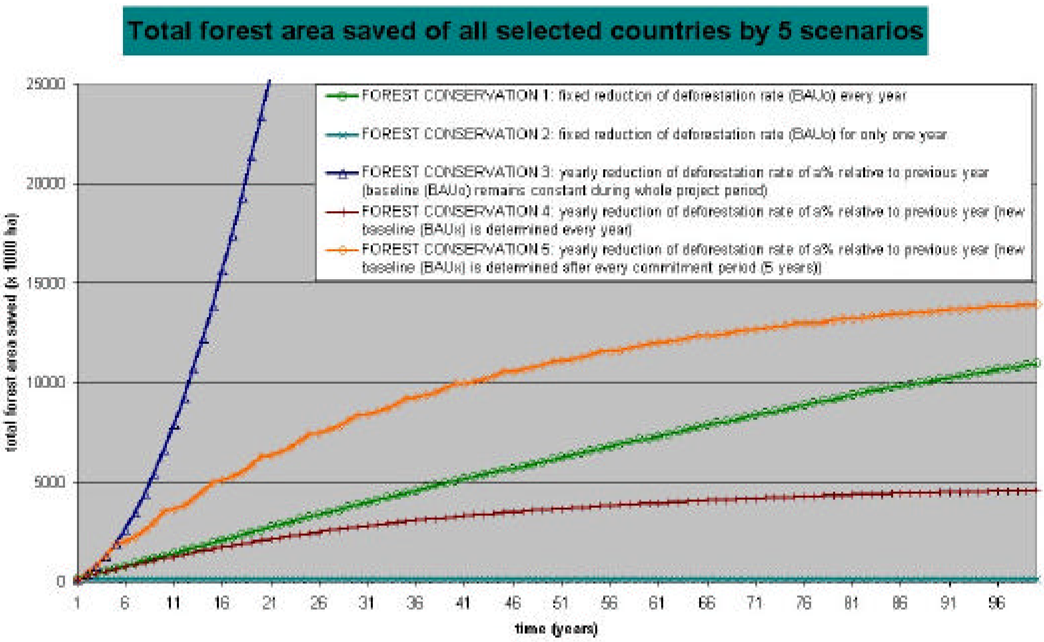

Figure 5. The impact of baseline and forest conservation strategies on the accumulated forest area conserved for the five forest conservation scenarios.

With an initial deforestation rate of 124,000 ha yr^{-1} in Angola, this means that in the first year 5,600 ha of forest is protected. We then assume that the deforestation rate has decreased to 124,000 – 5,600 = 118,400 ha yr^{-1} and the baseline scenario is adjusted accordingly. In the second year, 4.5% of the new baseline (= 5,328 ha) is protected and the baseline is reduced to 118,400-5,328 = 113,072 ha yr^{-1}. This process continues until deforestation reaches zero and the total area conserved in time is thus equal to the initial deforestation rate (124,000 ha in this case).

Forest conservation 5:
In this scenario the actual deforestation rate decreases by a fixed percentage each year as in scenario 4, but the BAU scenario is redefined after every commitment period (5 years). Relative to the BAU_x scenario (where BAU_x is now the deforestation rate at the end of the former commitment period), the forest area saved per year increases within a commitment period. After this commitment period the BAU scenario is redefined and the forest area saved per year becomes the forest area saved per year relative to the new BAU scenario. On long term the forest area saved per year approaches zero. The total forest area saved increases in time and becomes constant on the long term. The increase of the total area saved is largest at the end of each commitment period. This scenario is displayed by the orange lines in Figure 5 and Figure 6.

For Angola, this means that the first five years, the baseline is set at 124,000 ha yr^{-1} and the area protected annually ranges from 5,600 ha in the first year to 25,700 ha in the 5^{th} year. The baseline is then adjusted to 124,000-4,700=119,300 ha yr^{-1} and the area protected annually ranges from 4,500 ha in the 6^{th} year to 20,400 ha in the 10^{th} year. The new baseline then becomes 119,300-3,700=115,600 ha yr^{-1} and the process continues until the deforestation rate becomes zero.

3.3 Influence of criteria on available areas

The area available for af-/reforestation or for forest conservation projects is not static, but is strongly influenced by the adoption of certain criteria in a project. The adoption of criteria has a negative impact on the slowing down of the deforestation rate because only a fraction of the potential area can then be used for CDM projects. For example, sustainable forestry may not be feasible on all available land and adopting this criterion in a project will therefore have a negative effect on the available area. A similar reasoning can be made for other criteria and these criteria all tend to have negative impacts on the available area. Specific weights for area reduction have been assigned to each of the criteria, based on experience from the Dutch FACE projects. Our calculations are such that adoption of a criterion will result in a reduced area equal to multiplication by the weight factor assigned to that criterion. The area reduction factors are given in Table 17.

Table 17. Area reductions per criterion

Project criteria	Area reduction factor (%)	Remarks
Project framework	40	
Additionality	0	Implemented separately in baselines
Verifiability	20	
Compliance	25	
Environmental sustainability	50	0% for forest conservation
Socio-economic sustainability	25	
Sustainable forest management	25	0% for forest conservation
Transparancy	20	

As additionality is a key-element of any CDM project, we suppose that all CDM project initiatives will have to comply with this criterion to be eligible and it can therefore not be switched off in the spreadsheet model. Projects that would not comply with this criterion would not pass the identification phase. Additionality has been included in the baseline planting rates for af-/reforestation.

Per definition, existing natural forests satisfy the criteria of environmental sustainability and sustainable forest management. We therefore assume these two criteria to have no impact on the potential project area in case of forest conservation projects. This means that these two criteria are always set to zero (although not explicitly visible for the user in the model) for forest conservation projects.

Criteria only influence the potentially available project area when the option of using potential areas is selected. If the user opts to define his own area for the simulations, we assume that the criteria have been taken into account during selection of the area and there is therefore no need for further reduction of the area through criteria.

3.4 Project success rates and sink potentials

The Country Credit Ratings list published by the Institutional Investors Magazine (2001) has been used as a measure of the success rates of projects. When this factor is selected, the potential sink is multiplied by the credit rating (its value ranges between 0.95 for Switzerland to 0.078 for Afghanistan) to account for failed projects (which do not receive CERs). The area and total costs are not affected. However, when this factor is selected, the cost per ton C sequestered increases inversely with the value of the credit rating.

3.5 Carbon sequestration and emission calculations

This section describes the procedures for carbon sequestration calculations. All values of Carbon sequestration, emission or stocks are given in units of C. Units of CO_2 and associated costs can also be provided by setting a parameter in the parameter sheet to 3.67 (i.e. the ratio of the molecular weights of CO_2 and C).

Af-/reforestation:
The biomass increase in a plantation usually follows an S-curve. The biomass remains low in the first few years after planting, then increases more rapidly finally levels off to a maximum value when the plantation matures. Normally, the plantation is logged before reaching maturity and the site replanted. The time between planting and logging is called the rotation period T (in years). A growth model has been implemented in this version of CDMFSM. The biomass at a certain point in the rotation is calculated according to the logistic equation (Cooper, 1983):

$$B(t) = \frac{B_m}{1 + be^{-rt}}$$

where $B(t)$ is the biomass at time t, B_m the asymptotic maximum biomass, r the intrinsic growth rate (calculated somewhat arbitrarily as $\sqrt{T}$ to obtain realistic curves for both short and long rotation periods). The shape parameter b is calculated as:

$$b = \frac{B_m - B0}{B_m}$$

The asymptotic maximum biomass for commercial plantations was assumed to be double the country biomass provided by the FAO (2000). The course of $B(t)$ over time using a rotation length of 35 years is shown in Figure 6.

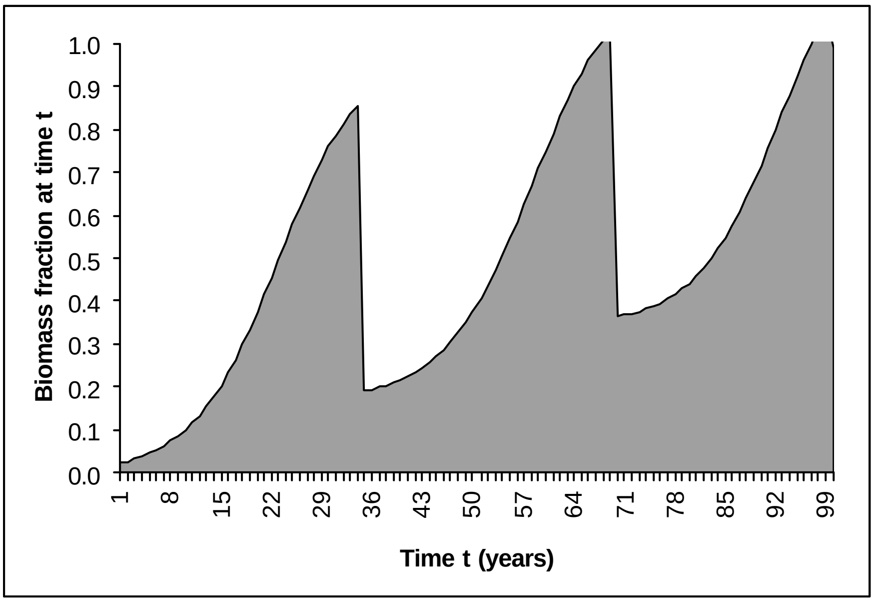

Figure 6. Plot of the ratio of the biomass at time t (=B(t)*) to the maximum biomass (*B_m*) over a 100-year period using a rotation length of 35 years.*

The carbon sink (F_C, Mt y^{-1}) resulting can be calculated from:

$$F_C = \Delta A_{ref} * B(t) * CC * K_{soil} * K_{CO_2}$$

where:

- ΔA_{ref} is the size of the afforested or reforested area (ha),
- K_{soil} is a correction factor for losses of carbon from the soil and litter layer (1.3; Nilsson and Schopfhauser, 1995),
- K_{CO_2} is a conversion factor to account for the conversion from C units to CO_2 units ($\boldsymbol{K}_{CO2}$ =3.67),
  $B(t)$ is biomass at time t (Cooper, 1983) and
- CC is the fraction of carbon in the biomass (assumed to be 0.5; IPCC/OECD/IEA, 1996).

For the calculation of the carbon sequestration over periods longer than the rotation length, a factor (set at 0.20 by default) was used to account for the return of carbon to the atmosphere after harvesting. As such, only 20% of the carbon stored at the end of a rotation is assumed to be permanently sequestered and is added to the sequestration in the next rotation.

Calculations were made for three budget periods, i.e. for the first commitment period (2000-2008, with or without banking) and for longer periods, being from 2000-2050 and 2000-2100. The calculations all started for the year 2000.

Forest conservation:
The C emissions as a consequence of deforestation can have been calculated as:

$$\boldsymbol{E_C = BMS * CC * D A_{def} * K_{soil} * K_{CO2}}$$

where:

- $\boldsymbol{E}_C$ is the C emission (Mt yr^{-1}) as a result of deforestation,
- ***BMS*** is the forest biomass (ton ha^{-1}; FAO, 1995),
- ***CC*** is the fraction of carbon in the biomass (assumed to be 0.5; IPCC/OECD/IEA, 1996),
- $D\boldsymbol{A}_{def}$ represents the size of the deforested area (ha),
- $\boldsymbol{K}_{soil}$ is a correction factor for losses of carbon from the soil and litter layer (1.3; Nilsson and Schopfhauser, 1995) and
- $\boldsymbol{K}_{CO2}$ is a conversion factor to account for the conversion from C units to CO_2 units ($\boldsymbol{K}_{CO2}$ =1 or 3.67).

In case of forest conservation a part of $D\boldsymbol{A}_{def}$ will be saved. How large this part of $D\boldsymbol{A}_{def}$ will be, is dependent of the scenario chosen.

3.6 Cost calculation procedures

The cost calculation procedure is represented schematically in Figure 5. Three kinds of costs can be distinguished for sink projects within CDM. These are:

a) operational costs
b) transaction costs
c) certification costs

The distinction made between costs for forest conservation and af-/reforestation projects is based on the assumption that for forest conservation the environmental sustainability and sustainable forest management have no amount in the (operational and transaction) costs, because they are naturally 'present'. Though the operational costs and the transaction costs are calculated on the basis of af-/reforestation projects, the forest conservation project costs per ton C are lower than the af-/reforestation project costs per ton C.

3.6.1 Operational costs

The operational costs are the costs of project implementation, including promotion, nurseries, technical assistance, training and overhead. The operational costs (***OC***) of the FACE and Noel Kempf projects were related to the Gross National Products (***GNP***) of the host countries using linear regression. This resulted in the following equation, which was used to calculate the basic operational costs for projects in different countries:

$$OC = 0.36 + 0.00019 * GNP \quad n=6,\ r^2=0.94$$

The operational costs are influenced by adoption of criteria in CDM projects. Factors relating the increase in costs to adoption of a certain criterion are given in Table 18.

Table 18. Project criteria and their weight factors influencing operational costs

Project criteria	Operational costs factors	
Project framework	0.525	
Additionality	0.000	
Verifiability	0.095	
Compliance	0.090	
Environmental sustainability	0.060	0.000 for forest conservation
Socio-economic sustainability	0.055	
Sustainable forest management	0.090	0.000 for forest conservation
Transparancy	0.085	
Total factor	1.000	0.850 for forest conservation

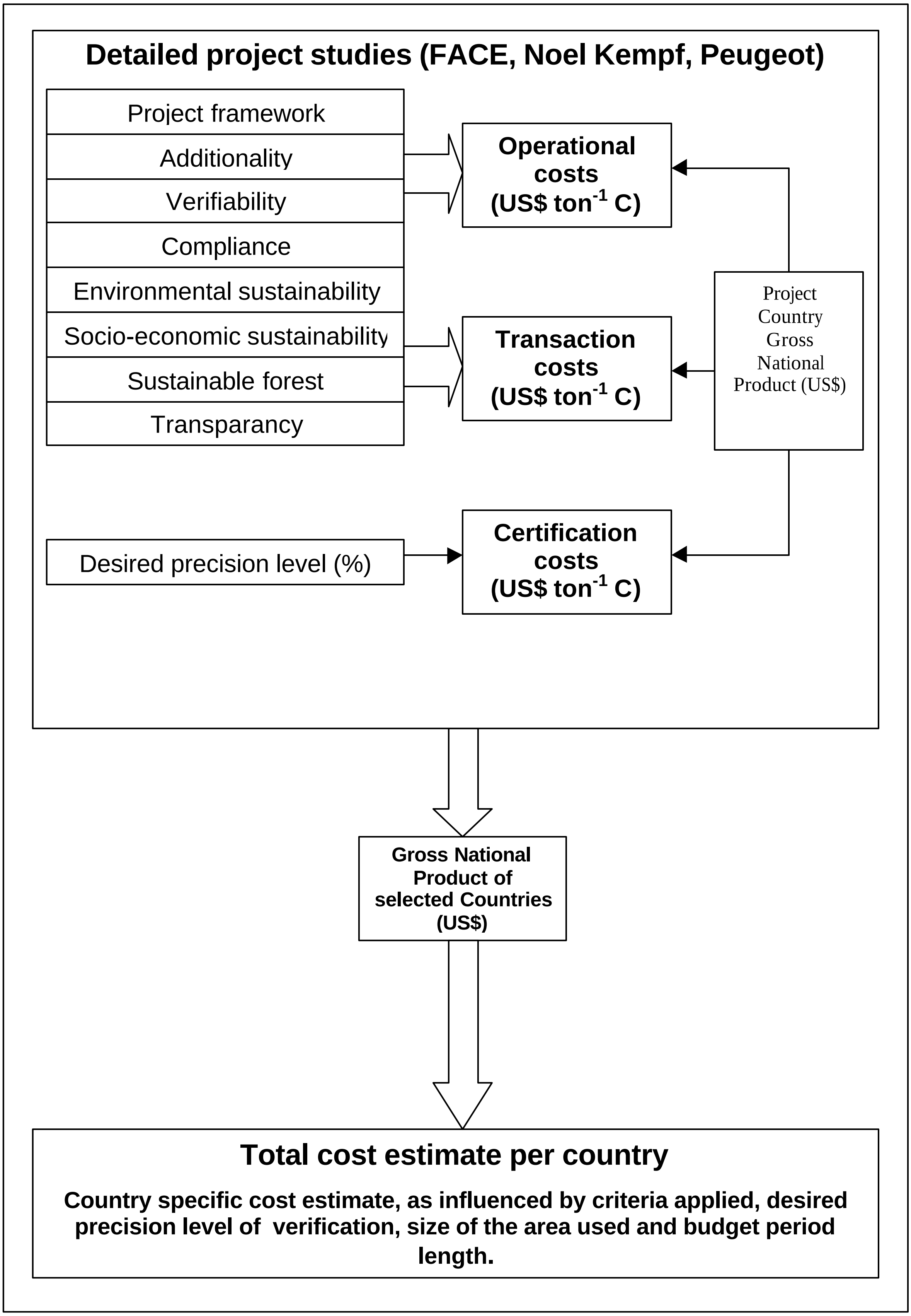

Figure 7. Schematic diagram of the cost calculation procedures in CDMFSM

3.6.2 Transaction costs

Transaction costs represent the running costs of projects and include the expenses made for preparation, certification and sale. The preparation cost for the FACE projects were the costs relating to the launch of the Face Foundation, the development of the contracts and the (internal) monitoring system MONIS, identification of the project countries as well as the projects themselves. Our present estimates are based on the transaction costs (***TC***) of the two FACE projects only and were also related to ***GNP***:

$$\boldsymbol{TC} = \mathbf{0.07 + 0.00096}*\boldsymbol{GNP} \quad \mathbf{n=2,\ r^2=1.00}$$

The transaction costs are also influenced by the adoption of criteria in CDM projects. Their weight factors are given in Table 19.

Table 19. Weight factors used to calculate the influence of adoption of criteria on the transaction costs

Project criteria	**Transaction costs**	
Project framework	0.055	
Additionality	0.020	
Verifiability	0.345	
Compliance	0.230	
Environmental sustainability	0.050	0.000 for forest conservation
Socio-economic sustainability	0.045	
Sustainable forest management	0.050	0.000 for forest conservation
Transparancy	0.205	
Total factor	1.000	0.900 for forest conservation

3.6.3 Certification costs

Certification costs depend partly on the level of uncertainty that is required for a project. Certification costs include a) monitoring (remote sensing, field work and reporting), b) costs incurred by the certifying agency, and c) in the case of the FACE projects, supervision by Face Foundation. If a low uncertainty level is needed, more sample plots will be required, which increases the costs. One way of dealing with the uncertainties is by creating a buffer, which accounts for these uncertainties. In the spreadsheet model, the level of precision can be given. The relation for the increase of certification costs (***CC***) with the desired precision level (***P***) was obtained from Powell (1999) with Noel Kempf project data. Relations between certification costs and gross national product were established for five precision levels, being 5, 10, 20, 25 and 30% and the respective equations relating the certification costs to host country ***GNP*** are given below.

$$\boldsymbol{CC} = \mathbf{0.89 + 0.00032}*\boldsymbol{GNP},\ \boldsymbol{P} = \mathbf{5\%}$$
$$\boldsymbol{CC} = \mathbf{0.63 + 0.00022}*\boldsymbol{GNP},\ \boldsymbol{P} = \mathbf{10\%}$$
$$\boldsymbol{CC} = \mathbf{0.58 + 0.00021}*\boldsymbol{GNP},\ \boldsymbol{P} = \mathbf{20\%}$$
$$\boldsymbol{CC} = \mathbf{0.58 + 0.00021}*\boldsymbol{GNP},\ \boldsymbol{P} = \mathbf{25\%}$$
$$\boldsymbol{CC} = \mathbf{0.57 + 0.00020}*\boldsymbol{GNP},\ \boldsymbol{P} = \mathbf{30\%}$$

Unlike the operation and transaction costs, the certification costs are not influenced by adoption of the criteria in projects.

3.6.4 Projection of present costs estimates to the future

The cost calculations for the different periods were based on the present costs of setting up a CDM project. For long-term financial projections a discount rate is normally used to correct for inflation, etc. This rate is usually set to a value of around 5%. Applying this discount rate would increase the cost estimates presented in this report by a factor of 1.8 (i.e. 1.05 to the power of 12) for the first commitment period and 11.5 and 131.5 for the 50- and 100-year periods, respectively.

The projects currently under investigation have not yet provided financial returns on the investment and may only start doing so after the first commitment period when plantations are mature. Projected cost estimates over longer periods will have to be corrected with income generated by the projects through future sale of timber, non-forest timber products, eco-tourism, etc. As the returns on the investment are presumably close to 100% for af-/reforestation projects, and perhaps a bit less for forest conservation projects, the present price level may be a fair indication for the costs of CDM sink projects in the near future (i.e. first commitment period).

4 Principles and criteria inventory for CDM projects

4.1 Selection of principles and criteria

The contemporary criteria sets for sink projects are based on a combination of criteria and guidelines for sustainable forestry, biodiversity, good governance and UNFCCC. These criteria sets contain criteria and principles that are not explicitly designed for JI, CDM or non-Kyoto projects. In most cases they are applicable to all of them. The emphasis on the criteria sets differs. Some posit general guidelines to support and stimulate good practise in sink projects, others provide specific criteria with indicators for the use of verification and certification activities.

This report includes the sets of criteria and principles of various organisations. The inventory of principles and criteria can be divided in three broad categories concerning CDM projects (Figure 8):

I. Principles and criteria of the UNFCCC: Climate Convention and Kyoto Protocol
II. Principles and criteria of forestry institutes
III. Principles and criteria of other (non-forestry) institutes

The principles and criteria of the three categories of institutes are not equally relevant to this study. The basic set of principles and criteria of the UNFCCC is most important for CDM projects, because this set contains the minimum requirements.

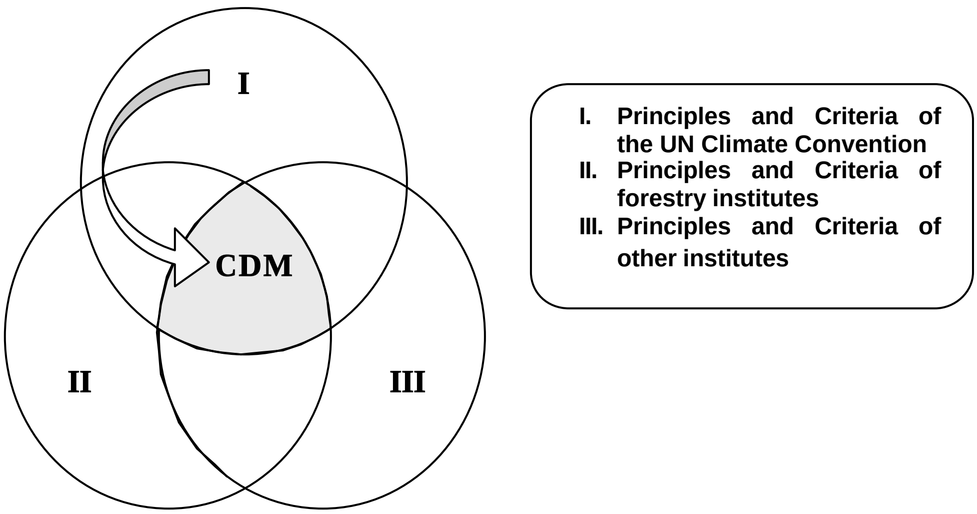

Figure 8. Hierarchy of three categories of principles and criteria visually displayed.

The principles and criteria of the forestry institutes describe the constraints to forestry projects in or outside the context of the UNFCCC. These criteria form a separate category because verification and certification in Sustainable Forest

Management are operational and are closely related to forest activities under the Kyoto Protocol.

The third category consists of 'criteria and principles' sets that are additional to the first two categories. Some of the criteria and principles are partially enclosed in those categories. Other strengthen the categories I and II, making them more extensive and at the same time harder to realise. This way a path is set out from category I to a combination of all categories. The third category encloses the first initiatives of criteria and principle sets for greenhouse gas abatement, sink and CDM projects.

This study only deals with carbon sinks related to the forestry sector, i.e. af-, reforestation and reduced deforestation, and not activities in e.g. the energy sector. Some of the criteria listed below may be to specific for these sectors to be applied. Differences between sectors can lead to revaluation of and change of emphasis on criteria and principles.

The category index is used to obtain a ranking of criteria sets. This ranking ranges from mandatory to additional. In general, additional criteria increase the project costs, not taking into account possible side-benefits derived from implementation of the criteria.

A total of 14 sets have been used. These are those of the UNFCCC, the Kyoto Protocol, CIFOR, ITTO, FSC, PEFC, COV, FIPIC, MPWG, WWF, Convention on Biological Diversity, World Bank, GEF, IPCC[4] and several Dutch policy papers. The UNFCCC and the Kyoto Protocol are part of the first Category. All criteria sets related to forestry organisations are included in the second category.

The third category is divided into three sections: 1) Sink and GHG abatement project criteria, 2) National (i.e. Dutch) criteria and 3) criteria set by International organisations. The sink and GHG abatement project criteria are part of those set by COV/SGS, FIPIC/ECOR and IPCC. The second section includes guidelines and criteria stated in Dutch policy documents. The World Bank, GEF and the Biodiversity Convention are the enclosed international organisations.

4.1.1 Climate Convention and the Kyoto Protocol

The articles of the UNFCCC under the Climate Convention and the Kyoto Protocol provide indirect criteria and guidelines for sink projects. Article 12 defines the Clean Development Mechanism and sets conditions on projects that may be eligible under this article. The following CDM criteria and conditions can be derived from the texts on this subject in the Climate Convention and Kyoto Protocol:

[4] UNFCCC = United Nations Framework Convention on Climate Change, CIFOR = Center for International Forestry Research, ITTO = International Tropical Timber Organisation, FSC = Forest Stewardship Council, PEFC = Pan European Forest Certification, COV = Carbon Offset Verification, FIPIC = Federation Internationale Pour L'Isolmente du Carbone, MPWG = Montreal Process Working Group, WWF = World Wildlife Fund, GEF = Global Environment Facility and IPCC = Intergovernmental Panel on Climate Change.

- Legal and institutional compliance
- Changes in carbon uptake must be real and measurable
- Financially and environmentally additional
- Technology transfer to non Annex I country
- Environmental sustainability
- Social sustainability
- Sustainable development requirement
- No unjustifiable discrimination between host countries
- Non-Annex I country will benefit from CDM projects
- Carbon sequestration before 2000 can not be accounted
- Public as well as private entities can participate
- Permanence needs to be ensured
- Sovereignty needs to be ensured

However, the texts in these articles provide only a framework for projects carried out under the Kyoto Protocol and can not be viewed as listing any operational criteria. There are too many possibilities for different interpretations of the same text by different actors. These articles must therefore be viewed only as rough guidelines for CDM projects. Decisions to be made at future sessions of the UNFCCC and specially developed criteria for sink projects or other types of CDM projects are considered to be the next step. Annex A provides a full description of the different criteria mentioned above and also includes literature references.

4.1.2 Forestry Institutes

A set of eight generic criteria is given in Table 20. This set of generic criteria is derived from principles and criteria guidelines defined by several international forestry, timber and certifying organisation (CIFOR[5], ITTO[6], FSC[7], PEFC[8], MPWG[9] and). However, not all the criteria listed in Table 20 are mentioned explicitly in the guidelines of these organisations. Some criteria are a logical consequence of other criteria listed in the certification guidelines, whereas some certificates and guidelines lack certain generic criteria. This does not imply that those guidelines are of lesser importance. The choice of the eight criteria listed in Table 20 is somewhat subjective. This means that other subdivisions, which would also include the same eight criteria, are possible.

The principles and criteria of the different organisations are given in Annex B. The numbers (① through ⑧) in this annex (separate column) correspond with the numbers (① through ⑧) in the column before the criteria in Table 20.

5 Center for International Forestry Research
6 International Tropical Timber Organisation
7 Forest Stewardship Council
8 Pan European Forest Certification
9 Montreal Process Working Group

4.1.3 Other institutes

Criteria and principles for CDM and sink projects can be expanded with criteria sets from outside the climate and forestry organisations. New sets are derived from regulations and guidelines of development aid on national and international level. The selection includes the GAVIM principles of the Dutch Ministry of Development, PCF criteria of the World Bank, general GEF criteria and UNDP principles. A description of the above documents is included in Annex C. The criteria and guidelines are linked with the generic criteria under paragraph 4.2.

4.1.3.1 Sinks and GHG abatement project criteria

For the purpose of this study, the selected criteria sets of COV/SGS[10], FIPIC[11] and WWF[12] have been assessed. The COV certification system was the most complete set assessed in this study. The system is already in practise and can be, in principle, applied to both greenhouse gas abatement and sink projects. The COV system does not include sustainable forest management criteria. These criteria are indirectly covered by environmental and socio-economic sustainability. Requirements for forestry activities are therefore specific included.

The FIPIC criteria set covers the same aspects as the COV, though the system is not as thorough and can only be referred to as a set of general guidelines.

The WWF criteria aim at CDM projects in general. The accent is on environmental sustainability, monitoring and verification. The forest management practises are completely left aside.

The IPCC criteria set is direct related to the UNFCCC, but only provides advisory guidelines and no binding criteria. When these guidelines are translated into operational criteria, they will be part of the first category. In the Special Report on Land Use, Land Use Change and Forestry by the IPCC five technical issues were explicitly addressed:

- Permanence and risks
- Baselines and additionality
- Leakage
- Accounting
- Associated impacts

A summary of the chapter on sink projects in the IPCC Special Report is provided in Annex E.

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10 Carbon Offset Verification/Société Génerale de Surveillance
11 Féderation Internationale Pour L'Isolemente du Carbone
12 World Wildlife Fund

4.1.3.2 National (Dutch) criteria

Several Dutch policy papers have stated criteria that could be applied to sink project under the CDM. The papers and guidelines come primarily from the Ministry of Agriculture, Nature Management and Fisheries and the Ministry of Development. These criteria, or a combination of them, are not sufficient to construct a practical criteria set for sink project under the CDM. The following documents and criteria have been assessed:

- *The Dutch Government Policy Paper on tropical rainforests, 1992, The Hague*
- *Forest policy act; international forestry policy, 1993, The Hague*
- *National criteria as a result from the Pan European Ministerial Conference on the protection of forests in Europe, 1993, Helsinki*
- *GAVIM principles of the Dutch Ministry of Development Co-operation*

Current policies primarily deal with non-sink aspects of potential sequestration projects. The emphasis is on environmental sustainability, socio-economic sustainability, management practises, sustainable forest management, political circumstances and compliance. The documents lack criteria or guidelines on verifiability of results, measurement requirements and additionality. The GAVIM principle approaches the criteria for CDM projects but the principles are not yet specific enough to be of immediate use in sink projects.

4.1.3.3 International organisations

The criteria of the GEF, World Bank, the Convention on Biological Diversity and UNCED have been assessed as well. The UNCED criteria are the result of the Stortenbeker working group in 1992 and can be considered to be the first set of criteria for sustainable forest management. The criteria set focuses on the continuation of functions of the forest ecosystem.

The GEF and World Bank have extended experience and knowledge with (environmental) projects in developing countries. About 40% of the GEF money is assigned for climate change projects and activities. Both organisations focus on consistency, fund additionality and quality (such as best practises, cost-effectiveness and local benefits). The principles and criteria of the World Bank and the Global Environmental Facility (GEF) are covered by the eight generic criteria defined in this study.

The Convention on Biological Diversity has a diverse set of criteria. The Primary focus is on conservation and sustainable use of resources. Identification, monitoring, education, training, adjusted decision-making and technology transfer are tools to fulfil these goals.

Adoption of criteria listed by international organisations is not a guarantee against project failure. This has been illustrated by Niles (2000), who calculated such failure rates[13] of World Bank projects across the world. The world average failure rate is 66%, varying between 90%[14] and 20% (Malaysia).

4.2 Generic set of criteria

Table 20 gives an overview of the criteria sets used by eight different international organisations dealing with forestry and sink-related organisations projects. A generic criteria set has been derived from this overview. Each criteria set mentioned in this study has been compared to the generic criteria set to detect overlap or supplements. The criteria are applicable to sink projects under CDM but must defined in more detail before being implemented. The criteria do not exclude plantation forests. Plantations can be managed sustainable if appropriate measures are taken. The eight generic criteria aim at sink projects under CDM. But the criteria, except the sustainable forestry management criterion, or also applicable to other CDM projects. The criteria address common principles that also apply to non-forestry projects.

Annex A to Annex C contain full descriptions of all criteria assessed in this study. Each criteria set is linked to the generic criteria set with the numbers ① through ⑧ stated in Table 20. A more extensive description of the generic criteria can be found in Annex D.

4.2.1 Project framework

The project framework should contain a policy, planning and institutional framework, in which the following issues are dealt with:

- management plan, management team and staff
- measuring, accounting, monitoring and verifying system
- project duration
- funding
- compliance, use rights and responsibilities

The project framework criterion also includes the organisational activities throughout the project lifetime that are described in a work plan.

[13] The estimates were derived by multiplying the percent of World Bank projects in a country that were evaluated as successful times the percent of projects in a country that were judged to be sustainable.
[14] Failure rates for Angola, Cambodia, CAR, Congo, Madagascar, Nicaragua, Nigeria, Paraguay and Zambia. The 10% succeeding rate resembles a rate lower than 10% or absent of data.

Table 20. Set of eight generic criteria derived from eight international forestry, timber and certifying organisations

Criteria ↓ / Organisation →	CIFOR	ITTO	FSC	PEFC	COV / SGS	FIPIC	MPWG	WWF
① Project framework	✓	✓	✓	✓	✓	✓	✓	✓
② Additionality					✓	✓		
③ Verifiability			✓		✓	✓		✓
④ Compliance	✓		✓		✓		✓	✓
⑤ Environmental sustainability	✓	✓	✓	✓	✓	✓	✓	✓
⑥ Socio-economic sustainability	✓	✓	✓	✓	✓	✓	✓	
⑦ Sustainable forest management	✓	✓	✓	✓	1		✓	
⑧ Transparency			✓		✓	✓		✓

1: indirectly includes in ③ and ④

The framework provides a solid base to secure the successful implementation of the project. It also provides a basis for implementation of additional criteria.

This criterion contributes to all objections and concerns, but especially to: permanence enhancement and risk reduction, knowledge transfer, competence and infrastructure, avoids political instability.

4.2.2 Additionality

Projects can not claim certified emission reductions unless project proponents make reasonable demonstration that the project's practices for emission reductions are 'additional' to the 'business as usual' (also called the 'reference case' or 'baseline'). Additionality is a key criterion for CDM projects due to the fact that the host countries do not have emission reduction targets themselves. As such, CDM projects can create new emission allowances for Annex 1 countries, which should be balanced by reductions in the non-Annex I host country for carbon neutrality reasons. Enforcing the additionality criterion should guarantee that projects can not claim certified emission reductions unless demonstrated that the claimed project's emission reductions are indeed 'additional' to the 'business as usual' scenario in the host country. CDM projects should, at least to some extent, be additional in financial terms to ensure that they would not have happened in the 'business as usual' scenario and to avoid subsidising commercially viable business activities. Additionality is crucial for the acquisition of CERs for sequestered carbon under the UNFCCC. The criterion demands evidence that the project would not have occurred otherwise. The additionality should be corrected for 'slippage and leakage'[15]. There are three categories of leakage: project, regional and national. Verifiability and additionality criteria should contain a framework to reduce leakage. Project and regional leakage can be controlled for a large part through measures on the project level. National leakage should be controlled on both national and project levels. Hence, without national co-operation, leakage on a national level cannot be controlled properly.

This criterion contributes to: accounting, additionality, leakage, permanence and risks.

4.2.3 Verifiability

The verification and monitoring of CDM sink projects requires effective monitoring and control systems. Monitoring procedures should be consistent and replicable over time. Furthermore, the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment should determine the frequency and intensity of monitoring. Special care is needed to determine leakage, risks and uncertainties of sink projects. The verifiability criterion guarantees a successful implementation of verification and monitoring methodology that is able to measure and determine the actual sequestered carbon, uncertainties, leakage and associated impacts.

This criterion contributes to: monitoring, accounting, additionality, leakage, permanence and risks.

4.2.4 Compliance

There should be compliance with international, national and local regulations and treaties. All applicable and legally prescribed fees, royalties, taxes and other charges should be paid. The host country should voluntary accept the CDM project, without any external intimidation or economic retaliation. This criterion could be used to solve sovereignty issues, as projects have to comply with national laws concerning landownership, etc.

Compliance contributes to: avoiding political instability, credit sharing, additionality and permanence.

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15 Slippage is the geographic relocation of GHG emission causing activities, as a result of the project's implementation. Leakage is increased GHG emissions indirectly incentivised by the project: e.g. increased down-stream processing activities.

4.2.5 Environmental sustainability

Maintenance, conservation and enhancement of biological diversity should reach environmental sustainability. Impacts on the ecosystem and its function should be prevented or reduced. Furthermore, the soil structure, fertility, water quality and biological activity should be maintained or improved.

Contributes to: environmental sustainability, additionality, leakage, monitoring and knowledge transfer.

4.2.6 Socio-economic sustainability

Socio-economic sustainability should be reached by preventing or reducing impact on local communities, their activities, their resources and their cultural values. Projects should encourage employment by indigenous people and promote technology/knowledge transfer, training and capacity building.

Contributes to: socio-economic sustainability, political sustainability, knowledge transfer, infrastructure and capacity building,

4.2.7 Sustainable forest management

The sustainable forest management (SFM) criterion is a derivative of the criteria for environmental and socio-economic sustainability. This criterion is enclosed because it addresses the issue of forest management more specifically.

Sustainable forest management should aim for protection, conservation and restoration of natural forests and sustainable management of plantations. Furthermore it should conserve or contribute to biological diversity. It should also strive toward economic viability, which means that yield and quality shall be sustained and the local economy be strengthened and diversified.

Contributes to: social and environmental sustainability and monitoring.

Objections	Criteria ①	②	③	④	⑤	⑥	⑦	⑧
Permanence and risks	●	●	●	●	●	●		
Baselines and additionality	●	●	●	●	●			●
Leakage: project and land-based	●	●	●		●			●
Accounting and accounting methods	●	●	●		●			●
Uncertainty in sink capacity and socio-economic processes	●		●		●		●	
Sustainable development: environmentally	●				●		●	
Sustainable development: Socio-economic	●					●	●	
Capacity-building and technology transfer	●				●	●		●
Political stability and liability	●			●		●		

Need Want

Table 21. Indicators of the eight generic criteria subdivided into eleven elements.

4.2.8 Transparency

Transparency should guarantee reproducible results from measurement and monitoring methods and give insight into the methodology. It should also guarantee insight into project progress, project impacts and results, management and funding to the UNFCCC, the concerned parties and everyone who is interested. Direct products of transparency are publications that are publicly accessible (hard-copy or through the Internet).

Contributes to: insight in leakage, additionality, monitoring, accounting and knowledge transfer.

4.3 Overview of generic criteria

The generic criteria selected from the criteria sets are listed in Table 21. The criteria are listed in hierarchical order. The first criteria are essential for a successful implementation of carbon sequestration projects. The other criteria are desirable to expand the reach of these sink projects and limit negative any impacts. The order is, to some extent, subject to change due to changes in objections to sinks in the CDM. The effect on costs and potential of sink projects in the CDM does affect the order.

The major objections to sinks in the CDM (i.e. scale, permanence and risk) are not covered by each criterion. The general criteria set can be utilised to deal with the technical issues, to which the objections are related. Table 21 links the criteria with the objections against sink projects in CDM.

Each criterion has its own set of indicators, which determine the extension of the criterion. The indicators concretise criteria, providing a detailed description of the criteria. Annex D provides a general overview of the indicators and elements of the criteria. These indicators are distilled from the criteria sets provided and used by relevant international organisations.

The criteria ‘additionality’and ‘project framework’ are crucial for the implementation of any sink project. Without these criteria, the framework for proper and effective management and implementation of other criteria lacks and one of most important criteria for accepting sink activities under the UNFCCC is not fulfilled.

Sustainable development is embedded in several criteria. It can be argued that sustainable development does not only add extra value to sink projects, but also deals with several of the technical issues. By providing substitution for local communities, a large part of the leakage can be prevented. In addition, sustainable development can be an incentive for capacity-building and technology transfer.

Implementation of sink activities under the CDM will, for a large part, depend on the inclusion of the incentive of industrialised countries to support developing countries in achieving sustainable development.

The lesser important criteria (see Table 21) will affect the costs and potential of carbon sequestration to some extend. Adopting these criteria increases project costs and the pressure on available land for sink activities. However, implementing these criteria is of great importance to minimise any negative effects of sinks under the CDM.

5 In-depth project and case studies.

5.1 Introduction

In-depth and case studies of existing projects were made to assess the impact of adoption of one or more criteria in CDM projects on project volume (i.e. potential area) and costs. For the in-depth studies, two FACE were selected. For Malaysia, a separate case study was made to see how sink projects could, in practice, be implemented in a political and legal framework.

5.2 Cost calculations

In a previous report (Waterloo et al., 2000) cost estimates of the FACE projects (Hol et al., 1999) were used to obtain estimates for the costs of carbon sequestration. The values used, however, were the quotient of the end capacity of the planted forests and the investment of FACE. This approach was one of the pre-Kyoto accounting options, which can now be regarded as obsolete. Moreover, in the calculations of Hol et al. (1999), the costs for certification and long-term monitoring, which are part of the transaction costs, were not taken into account. As a result, their cost estimates were only indicative for operational costs and do not reflect the total costs incurred by carbon sequestration projects.

Three factors determine the costs of C sequestration, i.e. 1) the costs per hectare for afforestation, 2) the capacity and rate of sequestration as compared to the baseline and 3) the method used for the accounting of the certified offset. If based on the maximum C sequestration capacity of the forests, the afforestation costs for the various FACE projects will range from 2.2 to 25.7 Euro per tonne C. Some 85% of all costs incurred by Face involve operational costs. Because the majority of preparation costs, including the costs relating to the launch of the Face Foundation, the development of the contracts and the monitoring system, the identification of the project countries as well as the projects themselves, were one-off in nature, the overhead is set to decrease substantially in time. Operational costs comprise planting costs (including the construction of infrastructure) as well as costs of supplementary research and training. At year-end 1997 the latter represented an average of 7% of aggregate costs, a percentage which is set to decrease as the projects progress.

Costs can be calculated on a per-hectare or a per tonne C basis. The latter requires the following data:

1. Costs per hectare
2. Sequestration of C per ha as compared to the baseline
3. Length of accounting period

Presently, the costs include:

- Operational costs: planting costs, the construction and maintenance of the infra-structural facilities and the project framework, and costs of supplementary research and training. Overheads of the FACE Foundation headquarters are allocated to the various projects with equal shares
- Transaction costs: the expenses made for preparation, certification and sale.
- Preparation cost: these are the costs related to the launch of the Face Foundation, the development of the contracts and the (internal) monitoring system 'MONIS', the identification of host countries and potential projects. Within the FACE Foundation, preparation costs are allocated to the different projects with equal shares.
- Certification costs include a) monitoring (remote sensing, fieldwork and reporting), b) costs incurred by the certifying organisation, and c) supervision of the certification process by the FACE Foundation.

The financial analysis requires the selection of an inflation and interest rate for discounting purposes. At present, the FACE Foundation uses 2% inflation and 6% discount rates to deduce NPVs.

Carbon accounting requires the selection of a suitable time frame. For Carbon sequestration projects this may be:

- the first commitment period (2008-2012),
- a number of consecutive budget periods,
- the project lifetime,
- the project lifetime after the start of the first budget period,
- any other time frame regarded as appropriate for the analysis, e.g. 25 or 50 years economic lifetime.

The determination of the costs per tonne C also depends on how the sequestration will be offset internationally. At the Kyoto Climate Conference, agreements were made on the timetable for achieving compliance with the greenhouse gas reduction obligations. The same timetable has been set for the settlement of JI projects. No timetable has as yet been set for projects coming under the CDM banner. At the final settlement date of 2012 about 45,000 ha of FACE projects, implemented until the end of 1999, will have resulted in the sequestration of some 2.2 million tonnes of C, as a very conservative estimate. Accumulating offsets from 1990 until the end of 2012, the approximately 33 million US$ of expenses will by that time result in costs of about 15 US$ per tonne C (see Table 22). If calculations are made for the offset during the commitment period 2008-2012, the costs per tonne C will be approximately 33 US$. In CDM (if at all applicable to sinks), accounting of certified emission reductions will be from the year 2000 towards the end of the commitment period ('banking'), yielding average costs for FACE of 9.2 US$ per tonne C. It should be noted that, as sequestration continues, the subsequent costs per tonne of C would drop considerably, as they will by then consist of nothing other than monitoring and reporting. There is quite a difference among FACE projects in terms of cost efficiency, the Netherlands and Czech projects being much more expensive than the ones in tropical regions (e.g. Ecuador, Uganda).

Table 22. Cost assessment per tonne C of FACE sequestration forests, in relation to the length of the accounting period. (values in US$ based on reforestation achieved until the end of 1999)

	Capacity-based [A]	1991-2012	2008-2012 [B]	2001 [C]-2012
All projects	5.5	14.7	33.0	
Tropics (CDM)	3.7		5	9.2

[A]: Quotient of total costs over end-capacity; [B]: Commitment period; [C]: start date for CDM accountability.

Because project implementation is ongoing, the project volumes included in the present analysis for the FACE projects are cut-off at year-end 1999. Projections are used for the Peugeot project.

The FACE Foundation has produced two figures for certified projects, which are likely to be relevant. These are estimations of the average sequestration rates during the first budget period (BP1) and total sequestration during the lifetime of the project. With regard to the latter, it should be noted that for CDM projects it would be required (at least according to current practice) to level future fluctuations in stocks because no provisions are available to deal with associated fluctuations in carbon credits. Therefore, the Average Storage Capacity (ASC) is used (see IPCC SR LULUCF), although it is not yet sure whether this is the most appropriate one. The time span over which the ASC is calculated is the lifetime of the projects, i.e. 99 years. The sequestration rates have been derived from projections over the lifetime of the projects, which are based on modelling results.

5.3 Certification

The certification procedure includes the assessment of risks and accuracy. To account for these issues, part of the sequestration claimed is retained in a buffer. The remaining amounts of carbon are referred to as ‘virtually risk-free’, which are listed below. The buffer size for the projects in Ecuador and Uganda are currently around 25 %. It is stressed that eventually some part of the buffer may be released, so that both BP1 and ASC may increase.

Because there is a certain risk factor attached to the projected carbon offsets, a carbon discount rate may be applied to account for these risks. This is suitable in case buyer liability is assumed. The size of the discount is however unclear, and buyer liability may be replaced by seller liability. Moreover, the buffer and the ASC reduce projections of sequestration quantities. Therefore, carbon discounting is not included in this analysis.

5.4 Eligibility criteria as cost factors

Eligibility criteria and related indicators as listed in Chapter 5 can be regarded as cost factors for individual projects. There are basically 2 approaches to establish the quantitative effect of these criteria, i.e.:

- include or exclude sub-sets of criteria or
- determine the weight of each criterion with regards to its effect on total costs or cost items

The advantage of the first approach is strictly methodological. It would assume project structures, which have no significance in reality. In fact, the effects of the selected criteria are essentially fuzzy and cannot be attached to a single cost item. Therefore, the second approach seems more appropriate, in spite of the fact that the weighing of criteria is at least partially subjective. The analysis given in the following sections for the FACE projects is based on the second approach. It should be clear that the weight factors are based on the experience and judgement of the FACE management team and that it is difficult to provide more objective indications.

The influence of criteria on project costs are given separately for the operational costs (i.e. implementation costs, including promotion, nurseries, technical assistance, training and overhead) and the transaction costs. The certification costs are much less dependent on the adoption of certain criteria in a project. The weights assigned to each criterion, expressed as percentages of total cost, are presented in Table 25 for Ecuador and Table 29 for Uganda.

The results indicate that requirements for a proper project framework weigh relatively heavily on operational costs. SFM-related requirements particularly have some effect on certification costs. This implies that the project will be SFM-compliant mostly due to other requirements, but that in order to demonstrate SFM compliance certain costs must be absorbed. Environmental sustainability will be assured provided that the identification of the project has been properly conducted. If significant costs are expected, the project may fail in the identification phase. Remaining costs pertain to training, research and monitoring. Socio-economic sustainability relies on an appropriate identification as well. Revenues for the beneficiaries depend on proper project management, and thus on monitoring, technical assistance and administration. As the projects are embedded in programmes for regional development and international frameworks, compliance is a significant cost factor particularly in project operation. It is not surprising that transaction costs are affected by the verifiability and transparency criteria. Additionality does not lead to significant project costs since the identification process is supposed to cover this before project implementation.

5.5 Effect of criteria on potential project area

The FACE Foundation has visited 14 countries to assess their potential for hosting projects. The countries included in this identification phase were Costa Rica, Indonesia (2 sites), Russia, Belize, Bhutan, Colombia, Poland, Jamaica, Venezuela, Czech Republic, Ecuador, Uganda, Malaysia and The Netherlands. Criteria adopted for the identification of projects included additionality, cost-efficiency and social acceptability. Furthermore, projects had to fit into the regional planning. The identification phase showed that baselines were not always transparent and that in some cases there was lack of faith in project sustainability. If potential projects are assessed against FACE Foundation criteria, land tenure appears as a major factor. FACE only concludes contracts with landowners. In quite a large number of developing countries, land titles may not be in the hands of people using the land. The capacity of FACE to manage a portfolio of projects is also an important factor. It is believed that in order to assure a good performance, projects should be lean and not very large. For example, large-scale plantations are excluded for environmental and ecological reasons, but also for the sake of proper control given the eligibility criteria. The quality of sink enhancement depends on verifiability and transparency, so these are also factors. If compliance with these criteria is to be assured, there will be certain limits to project size. It is however difficult to quantify this accurately. The results of the identification phase were that the majority of the potential projects in the 14 countries failed before implementation. Therefore, project identification against Face Foundation criteria does have a significant effect on project volume. As an approximation, 9/14th or 64 % of the thoroughly identified projects did not reach the implementation phase. It is unclear whether a larger number of countries or potential projects would have led to a higher or lower score. The failure of a project in a specific country does indicate that non-compliance with the adopted criteria was observed on the project level, but this does not reflect in any way on the potential of the countries to host other CDM projects.

5.6 Programa FACE de Forestacíon project (PROFAFOR), Ecuador.

Organisations:	FACE Foundation and INEFAN
Start date project:	3 June 1993 (Letter of Intent: 1998)
Land area contribution by FACE:	5.000 hectare/year
Land area in period 1993-2000:	34.500 hectare
Reforested area per 31-12-99:	21.472 hectare

The project aims at afforestation of high-elevation Paramo grasslands in the Andes with exotic and indigenous trees. The project area is reforested in co-operation with the local agricultural community. Agricultural activities (mainly cattle breeding) are not very profitable in the project area. The FACE Foundation collaborates with the Ecuadorian Forestry Service (INEFAN) to afforest 75.000 hectare of grassland. Local community organisations (e.g. farmers and village committees) apply for approval of afforestation projects on their land. The Profafor (Programa FACE de Forestacíon) programme was established to assess these community applications and settle contracts. If approval was gained, financial contributions and planting materials were provided. Exotic pine and eucalypt species are mainly planted at this moment because there is yet little knowledge on the silvicultural aspects of afforestation with indigenous trees. A knowledge base for indigenous species is being developed and will be made available by the FACE ECOPAR project. New forests of indigenous trees will be planted in the future, based on the experience gained in the ECOPAR project. The exotic trees will be harvested after 20 years and the harvested areas will be replanted with native species. The forests are owned by both small and big landholders, who obtain revenues from labour, non-timber forest products and timber production. A thinning and cutting scheme will reduce the total capacity of these forest systems to sequester C. The resulting lower storage capacity is a trade-off between carbon sequestration potential and socio-economic benefits for local communities. Estimates of the Carbon sequestration in the Ecuador project are given in Table 23, whereas cost aspects are given in Table 24.

Table 23. Afforested area and predicted carbon sequestration rates in the Ecuadorian project

Ecuador (Profafor)	**Value**	**Unit**
Area 1993-1999	24,000	Ha
BP1	0.14	Mt C
BP1/ha	5.7	t C ha^{-1}
ASC	0.5	Mt C
ASC/ha	19	t C ha^{-1}

Table 24. Cost aspects of the Ecuadorian FACE project

Cost type	**US$**	**US$ ha^{-1}**
Operational costs	9,600,000	400
Transaction costs	2,400,000	100

The impact of adopting one or more criteria on the project costs, expressed in percentages of the total project costs, is given in Table 25. This clearly shows that the project framework forms a large of the operational costs, whereas compliance, verifiability and transparency are important factors determining the transaction costs.

Table 25. Contribution of criteria to total project costs for the FACE project in Ecuador

Cost type	Project framework	SFM	Environmental sustainability	Socio-economic Sustainability	Compliance	Verifiability	Additionality	Transparency	Total
Operational costs (%)	47	9	8	4	11	11	0	10	100
Transaction costs (%)	4	5	5	6	22	35	1	21	100
Total (%)	42	8	7	4	12	14	0	11	100

Given the millions of hectares of secondary Paramo in the Ecuadorian Andes that are potentially available for af-/reforestation projects, the analysis in this study focussed on how certain criteria would limit the volume of carbon offsets (and area). Estimates for these volume reductions are given in Table 26.

Table 26. Estimates for the volume/area reduction associated with the adoption of criteria in an Ecuadorian project

	Project framework	SFM	Environmental sustainability	Socio-economic sustainability	Compliance	Verifiability	Additionality	Transparency
Volume reduction %	50	50	50	70	50	20	0	20

There may be significant overlap among criteria. For example, the environmental sustainability criterion may have almost the same effect as the SFM criterion. Project framework, SFM, environmental sustainability and compliance will eliminate a significant part of the planting area. The 50% values in the table are not more than an indication of their effect. Socio-economic sustainability will be more important as a reduction factor, since this depends for a great part on the sales of forest products. In case the project becomes too large there will be excessive competition on the markets for these products. Verifiability, additionality and transparency are estimated to be of less importance.

5.7 Uganda, UWA-Face project titled Rehabilitation of Mt. Elgon and Kibale National Parks.

Organisations:	FACE Foundation and Uganda Wildlife Authority
Start date project:	Juli 1994 (Letter of Intent: 1996)
Land area contribution by FACE:	27.000 hectare
Land area in period 1994-2000:	8700 hectare
Reforested area per 31-12-99:	8608 hectare

The project aims at the re-establishment of rainforest in the national parks of Mount Elgon and Kibale, which are both under management of the national park authorities. Due to increased population pressure caused by the inflow of refugees in the area, the ecosystems of these parks have been damaged. The Uganda government has, in co-operation with the IUCN, set up a development programme for local communities in the parks to avoid over-exploitation of the remaining forest and to cover the basic needs of the people. The Uganda Wildlife Authority established the project organisation UWA-FACE to implement reforestation projects in the parks. The existing forest presently serves to protect local water resources and to produce non-timber forest products. Furthermore, it will be an important asset for future eco-tourism activities and C sequestration. There will be no cutting regime. The reforestation projects generate employment for more than 1000 people over two planting seasons. Nurseries have been built to produce 600.000 trees annually. The aim is a recovery of approximately 35,000 hectare of tropical forest, of which about 25.000 hectare will be in Mount Elgon National Park and 10.000 hectare in the

Kibale National Park. Estimates of the Carbon sequestration in the Uganda project are given in Table 27, whereas cost aspects are given in Table 28.

Table 27. Afforested area and predicted carbon sequestration rates in the Uganda project (UWA-FACE)

	Value	**Unit**
Area 1994-1999	8,600	Ha
BP1	0.2	Mt C
BP1 ha^{-1}	20	t C ha^{-1}
ASC	0.9	Mt C
ASC ha^{-1}	110	t C ha^{-1}

Table 28. Cost aspects of the Uganda FACE project

Cost type	**US$**	**US$ ha^{-1}**
Operational costs	6,450,000	750
Transaction costs	1,075,000	125

The impact of adopting one or more criteria on the costs of the project in Uganda, expressed in percentages of the total project costs, is given in Table 29. This again shows that the project framework forms a large of the operational costs, whereas compliance, verifiability and transparency are important factors determining the transaction costs.

Table 29. Contribution of criteria to total project costs for the FACE project in Uganda

Cost type	Project framework	SFM	Environmental sustainability	Socio-economic sustainability	Compliance	Verifiability	Additionality	Transparency	Total
Operational costs	58	9	4	7	7	8	0	7	100
Transaction costs	7	5	5	3	24	34	2	20	100
Total	49	8	4	6	10	12	0	9	100

The FACE Foundation considers reforestation projects at any significant scale in Uganda only feasible in co-operation with national park authorities (UWA). This is because of socio-economic factors such as the opportunity cost for land and the required security about land tenure. Furthermore, national parks can add functions such as watershed management and carbon sequestration to forest ecosystems without obstructing the livelihoods of large numbers of people. The volume/area reduction numbers in Table 30 therefore pertain to an analysis, which was limited to national parks in Uganda.

The reduction values attached to the various criteria are generally low. A large number of national parks in a portfolio of projects in Uganda would increase the strain on UWA, which may frustrate project framework, verifiability and transparency to some degree. It is also expected that local communities living just outside the parks will be limited in their use of forest resources during the rehabilitation stage of the forests, thus affecting the socio-economic sustainability.

Table 30. Estimates for the volume/area reduction associated with the adoption of criteria in the Uganda project

	Project framework	SFM	Environmental sustainability	Socio-economic sustainability	Compliance	Verifiability	Additionality	Transparency
Volume reduction %	30	0	0	30	0	20	0	20

5.8 Malaysia

5.8.1 Cost scenarios for carbon storage by preventing deforestation in Malaysia

5.8.1.1 Introduction

This section describes how the implementation of sink projects can be incorporated into the legal frameworks of a country. The case study is made for Malaysia where Carbon emissions by deforestation could be avoided through reforestation and conservation projects. It should be noted here that in countries where the deforestation rate is low or zero as a result of good forest management, the opportunity to gain income from carbon rights will also be limited to zero. Efforts to promote conservation and reforestation are effective means to counteract emissions from land use change and have the added advantage of contributing to the conservation of biodiversity. This case study could be made with the help of the Department of Forestry in Kuala Lumpur and their information is appreciated. However, all views expressed in this study are those of the Dutch working group only.

In this case study, we shall explore the possible costs and benefits through extra efforts (for additionality) to avoid deforestation in the Permanent Forest categories (scenario 1) and the impact of extra efforts to maintain carbon stocks in State Forests (scenario 2).

5.8.1.2 Forest categories in Malaysia

Land use issues are the responsibility of the State in Malaysia. A number of forest categories have been recognised. Some of these categories are not counted into the deforestation rate, such as state land forests, which are earmarked for (urban) development. In this case the term ‘forest loss’ is used, rather than deforestation. Permanent categories of natural forest, which are threatened by deforestation in Malaysia include:

- Permanent Forest Estate (PFE),
- Wild life reserves,

- Bird sanctuaries and
- National parks.

In the PFE, production forest areas have been identified for selective timber harvesting, whereas protection forests have been declared protected for environmental reasons.

In Malaysia, 4.81 million ha of agricultural plantations have been established over the years. The establishment of rubber plantations in particular is conceived to be a good alternative to timber harvested in natural forests (Thang, pers. comm.). These plantations form a forest category in itself, which will not be considered further here. Another forest category is that of Native Customary Right forest land where, among others, traditional agriculture (e.g. shifting cultivation) and agro-forestry activities are allowed. The deforestation activities permitted in this category are not legal in the permanent forest areas.

5.8.1.3 Forest areas in Malaysia

Estimates from 1998 indicate that the total forest area in Malaysia covers 19.0 Mha, or 58% of the total area. A forest area of 14.3 Mha has been assigned to the PFE category. A large part of this area (10.8 Mha) has been assigned Production Forest. The remaining 3.4 Mha has been assigned Protection Forest for water resources protection and soil conservation, whereas 90,400 ha is under protection as Virgin Jungle Reserves (JVG). These JVG areas represent different forest ecosystems in Malaysia and are used as in-situ arboreta. Another 2.12 Mha serve as wildlife reserves and bird sanctuaries. Finally, 0.5 Mha coincide with the PFE including an area of 0.3 Mha in Peninsular Malaysia and 0.1 Mha in Sabah (Thang, pers. comm.). Permanently managed natural forest therefore covers an area of 12,6 million ha.

To meet the purpose of this case study, the following assumption were made just to get an idea of the overall possibilities of CDM projects in Malaysia, without representing the actual facts. We assume that there is a deforestation rate in the permanent forest areas (10.3 Mha) of 1%, which is, for the ease of calculations, set at a loss of 100,000 ha of forest in terms of biomass.

For simulations with the scenarios listed above, we have assumed that the deforestation rate in Malaysia is 1% of the total forest area per year, and may be decreased by CDM activities to 0.5. It is a fact that these assumptions may not be beneficial for countries that have already achieved low deforestation rates through good forest management. For instance, the loss of forested areas in Peninsular Malaysia between 1993 and 1998 was 0.1 Mha (from 6.0 Mha to 5.9 Mha), which is equivalent to an annual loss of 15,000 ha, i.e. far less than 1% on an annual base. .

In the scenario for public land (scenario 2), we assume that 50% of the area will be set aside for PFE. There are indeed efforts to add State Forest land to the PFE. In

Peninsular Malaysia, the PFE covered 4.7 Mha in 1983 and 4.9 Mha in 1998, adding 0.2 Mha over the 15-year period.

5.8.1.4 Sustainable Forest Management third party certification

In July 2000, the National Forestry Council in Malaysia agreed with the 'Malaysian Criteria and Indicators (MC&I)' for sustainable forest management, responding to market conditions for certified timber in the export markets. In 2000, the PFE production forests are expected to be in the process of certification under the MC&I of the National Timber Certification Council Malaysia (NTCC Malaysia). These criteria and indicators cover both national and Forest Management Unit (FMU) levels. The third party auditing is ongoing for all permanent production forest in Peninsular Malaysia and is based on a) the minimum requirements set by the Dutch government as adopted by the Keurhout foundation and b) a sub-set of the requirements of the MC&I. This subset can be considered to comply with all crucial criteria and indicator requirements for sustainable forest management.

The third party certification will presumably be an extra stimulus to stop intrusion in the PFE and will help to conserve the forest resources for future generations. We expect that in the coming years the States of Sarawak and Sabah will follow the example set by Peninsular Malaysia. In this respect it may be important that the efforts in COP 6 in the Haque will appreciate the efforts of countries to achieve sustainable forest management. It should be avoided that good behaviour of governments with respect to forest conservation and battling deforestation is costly in terms of achieving carbon credits.

5.8.1.5 Costs of sustainable forest management certification

The present direct costs for certification audits and trekking of the timber to the consumer (chain of custody) are 2-3 USD per cubic meter of timber. Assuming a rotation period of 30 years, a net extraction of 60 m^3 ha^{-1} and a total production area of 14,3 Mha, the costs on a per hectare basis of production forest land are about 4-6 USD. This figure is expected to decrease in response to a higher degree of compliance with sustainable forest management criteria, and increased competitors in the certification business.

The indirect costs of complying with the standards of performance set for sustainable forest management are high. These costs include those for infrastructure improvement, project management and monitoring costs. We estimated the indirect costs in Peninsular Malaysia, with 2,83 Mha of production forest (Thang, pers. comm.), at 0.46 billion USD (New Straits Times, 1998; Thang, pers. Comm.) or about 300 USD per ha over a period of 30 years.

The direct economic returns from sustainably managed forests after regulation are not impressive. Preliminary calculations indicate that within a rotation period a return of 50 USD ha^{-1} yr^{-1} can be achieved, which is only one-tenth of the return gained from a well-managed oil palm plantation (Diemont, 2000a). However, when the public value of the natural forest is taken into consideration, the return may well be higher than gained from any agricultural use of the area (Diemont 2000a). The question is how to take these public values into account, i.e. who is willing to pay? In this respect, the income generated by extra efforts to conserve the carbon pool formed by natural forest is not only interesting from a cost perspective for Annex 1 countries, but also as a source of income for Annex 2 countries such as Malaysia.

5.8.1.6 Scenario`s

Two scenarios will be described below. The first deals with the Production Forest area in the PFE, whereas the second concerns Forest State land.

Scenario 1 'PFE'

As sustainable forest management certification does imply that high standards of performance must be achieved, there is no reason to assume that the additional cost for carbon credits are high. Sustainable forest management certification implies already that no excess logging is allowed, that the boundaries of forest areas remain fixed and that, in principle, carbon fixation can be estimated fairly easily.

Assuming that annually one percent of forest in the PFE (or 100,000 ha) will be saved, the income generated is equivalent to USD 20 per ha, assuming that 200 tonne C per ha is saved and that the price of the carbon will be 10 USD per ton C. Special attention should be given to peat forests in Malaysia. Because these peat lands store some 2,500 tonne C ha-1.

For protection forest and national parks, extra costs may have to be made to estimate the standing biomass and control the park boundaries. The costs of estimating standing biomass in protection forest are estimated 2.20 USD per ha using a 1% sampling intensity forest inventory. The costs of cutting and controlling the boundaries are 5,620 per km. No reliable estimates of these costs are yet available, but current estimates converge on a cost lower than 0,25 USD on a per hectare base (Thang, pers. Comm.).

It should also be noted that the carbon content of virgin forest in a forest ecosystem may be 40 percent higher when compared to regulated natural forest in the same system. This in spite of the fact that from a marketable timber perspective the regulated production forests may be much more productive in terms of annual increments as compared to the virgin forest. If future research confirms this assumption it may become more profitable in future to convert natural production forest to Protection forest.

At present, countries in SE Asia, such as Indonesia and Malaysia, are already securing future timber demands through the establishment of forest plantations, which are thought more cost effective (Worldbank study) than timber harvesting in natural forest.

Annual average costs for forest management in production forest, including administrative and development costs, are 9.9 USD ha^{-1} and are estimated at 0.6 USD ha^{-1} for protection forest. The costs in case of sustainable forest management are presumably 1.5–2 times higher than the costs quoted above.

Scenario 2 ' state forest'

The State forest area set aside for conversion and land development purposes covers about 5 Mha. Assuming that Malaysia is willing to make an extra effort to keep this carbon pool as it is for the next 25-30 years, Malaysia may not only contribute significantly to keep global development sustainable, but could also generate revenues. In this respect it is relevant that already 1 Mha of Forest State land is in the process of re-gazettement and will be added to the PFE in Peninsular Malaysia.

Assuming that 50% of the total area will not be converted, this would provide an additional emission savings of 100 ton C ha-1, which generates revenue of 1000 USD, assuming a discount rate of 5%. In the case of peat forest, the savings could be at least a factor 5 to 10 higher. Over a period of 25 years a loss of peat after development of to 4 to 8 cm yr-1 could occur, which is equivalent to 500 tot 1000 tonnes C loss over the period.

5.8.1.7 Conclusions

An extra effort to conserve part of the Forest State land could mean a significant contribution to conserving the global carbon pool and therefore generate important revenues to the forest owner. For peat forests the revenues from carbon sequestration may be higher then those from conversion to oil palm plantation forest. All conclusions are very sensitive for the revenues to be expected from the CERs.

In Malaysia, a land use planning system exists, which could prevent leakage, and when sustainable forest management certification is in place leakage can be controlled.

It should further be noted that:
1. Through sustainable forest management and certification of sustainable forest management for all production forest it is to be expected that in this forest category little deforestation will occur because certificates will be withdrawn.
2. There is a risk that where sustainable forest management is realised, the effort will not be judged as an extra effort. This would imply that good behaviour comes with a cost.

3. Recognising the extra effort where Forest State land is re-gazetted for inclusion in the PFE could substantially reinforce sound management planning and combat deforestation. Initiatives in progress in Malaysia should be accounted for.
4. A lifetime analysis of harvested timber should also be included to estimate the contributions made of production forest to sequester carbon. The same should be done to compare the use of wood products and the use of fossil energy for alternatives for wood products.
5. There is a need for a market analysis with respect to carbon rights as to get a reasonable price for 'producers' which operate in an imperfect market.

The extra costs of conserving carbon in PFE, which is already sustainably managed, will be negligible, but the costs to achieve sustainable forest management are high as compared of the income generated. With respect to timber no 'green' premium can be expected (de Boer, 1998) and the income from carbon is only 20 USD ha^{-1}. For peat forests the annual income from carbon are about 100 USD ha^{-1} in the PFE. There is a need to estimate the total value of the forest as to see whether investments in sustainable forest management are also economically sustainable. If so, it is possible that non-Annex 1 countries will link the issue of economically sustainable forestry to the costs to achieve sustainable forest management.

6 Carbon sequestration and costs.

The CDMFSM model (Version 2.01; Waterloo et al., 2001), developed by Alterra in the context of this study, was used to estimate the area available to projects, total carbon sequestration potentials and costs for a number of developing countries. The model can be obtained from Alterra or from the lead author. The calculation procedures have been described in Chapter **Error! Reference source not found.** and are also available in the form of a manual. Based on the information gained from existing carbon sequestration projects, as presented in the previous chapters, simulations were made for af-/reforestation activities and for a number of forest conservation scenarios. In this chapter, comparisons will be made between af-/reforestation and forest conservation carbon sequestration potentials and their costs. The impact of criteria on these issues will also be illustrated. The most realistic estimates are, in our view, derived when all criteria are adopted. It is our opinion that adherence to the criteria may also reduce the risks of project failure to a large extent.

6.1 Af-/reforestation

Duing COP6-is in Bonn, July 2001, the partoes agreed upon including af-/reforestation activities in CDM. The area of plantations in developing countries more than doubled from 40 Mha in 1980 to about 81 Mha in 1995 (FAO, 1997). Regional FAO estimates of the area presently under forest and non-forest plantation in developing countries, and annual establishment rates for plantations for wood supply are given in Table 31. This shows that almost 75% of the plantations are in the Asia – Pacific region, with China (21 Mha) and India (20 Mha) having major shares in the total. Because protection forests are not taken into account, the actual totals may be slightly higher than those given in Table 31. At the same time, however, over a 100 Mha of natural forest was lost through deforestation.

Table 31. Estimates for 1995 of the area under forest and non-forest plantations in Africa, Asia/Oceania and Latin America and the annual establishment rate of plantation forests for wood supply (FAO, 1999). Annual C sequestrations have been calculated from the regional establishment rates with the procedures detailed earlier in this report

Region	Estimated net forest area[1] (*1000 ha)	Annual establishment rate[1] (*1000 ha)	Potential sequestration[1,3] (Mt C yr^{-1})	Estimated net non-forest area[2] (*1000 ha)
Africa	5,861	288	32	772
Asia & Oceania	40,471	2,330	258	1,912
Latin America	8,898	401	61	23,851
Total	55,230	3,019	351	26,535

[1] Plantations for wood supply only, not for other purposes (e.g. protection plantations)
[2] Non-forest plantations include rubber, coconut and oil palm plantations
[3] For first commitment period, using annual establishment rates as potential area for reforestation

The total area under plantations in the countries selected for this study amounts to 116 Mha. The current regional planting rates vary widely, ranging from 0.01 Mha in Oceania to 3.4 Mha in Asia, with the largest planting occurring in India (1.5 Mha) and China (1.1 Mha). The combined annual planting rate for all selected countries is 4.1 Mha (worldwide=4.5 Mha yr^{-1}; FAO, 2000). This planting rate can be considered a baseline level against which it is possible to assess additionality. The present study estimates that the area potentially available for afforestation is 3-4% of the agricultural area (Nilsson and Schopfhauser, 1995). For the selected 70 countries the potential area would then amount to 86 Mha when criteria are not taken into account and is reduced to 7 Mha when all criteria are adopted.

For brevity, only the regional estimates will be presented in this chapter. Values for the individual countries for two simulations are presented in Table 49 (without criteria) and Table 50 (with criteria) in Annex F. Taking the current rate of planting into account and assuming a 25% increase of the current planting rate due to CDM, the potential area for 'additional' af-/reforestation is 24 Mha over a 100-year period or 10 Mha for the first 12 years (i.e. with banking, Table 32). This results in a potential sink of 95 Mt C in the first commitment period with banking from 2002 onwards, or 61 Mt C without banking. This sink, however, may still have to be corrected for project failures, reducing it to 45 Mt C (Table 33) and 29 Mt C for the first commitment period, respectively.

Table 32. Regional summary of af-/reforestation simulations for three budget periods (banking from 2002 onwards) without adoption of criteria. Certification precision level set at 20% (affecting costs only), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	Af-/reforestation area	Sequestration 2008-2012	Costs 2008-2012	Sequestration 2000-2050	Costs 2000-2050	Sequestration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	267	3	11	34	132	100	390
Africa	368	4	10	74	203	214	581
Asia	8080	64	174	541	1456	1065	2901
Oceania	19	0	0	1	2	2	6
South America	1466	25	137	365	2032	924	5247
Total	**10201**	**95**	**332**	**1014**	**3825**	**2305**	**9124**

Table 33. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) without adoption of criteria (except for additionality), but taking 'project success rates' into account. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	Af-/reforestation area	Sequestration 2008-2012	Costs 2008-2012	Sequestration 2000-2050	Costs 2000-2050	Sequestration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mton C)*	*(x 10^6 \$)*	*(Mton C)*	*(x 10^6 \$)*
C.America/Caribbean	100	1	11	15	152	42	419
Africa	70	1	10	14	204	42	609
Asia	4437	32	183	328	1702	664	3636
Oceania	6	0	1	0	2	1	7
South America	679	12	139	170	2190	449	5867
Total	**5291**	**45**	**343**	**527**	**4250**	**1198**	**10539**

When all criteria are adopted (Table 34, Table 35), the potential planting area drops to 1.7 Mha for the first commitment period (including banking, Table 34) and 2.1 Mha for the 100-year period. The potential sink associated with this option is 24 Mt C in the first commitment period with banking from 2002 onwards, or 14 Mt C without banking (Table 35). It is clear that the largest potentials exist in Asia and South America (see also Figure 11, Figure 12 on pages 135 and 136).

Table 34. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	1	20	5	83	16	257
Africa	306	3	24	27	237	65	517
Asia	743	9	68	28	224	79	619
Oceania	1	0	0	0	0	0	1
South America	497	11	290	44	1093	125	3233
Total	**1680**	**24**	**402**	**105**	**1637**	**286**	**4628**

Table 35. Summary of results for af-/reforestation simulations for the three budget periods (no banking) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 35-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	1	13	5	83	16	257
Africa	306	2	15	27	237	65	517
Asia	743	5	42	28	224	79	619
Oceania	1	0	0	0	0	0	1
South America	497	6	167	44	1093	125	3233
Total	**1680**	**14**	**237**	**105**	**1637**	**286**	**4628**

If we assume a lower increase in planting rates (e.g. 10% instead of 25%) due to CDM, the potential area and sink become reduced to 0.9 Mha and 12 Mt C (Table 36), respectively. Changing the rotation length to 10 years instead of 35 years increases the sink slightly to 27 Mt C (Table 37) instead of 24 Mt C for the 35-year rotation (with banking), but such a short rotation period is much less likely to be sustainable in the long run. Increasing the rotation length to 60 years has the opposite effect and creates a sink of only 16 Mt C for the first budget period (with banking).

The potential long-term sequestration of C ranges from 153 Mt C (100 years, all criteria adopted) for a 10% increase in planting as a result of CDM (Table 36) to 286 Mt C for a 25% increase (Table 34). The maximum potential (no criteria) is 2.3 Gt over 100 years (Table 32), which is reduced to 1.2 Gt when project failure rates are taken into account (Table 33).

Figure 9 and Figure 10 show the impact of criteria and the rotation period length on the annual sequestartion total for the five regions. The annual variations shown in these graphs are the result of harvesting at the end of a rotation and subsequent release of the carbon stored during the rotation (due to biomass decay, burning, increased soil respiration, etc.). The actual amount stored at the end of a budget period therefore depends on what phase of the rotation the forest is in, resulting in low values at the initial stage to high values at the final stage of the rotation.

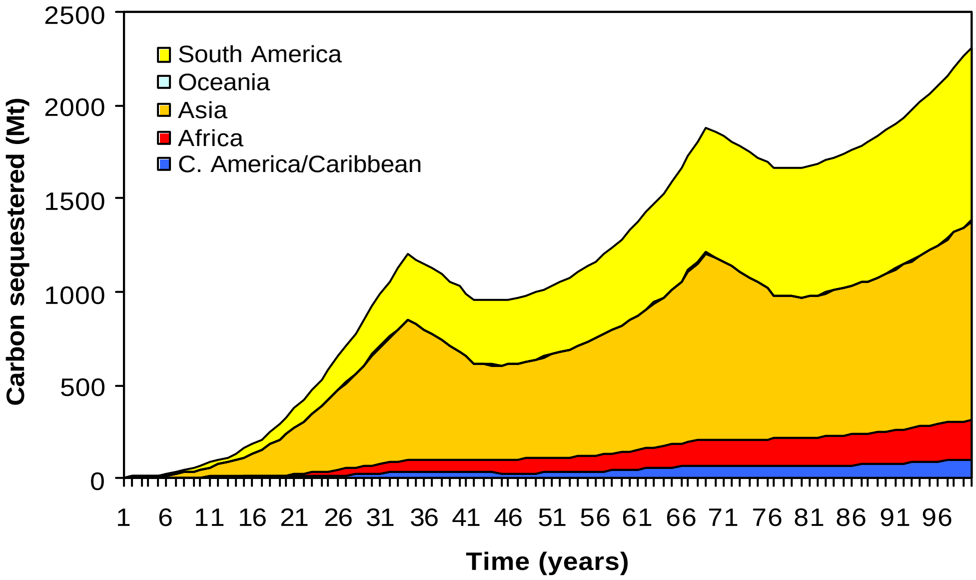

Figure 9. Carbon sequestration of af-/reforestation projects for different regions. Assuming a 25% increase in planting rates, a 35-year rotation period and no criteria adopted

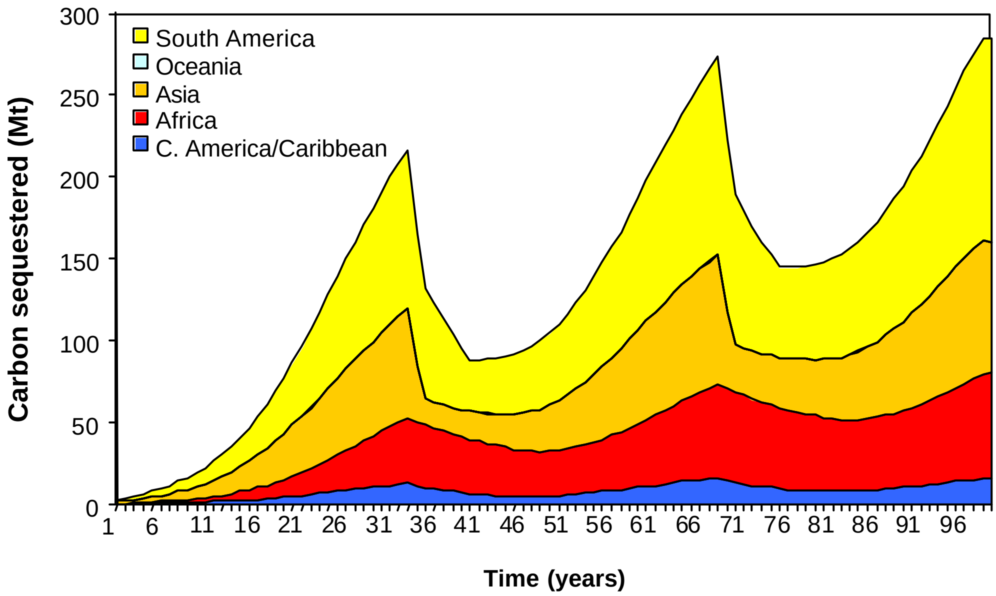

Figure 10. Carbon sequestration of af-/reforestation projects for different regions. Assuming a 25% increase in planting rates, a 35-year rotation period and all criteria adopted

Table 36. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 10% increase in current planting rate due to CDM instead of 25% and a 35-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	55	1	9	3	42	8	124
Africa	128	1	10	15	118	31	254
Asia	464	5	39	17	129	49	365
Oceania	1	0	0	0	0	0	0
South America	264	5	143	23	565	65	1697
Total	**912**	**12**	**200**	**57**	**854**	**153**	**2439**

Table 37. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in currrent planting rate due to CDM and a 10-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	2	29	6	92	12	187
Africa	306	5	36	23	185	48	382
Asia	743	5	41	27	207	69	550
Oceania	1	0	0	0	0	0	1
South America	497	15	402	44	1145	92	2339
Total	**1680**	**27**	**508**	**100**	**1630**	**221**	**3458**

Table 38. Summary of results for af-/reforestation simulations for the three budget periods (banking from 2002 onwards) with adoption of all criteria. Certification precision level set at 20% (affecting costs), 25% increase in current planting rate due to CDM and a 60-year rotation period

Region	Af-/refores-tation area	Seques-tration 2008-2012	Costs 2008-2012	Seques-tration 2000-2050	Costs 2000-2050	Seques-tration 2000-2100	Costs 2000-2100
	(x 1000 ha y^{-1})	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*	*(Mt C)*	*(x 10^6 \$)*
C.America/Caribbean	133	1	14	15	242	15	240
Africa	306	2	17	55	423	59	441
Asia	743	5	42	71	559	76	594
Oceania	1	0	0	0	1	0	1
South America	497	7	197	112	2909	116	2978
Total	**1680**	**16**	**270**	**253**	**4134**	**265**	**4254**

From the results presented above, it becomes clear that the potential sink for af-/reforestation (Table 33) is reduced to a large part when project success rates (Table 34) or CDM criteria (Table 35) are taken into account (from a potential 95 Mt C to 24 Mt C for the first budget period, including banking). Taking a 10% increase in planting rates instead of 25% results in a further reduction to 8 Mt C (Table 36), whereas changing rotation lengths results in estimates between 27 Mt C (10-year rotation) to 16 Mt C (60 year rotation) for the first commitment period (Table 37, Table 38). However, the longer rotation period does lead to higher sequestration in the long-term (100 Mt C vs. 253 Mt C in 2050) and sustainable forestry will also be easier to demonstrate than for a short-rotation forest. The relatively low sequestration rates for the first commitment period reflect the slow growth of plantations during the first years after planting.

Due to the large size of their agricultural areas and their relatively high planting rates, India, Brazil, Argentina and China have the largest potentials for carbon sequestration through af-/reforestation activities (Table 49, Table 50, see also Figure 11 and Figure 12 on pages 135 – 136). China also has a positive net annual change in forest (no net deforestation within the country) and may therefore encounter less problems with accounting for leakage. As a region, Asia seems to offer the largest potential for af-/reforestation, followed by South America.

The costs of carbon sequestration through af-/reforestation range from 2.2 (Democratic Republic of Congo) – 8.8 US$ per tonne C (Argentina) (no criteria adopted, 20% buffer) to 4.3 - 46.7 US$ per t C (all criteria adopted). The regional costs in the latter case range from 7.31 US$ per t C for Africa to 28.25 US$ per t C in South America, respectively, using a 20% buffer. The costs for the budget period are in the range of 200 - 508 million US$.

6.2 Forest conservation.

At the time of this study, forest conservation was still an option for carbon sequestration under the CDM in the first commitment period. However, during COP6-bis in July 2001, the parties decided that forest conservation projects would not be eligible under CDM for the first commitment period. This has rendered the following section somewhat less relevant as most attention will now be focused on af-/reforestation projects.

For the 70 developing countries selected for this study the annual deforestation rate totals 9.5 Mha yr^{-1}. Regional deforestation rates range between 0.1 Mha yr^{-1} for Oceania to 4.7 Mha yr^{-1} for Africa. Deforestation in the South American region amounts to 3.7 Mha yr^{-1}, of which 2.3 Mha yr^{-1} occurs in Brazil alone. The main problem with defining a sink potential for forest conservation projects is in estimating how much these deforestation rates could be reduced through conservation projects. Additionality (as expressed on a country level) would imply that all CDM forest conservation projects combined would result in reduced deforestation rates for a region/country as compared to a certain baseline level (*e.g.* current deforestation rates). For projects in countries with increasing deforestation rates (*e.g.* Brazil), this will be very hard to demonstrate. This is one of the reasons that forest conservation will not be eligible for CDM in the first commitment period.

Country specific estimations of the sink and costs are presented for the five different forest conservation scenarios in Table 51 – Table 60 and graphically for the first budget period in Figure 11 and Figure 12 on pages 135 and 136. For brevity, only regional values of the C sequestration totals and cost estimates will be given in this chapter for different reductions in deforestation rates (1%, 5% and an assumed, country specific reduction rate).

For the calculations in Forest Conservation Scenario 1, deemed the most realistic of the five, we assumed a fixed percentage of the initial deforestation rate, and therefore a fixed forest area, to be saved annually. Relative to the Business As Usual (BAU_0) scenario, *i.e.* the initial deforestation rate, the total forest area saved is linearly growing each year. This means that the area saved each year is the sum of that saved in the previous year and the fixed percentage of last year's deforestation rate. The regional country specific deforestation reduction rate values used in the calculations range from 0.56% for Asia to 4.72% for Oceania. The values used for Brazil and Indonesia, which have the highest deforestation rates, are 0.39% and 0.03%, respectively. The results of different options are given in Table 39 – Table 44.

Table 39. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. No criteria were adopted and the sink values may therefore be considered the maximum possible for the different regions. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	149	23	97	566	90	382	678	105	448
Africa	531	30	112	2373	133	499	4583	257	974
Asia	165	10	40	748	48	181	1408	86	316
Oceania	53	2	6	239	9	27	478	18	54
South America	770	76	397	3498	347	1802	6966	691	3595
Total	**1667**	**142**	**651**	**7423**	**627**	**2892**	**14113**	**1158**	**5388**

Table 40. Area, sink and cost estimates for forest conservation scenario 1 using a 1% deforestation reduction. No criteria were adopted and the sink values may therefore be considered the maximum possible for the different regions. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	38	5	18	138	20	73	174	24	86
Africa	522	36	88	2083	137	337	3018	209	516
Asia	277	21	72	1257	94	326	1961	147	514
Oceania	13	0	1	60	2	7	119	4	13
South America	414	52	280	1881	238	1275	3729	472	2539
Total	**1263**	**114**	**460**	**5418**	**491**	**2018**	**9001**	**857**	**3669**

Table 41. Area, sink and cost estimates for forest conservation scenario 1 using a 5% deforestation reduction. No criteria were adopted and the sink values may therefore be considered the maximum possible for the different regions. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	188	26	91	689	102	366	868	120	430
Africa	2609	179	440	10416	684	1685	15090	1046	2581
Asia	1383	103	359	6285	469	1632	9803	734	2572
Oceania	65	2	7	298	11	33	595	22	66
South America	2069	261	1402	9402	1188	6374	18647	2360	12697
Total	**6313**	**572**	**2300**	**27090**	**2455**	**10090**	**45004**	**4283**	**18346**

Table 42. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. Project failure rates are used. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	52	8	35	202	33	144	247	40	172
Africa	181	9	38	815	39	169	1603	76	335
Asia	97	6	24	442	29	108	845	53	191
Oceania	13	1	2	61	2	7	122	5	14
South America	290	29	161	1319	131	730	2632	262	1458
Total	**633**	**53**	**259**	**2838**	**234**	**1158**	**5449**	**435**	**2169**

Table 43. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. All criteria adopted. The certification precision level was set at 20% (affecting costs) and banking from 2002

Regions	Area 2008-2012	Sink 2008-2012	Costs 2008-2012	Area 2000-2050	Sink 2000-2050	Costs 2000-2050	Area 2000-2100	Sink 2000-2100	Costs 2000-2100
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	32	5	74	122	19	293	146	23	343
Africa	115	7	79	512	29	353	990	56	696
Asia	36	2	29	162	10	130	304	19	221
Oceania	11	0	3	52	2	16	103	4	32
South America	166	16	333	756	75	1515	1505	149	3023
Total	**360**	**31**	**518**	**1603**	**135**	**2307**	**3048**	**250**	**4315**

Table 44. Area, sink and cost estimates for forest conservation scenario 1 using a country specific deforestation reduction. All criteria adopted. The certification precision level was set at 20% (affecting costs) and no banking

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10^6 \$)*	*(x1000 ha)*	*(Mt C)*	*(x10^6 \$)*	*(x1000 ha)*	*(Mt C)*	*(x 10^6 \$)*
C.America / Caribbean	15	2	34	122	19	293	146	23	343
Africa	52	3	36	512	29	353	990	56	696
Asia	16	1	13	162	10	130	304	19	221
Oceania	5	0	2	52	2	16	103	4	32
South America	76	7	151	756	75	1515	1505	149	3023
Total	**164**	**14**	**236**	**1603**	**135**	**2307**	**3048**	**250**	**4315**

The sink gained for the different forest conservation scenarios using country specific deforestation reductions without adoption of criteria, but with banking, ranges from 13 Mt C (Scenario 2,Table 53) to 655 Mt C (scenario 3, Table 55). The sink gained for Forest Conservation scenario 1 is 142 Mt C. Adoption of all criteria reduces this to 31 Mt C when banking is allowed in the first commitment period and 14 Mt C when no banking occurs. The largest sinks occur in Brazil, Argentina and Guyana (3 Mt C each). The costs range from 4.01 US\$ per tonne C in the Democratic Republic of Congo to 43.11 US\$ per tonne C in Argentina. Regional costs range from 2.74 US\$ t^{-1} C (Africa) to 6.27 US\$ t^{1} C (South America) without adoption of criteria to 6.80 US\$ t^{1} C to 26.10 US\$ t^{1} C when all criteria are adopted. For a graphical overview of sink potentials in the first budget period see also Figure 11 and Figure 12 on pages 135 -136).

Over a 100-year period a sink of 250 Gt C can be realised (all criteria adopted) by protecting 3.0 Mha of forest (Table 44). In view of increasing deforestation rates, forest conservation projects may have problems to comply with the leakage criterion, especially in Brazil and Indonesia. Changes in deforestation rates would place heavy demands on changing the political and socio-economic fabric of the societies involved, which may be difficult and costly. As the present criteria – cost relation reflect that experienced at project level only, achieving such a change may be much more costly than our simulations indicate.

The total sink estimates for 1% and 5% deforestation reductions are 0.1 Gt C and 0.6 Gt C for the first commitment period and 0.9 Gt C and 4.2 Gt C for a 100-year period, respectively.

Forest conservation scenario 2 is basically the same as Forest conservation 1, but with a single forest conservation activity in the first year and no additional conservation activities in later years. This scenario therefore simulates a 'single project' of which the gains are constant (13 Mt C without and 3 Mt C with criteria adopted, see Table 53 and Table 54) and can be used in the first commitment period, or distributed evenly over the 50- or 100-years periods. For the latter periods, CERs at values of only 3.1-0.7 Mt C or 1.6-0.4 Mt C, respectively, can be obtained during the first commitment period (with banking). Consequently, the gains are much less than for a continuous implementation of new projects over time. Using project succes rate factors, a sink of 5 Mt C is obtained (Table 45). The gains are highest in

Brazil (1.2 Mt C at a cost of $7*10^6$ US$) and Argentina (1.2 Mt C at a cost of $11*10^6$ US$, no criteria applied). Regional values range between 0.2 Mt C for Oceania and 7 Mt for South America (without criteria) at a cost of 1 and 36 million US$, respectively. When criteria are adopted these respective values become 0.0 and 1.5 Mt C at a cost of 36 Million US$ for the latter.

Table 45. Area, sink and cost estimates for forest conservation scenario 2 using country specific deforestation reductions and project failure rates. The certification precision level was set at 25% (affecting costs) and banking from 2002

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	5	0.7	3	5	0.7	3	5	0.7	3
Africa	16	0.8	3	16	0.8	3	16	0.8	3
Asia	9	0.6	2	9	0.6	2	9	0.6	2
Oceania	1	0.0	0	1	0.0	0	1	0.0	0
South America	26	2.6	15	26	2.6	15	26	2.6	15
Total	**58**	**4.8**	**23**	**58**	**4.8**	**23**	**58**	**4.8**	**23**

Forest conservation scenario 3 (see Table 55 and Table 56) is the most ambitious scenario as it aims for a maximum reduction in deforestation rates in time. In this scenario the actual deforestation rate decreases by a fixed percentage each year relative to the BAU_0 baseline scenario. To achieve this, increasingly larger areas have to be conserved annually. The potential sink capacity for this scenario ranges from 0.9 Gt C for the first commitment period to 21 Gt C over a the 100-year period. If we adopt all criteria, the potential drops to 0.2 and 8 Gt for the respective periods. To get this sink without the adoption of any criteria, a natural forest area of 217 Mha has to be conserved over a 100-year period at a cost of $97*10^9$ US$ at a 20% precision level, or $146*10^9$ US$ at a 5% precision level. The BAU_0 baseline deforestation over that period totals 911 Mha, with associated Carbon loss of 86 Gt C. This implies that this ambitious scenario would reduce the deforestation and associated loss of carbon by 24% as compared to the BAU_0 scenario over 100 years. Adoption of criteria leads to a lower conservation area (91 Mha) and sink capacity (8 Gt) at a higher cost of $136*10^9$ US$ (20% precision level). The results for a simulation where project failure rates are used, rather than criteria, are shown in Table 46.

Table 46. Area, sink and cost estimates for forest conservation scenario 3 using country specific deforestation reductions and project failure rates. The certification precision level was set at 25% (affecting costs) and banking from 2002

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America / Caribbean	217	36	152	1827	320	1352	2572	416	1735
Africa	659	32	133	5113	250	963	11341	557	2099
Asia	422	29	118	4542	359	1668	10828	829	3902
Oceania	68	3	8	859	32	94	2341	88	257
South America	1411	142	774	17337	1887	9941	50600	5822	30457
Total	**2777**	**241**	**1184**	**29679**	**2849**	**14018**	**77682**	**7712**	**38450**

Forest conservation scenarios 1-3 used the BAU_0 baseline to calculate the gains in carbon. In scenarios 4 and 5, the baseline is adapted to reflect changes in the deforestation rate as a result of the CDM sink activities. In Forest conservation scenario 4, the baseline is changed annually on the basis of the area conserved in the previous year, whereas this is done every five years (reflecting commitment period lengths) in Forest conservation scenario 5.

The maximum area conserved (no criteria) is 1.1 Mha with the annual adaptation of the baseline (scenario 4, Table 57) and 3.4 Mha with the 5-year baseline adaptation (scenario 5, Table 59). The differences in area between these scenarios are the result of the need to decrease deforestation annually by a fixed percentage. This means that in scenario 5, the area to be protected has to increase every year, until the baseline is changed. The sequestration potentials of these scenarios for the first commitment period indicate an increase from 98 Mt to 294 Mt C as a result of changes in the baseline adaptation (no criteria used). If criteria are adopted, the sink capacity reduces to 28-80 Mt C (Table 58, Table 60). Over a period of 100 years, these scenarios would sequester 341-1046 Mt (no criteria) or 141-425 Mt C (with criteria), respectively. The costs would amount to $2.4\text{-}7.4*10^9$ US$ at a precision level of 25% and all criteria adopted. Both scenarios assume that the reduction in the deforestation rates by conservation measures is real and permanent. Such changes in deforestation rates would place heavy demands on changing the political and socio-economic fabric of the societies involved, which may be difficult and costly. As the present criteria – cost relation reflect that experienced at project level, achieving such a change may be much more costly than our simulations indicate. Overviews of the results for these scenarios using project failure rates rather than criteria are given in Table 47 and Table 48.

Table 47. Area, sink and cost estimates for forest conservation scenario 4 using country specific deforestation reductions and project failure rates. The certification precision level was set at 25% (affecting costs) and banking from 2002 onwards

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	31	5	22	55	9	39	58	10	40
Africa	87	4	17	140	7	25	160	8	28
Asia	61	4	18	140	12	57	184	16	78
Oceania	10	0	1	26	1	3	31	1	3
South America	214	22	117	547	62	325	773	93	486
Total	**403**	**36**	**176**	**907**	**92**	**449**	**1207**	**128**	**635**

Table 48. Area, sink and cost estimates for forest conservation scenario 5 using country specific deforestation reductions and project failure rates. The certification precision level was set at 25% (affecting costs) and banking from 2002 onwards

Regions	**Area 2008-2012**	**Sink 2008-2012**	**Costs 2008-2012**	**Area 2000-2050**	**Sink 2000-2050**	**Costs 2000-2050**	**Area 2000-2100**	**Sink 2000-2100**	**Costs 2000-2100**
	(x1000 ha)	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x10⁶ $)*	*(x1000 ha)*	*(Mt C)*	*(x 10⁶ $)*
C.America/Caribbean	96	16	67	174	30	123	183	30	126
Africa	283	14	57	451	23	82	513	26	91
Asia	187	13	54	434	36	174	566	47	235
Oceania	31	1	3	81	3	9	97	4	11
South America	637	64	350	1683	191	996	2367	284	1482
Total	**1234**	**108**	**531**	**2823**	**283**	**1384**	**3725**	**392**	**1945**

7 Conclusions

There were a number of issues that needed to be resolved before sink projects could be included in the CDM. These issues were related to the reversibility of terrestrial sinks (permanence), the scale of the potential carbon sequestration in sink projects and uncertainties in baselines, verification methods and sovereignty issues. This study was initiated to address some of the concerns surrounding the use of sinks in the CDM and to provide better estimates of the potential sink capacity and costs of sink activities in developing countries. Draft versions of this report were available to the Dutch Government during the negotiations at COP6 and COP6-bis in The Hague and Bonn, respectively. The final version of this report has only become available after COP6-bis, where the decision was made not to include forest conservation projects in the CDM, but to allow af-/reforestation activities.

Three main topics have been addressed in the study, being:

1) Definition of criteria for CDM projects, with the emphasis on sink projects in the forestry sector
2) In-depth studies to see how criteria may affect carbon sequestration potentials and costs, based on a study of several existing sink projects
3) Extrapolation of the results to 70 developing countries to obtain country specific and regional estimates of sink potentials and cost

A detailed study of the criteria and guidelines used by the UNFCCC Climate Convention and Kyoto Protocol and several forestry and other (non-forestry) institutes resulted in a set of eight generic criteria. These criteria are formulated such as to provide specific guidelines for CDM projects and include project framework, additionality, verifiability, compliance, environmental and socio-economic sustainability, transparency and sustainable forest management requirements. With the exception of the sustainable forest management criterion, which is relevant to sink projects in the forestry sector only, these criteria may be applied to any CDM project. The criteria deal with key project elements such as project formulation, risk reduction, knowledge transfer and capacity building, competence, infrastructure, socio-economic, political and environmental factors, accounting and verification methods, leakage, permanence and credit sharing. Strict adherence to these criteria by projects would:

- minimise the risk of project failure
- provide guarantees relating to the permanence of the sink (e.g. through socio-economic and environmental sustainability)
- affect the scale of the sink capacity
- ensure additionality and eligibility eligible for receiving CERs
- ensure proper project management
- provide technology transfer, training and capacity building
- minimise leakage at the project level, and to a lesser extend at the regional level

The adoption of criteria has a large impact on both the sink capacity (through the land available for sink activities) and on costs. The criteria reduce the scale of potential forestry sector CDM projects by a factor 3 or more. This is mainly through the need for a project framework, socio-economic sustainability, etc.

Additionality and permanence play important roles in CDM forestry projects. At project level, additionality is defined as whether the project would have been implemented without the CDM or not. This is difficult to assess on a country scale. This study therefore uses current planting rates as baseline to define if af-/reforestation projects are additional, *i.e.* all individual projects together should result in an increase in planting rates. For forest conservation on a country level, we assume that the additionality criterion is satisfied when the deforestation trend is reversed. Additionality considerations therefore determine how much the planting rate is increased (AR) or how much the deforestation rate is reduced (forest conservation) and thereby affect the areas and sink potentials to a large extent. Permanence of forest carbon stores cannot be guaranteed as the forest may be affected by fires, diseases, or changing priorities of local landowners. However, using a buffer based on such risks may ensure some degree of permanence.

In view of the high failure rates of World Bank projects in developing countries (20-90%; Niles, 2000), adoption of the presently defined set of criteria for CDM projects may guarantee carbon neutrality to a large extent, and also goes a long way to solve permanence and sovereignty issues. Furthermore, adherence to the criteria may reduce the risk of project failure, increase the chances of projects being eligible for receiving CERs and may go a long way into providing some guarantees for the permanence of the sinks. The consequence of adopting these criteria is that projects will become more expensive and that there will be less area available for the execution of such projects (sustainability issue). The risk of failure can be minimised even more by only allowing projects that are requested and initiated by local communities.

The estimate for the potential area for af-/reforestation (86 Mha) is much larger than the present annual rate of af-/reforestation in all tropical countries (4.5 Mha). However, the additionality criterion requires an extra effort to what is planted now, so that the total area than can be planted by CDM projects is about 12 Mha, assuming that a 25% increase in the present planting rates can be realised through CDM.

Reducing deforestation rates is a difficult process because of the political and socio-economic drivers acting in favour of development through deforestation. It is therefore very uncertain if the reduction factors (about 1.6%, weighted average) used in this study can be reached. The forest conservation sink capacity could therefore, in practice, be somewhat lower than the values presented here.

Estimated sink potentials range from 95 Mt C in the first commitment period for af-/reforestation projects to 13 – 655 Mt C for forest conservation projects. Application of the criteria reduces these potentials to 24 Mt C for af-/reforestation projects to 3 – 172 Mt C for forest conservation projects. Due to its large forest and agricultural land area, Brazil has the highest potential for both af-/reforestation projects (6 Mt with criteria) and forest conservation projects (0 - 18 Mt C) for the first budget period. However, in view of the fact that the deforestation rate in Brazil went up by 15% this year it will be very difficult for projects to demonstrate compliance with the additionality criterion and to avoid leakage. Long-term potentials (100-year period) range from 0.3 Gt C (with criteria) to 2.3 Gt C (no criteria) for af-/reforestation sink activities. Corresponding values for forest conservation activities range from 0 – 7.8 Gt (with criteria) to 0.01 – 21Gt C (no criteria).

Cost calculations indicate that the costs of C sequestration with forest conservation projects in the different regions range from 8.2 US$ tonne^{-1} C in Africa to 29.2 US$ t^{-1} C in South America when all criteria are adopted (5% precision level). Lower costs (4.2 – 9.1 US$ t^{-1} C) are obtained without criteria. Af-/reforestation activities are more expensive as the criteria of sustainable forest management and environmental sustainability, which are not applied to forest conservation projects, are costly. The cost ranges for af-/reforestation projects range between 24.8 US$ tonne^{-1} C in Asia and 75 US$ tonne^{-1} C in South America (5% precison level) with all criteria adopted. In case no criteria are posed, these values become 4.1 and 9.0 US$ tonne^{-1} C, respectively. If project failure rates are used, African projects become the most expensive with a regional value of 26.5 US$ t^{-1} C, whereas Asian projects are least expensive at 10.8 US$ t^{-1} C.

The estimates given for the different activities with criteria adopted are in our view closer to reality than those without criteria. The sink potentials are therefore much lower than previously thought in view of the constraints that should be posed to sink projects within the CDM. The fact that the deforestation rate in the tropics is still increasing (15.2 Mha, FAO, 2000) suggests that the implementation of forest conservation projects within the CDM will be difficult in view of the uncertainties concerning leakage and additionality. This supports the decision taken at COP6-bis to exclude forest conservation projects from participating in the CDM in the first commitment period.

Cost calculations in the present study have not been corrected for inflation, etc. using discount rates for future financial projections. However, this may be balanced by the fact that any future returns on the investment have also not been taken into account due to lack of data as the projects investigated in detail have not reached that stage yet. The CDMFSM model, on which the calculations in this report are based, can easily be extended to include these factors once the data becomes available.

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Annex A Principles and criteria of the Climate Convention and the Kyoto Protocol

United Nations Framework Convention on Climate Change	
Article 3	
3.4 The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.	⑥
3.5 The Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change. Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.	⑥
Article 4	
4.4 The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects. (art. 4.4)	⑥
4.5 The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies. (art 4.5)	⑥

Kyoto Protocol	
Article 2	
2.1 Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation.	⑦ / ④
Article 12	
1. A clean development mechanism is hereby defined.	
2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.	④
3 Under the clean development mechanism: (a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and (b) (b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.	⑤ / ⑥
4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.	

5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of: (a) Voluntary participation approved by each Party involved; (b) (b) Real, measurable, and long-term benefits related to the mitigation of climate change; and (c) (c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.	① / ② / ③
6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.	
7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.	⑧
8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.	
9. Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and in the acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.	①
10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.	④

Annex B Principles and criteria of forestry institutes

CIFOR Principles and Criteria (Center for International Forestry Research)	
1 Policy, planning and institutional framework are conducive to sustainable forest management	①
1.1 There is sustained and adequate funding for the management of forests 1.2 Precautionary economic policies exist 1.3 Non forestry policies do not distort forest management 1.4 A functioning buffer zone exists 1.5 Legal framework protects access to forest and forest resources 1.6 Demonstrated reinvestment in forest-use options	
2 Maintenance of ecosystem integrity	⑤
2.1 The processes that maintain biodiversity in managed forests (FMUs) are conserved 2.2 Ecosystem function is maintained 2.3 Conservation of the processes that maintain genetic variation	
3 Forest management maintains or enhances fair intergenerational access to resources and economic benefits	⑥
3.1 Local management is effective in controlling maintenance of, and access to, the resource 3.2 Forest actors have a reasonable share in the economic benefits derived from forest use 3.3 People link their and their children's future with management of forest resources	
4 Concerned stakeholders have acknowledged rights and means to manage forests cooperatively and equitably	⑥
4.1 Effective mechanisms exist for two-way communication related to forest management among stakeholders 4.2 Local stakeholders have detailed, reciprocal knowledge pertaining to forest resource use (including user groups and gender roles), as well as forest management plans prior to implementation 4.3 Agreement exists on rights and responsibilities of relevant stakeholders	
5 The health of the forest actors, cultures and the forest is acceptable to all stakeholders	⑦
5.1 There is a recognisable balance between human activities and environmental conditions 5.2 The relationship between forest management and human health is recognised 5.3 The relationship between forest maintenance and human culture is acknowledged as important	
6 Yield and quality of forest goods and services are sustainable	⑦
6.1 Forest management unit is implemented on the basis of legal title on the land, recognised customary rights, or clear lease agreements 6.2 Management objectives are clearly and precisely described and documented 6.3 Forest management plan is comprehensive 6.4 Implementation of the management plan is effective 6.5 An effective monitoring and control system audit's management's conformity with planning 6.6 Equitable distribution and presence of economic rent	

ITTO Criteria (International Tropical Timber Organisation)	
1 Enabling Conditions for Sustainable Forest Management	①
2 Forest Resource Security	⑦
3 Forest Ecosystem Condition	⑦
4 Flow of Forest Produce	⑦
5 Biological Diversity	⑤
6 Soil and Water Protection	⑤
7 Social, Cultural and Economic Effects	⑥

FSC Principles and Criteria (Forest Stewardship Council)	
1 Compliance with laws and FSC principles	④
1.1 Forest management shall respect all national and local laws and administrative requirements. 1.2 All applicable and legally prescribed fees, royalties, taxes and other charges shall be paid. 1.3 In signatory countries, the provisions of all binding international agreements such as CITES, ILO Conventions, ITTA, and Convention on Biological Diversity, shall be respected. 1.4 Conflicts between laws, regulations and the FSC Principles and Criteria shall be evaluated for the purposes of certification, on a case by case basis, by the certifiers and the involved or affected parties. 1.5 Forest management areas should be protected from illegal harvesting, settlement and other unauthorized activities. 1.6 Forest managers shall demonstrate a long-term commitment to adhere to the FSC Principles and Criteria.	
2 Tenure and use rights and responsibilities	①
2.1 Clear evidence of long-term forest use rights to the land (e.g. land title, customary rights, or lease agreements) shall be demonstrated. 2.2 Local communities with legal or customary tenure or use rights shall maintain control, to the extent necessary to protect their rights or resources, over forest 2.3 Appropriate mechanisms shall be employed to resolve disputes over tenure claims and use rights. The circumstances and status of any outstanding disputes will be explicitly considered in the certification evaluation. Disputes of substantial magnitude involving a significant number of interests will normally disqualify an operation from being certified.	
3 Indigenous people's rights	⑥
3.1 Indigenous peoples shall control forest management on their lands and territories unless they delegate control with free and informed consent to other agencies. 3.2 Forest management shall not threaten or diminish, either directly or indirectly, the resources or tenure rights of indigenous peoples. 3.3 Sites of special cultural, ecological, economic or religious significance to indigenous peoples shall be clearly identified in cooperation with such peoples, and recognized and protected by forest managers. 3.4 Indigenous peoples shall be compensated for the application of their traditional knowledge regarding the use of forest species or management systems in forest operations. This compensation shall be formally agreed upon with their free and informed consent before forest operations commence.	
4 Community relations and worker's rights	⑥
4.1 The communities within, or adjacent to, the forest management area should be given opportunities for employment, training and other services. 4.2 Forest management should meet or exceed all applicable laws and/or regulations covering health and safety of employees and their families. 4.3 The rights of workers to organize and voluntarily negotiate with their employers shall be guaranteed as outlined in Conventions 87 and 98 of the International Labour Organisation (ILO). 4.4 Management planning and operations shall incorporate the results of evaluations of social impact. Consultations shall be maintained with people and groups directly affected by management operations. 4.5 Appropriate mechanisms shall be employed for resolving grievances and for providing fair compensation in the case of loss or damage affecting the legal or customary rights, property, resources, or livelihoods of local peoples. Measures shall be taken to avoid such loss or damage.	
5 Benefits from the forest	⑦
5.1 Forest management should strive toward economic viability, while taking into account the full environmental, social and operational costs of production, and ensuring the investments necessary to maintain the ecological productivity of the forest. 5.2 Forest management and marketing operations should encourage the optimal use and local processing of the forest's diversity of products. 5.3 Forest management should minimize waste associated with harvesting and on-site processing operations and avoid damage to other forest resources. 5.4 Forest management should strive to strengthen and diversify the local economy, avoiding dependence on a single forest product. 5.5 Forest management operations shall recognize, maintain and, where appropriate, enhance the value of forest services and resources such as watersheds and fisheries.	

5.6 The rate of harvest of forest products shall not exceed levels, which can be permanently sustained.

6 Environmental impact ⑤

6.1 Assessment of environmental impacts shall be completed — appropriate to the scale, intensity of forest management and the uniqueness of the affected resources — and adequately integrated into management systems. Assessments shall include landscape level considerations as well as the impacts of on-site processing facilities. Environmental impacts shall be assessed prior to commencement of site-disturbing operations.

6.2 Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g., nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.

6.3 Ecological functions and values shall be maintained intact, enhanced or restored, including:
1. Forest regeneration and succession
2. Genetic, species, and ecosystem diversity
3. Natural cycles that affect the productivity of the forest ecosystem

6.4 Representative samples of existing ecosystems within the landscape shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources.

6.5 Written guidelines shall be prepared and implemented to: control erosion; minimize forest damage during harvesting, road construction, and all other mechanical disturbances; and protect water resources.

6.6 Management systems shall promote the development and adoption of environmentally friendly non-chemical methods of pest management and strive to avoid the use of chemical pesticides. World Health Organization Type 1A and 1B and chlorinated hydrocarbon pesticides; pesticides that are persistent, toxic or whose derivatives remain biologically active and accumulate in the food chain beyond their intended use; as well as any pesticides banned by international agreement, shall be prohibited. If chemicals are used, proper equipment and training shall be provided to minimize health and environmental risks.

6.7 Chemicals, containers, liquid and solid non-organic wastes including fuel and oil shall be disposed of in an environmentally appropriate manner at off-site locations.

6.8 Use of biological control agents shall be documented, minimized, monitored and strictly controlled in accordance with national laws and internationally accepted scientific protocols. Use of genetically modified organisms shall be prohibited.

6.9 The use of exotic species shall be carefully controlled and actively monitored to avoid adverse ecological impacts.

7 Management plan ①

7.1 The management plan and supporting documents shall provide:
1. Management objectives.
2. Description of the forest resources to be managed, environmental limitations, land use and ownership status, socioeconomic conditions, and a profile of adjacent lands.
3. Description of silvicultural and/or other management system, based on the ecology of the forest in question and information gathered through resource inventories.
4. Rationale for rate of annual harvest and species selection.
5. Provisions for monitoring of forest growth and dynamics.
6. Environmental safeguards based on environmental assessments.
7. Plans for the identification and protection of rare, threatened and endangered species.
8. Maps describing the forest resource base including protected areas, planned management activities and land ownership.
9. Description and justification of harvesting techniques and equipment to be used.

7.2 The management plan shall be periodically revised to incorporate the results of monitoring or new scientific and technical information, as well as to respond to changing environmental, social and economic circumstances.

7.3 Forest workers shall receive adequate training and supervision to ensure proper implementation of the management plan.

7.4 While respecting the confidentiality of information, forest managers shall make publicly available a summary of the primary elements of the management plan, including those listed in Criterion 7.1.

8 Monitoring and assessment ③

8.1 The scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment should determine the frequency and intensity of monitoring. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.

8.2 Forest management should include the research and data collection needed to monitor, at a minimum, the following indicators:

1. Yield of all forest products harvested
2. Growth rates, regeneration and condition of the forest
3. Composition and observed changes in the flora and fauna
4. Environmental and social impacts of harvesting and other operations
5. Costs, productivity and efficiency of forest management

8.3 Documentation shall be provided by the forest manager to enable monitoring and certifying organizations to trace each forest product from its origin, a process known as the 'chain of custody'.

8.4 The results of monitoring shall be incorporated into the implementation and revision of the management plan.

8.5 While respecting the confidentiality of information, forest managers shall make publicly available a summary of the results of monitoring indicators, including those listed in Criterion 8.2.

9 Maintenance of high conservation value (natural) forests ⑤

9.1 Trees planted in natural forests may supplement natural regeneration, fill gaps or contribute to the conservation of genetic resources. Such plantings shall not replace or significantly alter the natural ecosystem.

9.2 The use of replanting as a technique for regenerating stands of certain natural forest types may be appropriate under certain circumstances. Guidelines on the acceptable intensity and spatial extent of tree planting will be addressed in national and regional forest management standards to be approved by the FSC. In the absence of such national or regional standards, guidelines developed by the certifier and approved by the FSC will prevail.

10 Plantations ⑦

10.1 The management objectives of the plantation, including natural forest conservation and restoration objectives, shall be explicitly stated in the management plan, and clearly demonstrated in the implementation of the plan.

10.2 The design and layout of plantations should promote the protection, restoration and conservation of natural forests, and not increase pressures on natural forests. Wildlife corridors, streamside zones and a mosaic of stands of different ages and rotation periods, shall be used in the layout of the plantation, consistent with the scale of the operation. The scale and layout of plantation blocks shall be consistent with the patterns of forest stands found within the natural landscape.

10.3 Diversity in the composition of plantations is preferred, so as to enhance economic, ecological and social stability. Such diversity may include the size and spatial distribution of management units within the landscape, number and genetic composition of species, age classes and structures.

10.4 The selection of species for planting shall be based on their overall suitability for the site and their appropriateness to the management objectives. In order to enhance the conservation of biological diversity, native species are preferred over exotic species in the establishment of plantations and the restoration of degraded ecosystems. Exotic species, which shall be used only when their performance is greater than that of native species, shall be care-fully monitored to detect unusual mortality, disease, or insect outbreaks and adverse ecological impacts.

10.5 A proportion of the overall forest management area, appropriate to the scale of the plantation and to be determined in regional standards, shall be managed so as to restore the site to a natural forest cover.

10.6 Measures shall be taken to maintain or improve soil structure, fertility, and biological activity. The techniques and rate of harvesting, road and trail construction and maintenance, and the choice of species shall not result in long term soil degradation or adverse impacts on water quality, quantity or substantial deviation from stream course drainage patterns.

10.7 Measures shall be taken to prevent and minimize outbreaks of pests, diseases, fire and invasive plant introductions. Integrated pest management shall form an essential part of the management plan, with primary reliance on prevention and biological control methods rather than chemical pesticides and fertilizers. Plantation management should make every effort to move away from chemical pesticides and fertilizers, including their use in nurseries. The use of chemicals is also covered in Criteria 6.6 and 6.7.	
10.8 Appropriate to the scale and diversity of the operation, monitoring of plantations shall include regular assessment of potential on-site and off-site ecological and social impacts, (e.g. natural regeneration, effects on water resources and soil fertility, and impacts on local welfare and social well-being), in addition to those elements addressed in principles 8, 6 and 4. No species should be planted on a large scale until local trials and/or experience have shown that they are ecologically well adapted to the site, are not invasive, and do not have significant negative ecological impacts on other ecosystems. Special attention will be paid to social issues of land acquisition for plantations, especially the protection of local rights of ownership, use or access.	

PEFC Criteria (<u>P</u>an <u>E</u>uropean <u>F</u>orest <u>C</u>ertification)	
1 Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles	⑤/ ⑦
2 Maintenance of forest ecosystem health and vitality	⑤
3 Maintenance and encouragement of productive functions of forests (wood and non-wood)	⑦
4 Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems	⑤
5 Maintenance and appropriate enhancement of productive functions in forest management (notably soil and water)	⑦
6 Maintenance of other socio-economic functions and conditions	⑥

MPWG Criteria (<u>M</u>ontreal <u>P</u>rocess <u>W</u>orking <u>G</u>roup)	
1 Conservation of Biological Diversity	⑤
2 Maintenance of Productive Capacity of Forest Ecosystems	⑦
3 Maintenance of Forest Ecosystem Health and Vitality	⑤
4 Conservation and Maintenance of Soil and Water Resources	⑤
5 Maintenance of Forest Contribution to Global Carbon Cycles	⑤
6 Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies	⑥
7 Legal, Institutional and Economic Framework for Forest Conservation and Sustainable Management	④
8 Legal and Institutional Framework	①
9 Sustainable Forest Production	⑦
10 Conservation of Forest Ecosystems	⑤
11 Local Socio-economic Benefits	⑥

Annex C Principles and criteria of other organisation

Sink and GHG abatement project criteria

COV / SGS Criteria (Carbon Offset Verification / Société Génerale de Surveillance)	
Acceptability • Host country's acceptability (local development and economic priorities, host country AIJ acceptability) • Non-host country's acceptability	④
Additionality • Baseline vs. Project Case • Determination of the baseline (historical series, predicting future trends) • Determination of the additionality (emissions additionality, programme intent, financial additionality)	②
Externalities • GHG-related externalities (slippage, leakage) • Non GHG-related externalities (development impacts, environmental issues)	③/ ⑤/ ⑥
Capacity • Financial capacity • Management capacity • Infrastructure and technology capacity • Demonstrability	①

FIPIC / ECOR Principles and Criteria (Fedération Internationale Pour L'Isolmente du Carbone)	
1 Verifiability	②/ ③/ ⑧
1.1 Method of quantification 1.2 Establishment of additionality 1.3 Baseline case 1.4 Project case 1.5 Monitoring system 1.6 Transparency	
2 Viability	①/ ⑤/ ⑥
2.1 Economic sustainability 2.2 The Management System Viability 2.3 Social and Institutional Sustainability 2.4 Ecological sustainability	
3 Responsibility	⑤/ ⑥
3.1 Social responsibility 3.2 Environmental responsibility	

WWF Principles and Criteria (World Wildlife Fund)	
1. Prioritised technologies should be guaranteed additional	②
2. Prioritised technologies should be small project technologies	①
3. Ratification of the Kyoto Protocol and the Convention	④
4. Production of a national CDM plan	①
5. Conduct a full Environmental Impact Assessment	⑤
6. Monitoring and reporting	③
7. Hazardous wastes	⑤
8. Compliance of CDM projects with other Conventions	④
9. Transparency and full public access	⑧
10. CDM financing	⑥

National (Dutch) criteria

The Dutch Government's Policy paper on Tropical Forests (1992) Guidelines:	
1. Efforts to ensure that the existing acreage of tropical rainforests including – both primary and secondary forest – is preserved	⑤ / ⑦
2. The need to set priorities with regard to the protection of primary tropical rainforest and, in this context, to promote the development of a cohesive international network of large areas of primary tropical rainforests currently protected or to be protected in the future, in order to preserve their natural value and genetic diversity and the environment in which tribal peoples live	⑤ / ⑦
3. Recognition of the possibilities of economic use being made (in certain cases) of degraded tropical rainforest, which may contribute to the preservation of a permanent acreage of forest, provided that such use is sustainable	⑤ / ⑥
4. The desirability of rehabilitation areas of tropical rainforest which have already been exploited, so that they may again perform their functions, and particularly their regulations and production functions, as forest in the future, of increasing the forest acreage and, where the initial position is favourable, of restoring valuable ecosystems	① / ⑥ / ⑦
5. The need to develop a scientifically based land-use planning system, which provides for the preservation of the largest possible forest acreage, including that of the country concerned	① / ⑦
6. Support for the activities of countries complying with the above in terms of policy development, planning and implementation, bearing in mind the specific situation as regards the tropical rainforest and socio-economic factors in the country concerned	④ / ⑥
7. The Netherlands' position on individual activities to be conditional on the link with the domestic policy of the country concerned and to the quality that policy.	① / ④
Policy strategies	
1. Active protection of surviving virgin rainforest	⑤ / ⑦
2. In principle, no collaboration with projects and developments that are harmful or potentially harmful to the rainforest	① / ⑤
3. Encouraging planned land use and land management along with sustainable agriculture and forestry	① / ⑥ / ⑦
4. The tropical timber trade: controlled harvesting; encouraging the formulation and implementation of long-term planned timber production.	⑦
5. National and international encouragement for afforestation and re-afforestation projects	④
6. Strengthening institutions and legislation; empowerment local populations	① / ④
7. Strengthening the political and social base in tropical nations	⑥
8. Improving economic relations and relieving the debt burden	⑥
9. Increasing scope for national and international tropical rainforest policy by strengthening research and institutions.	⑥

National criteria resulted from the Pan European Ministerial Conference on the protection of forests in Europe (Helsinki, 1993)	
10. Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles	⑤
11. Maintenance of forest ecosystem health and vitality	⑤
12. Maintenance and encouragement of productive functions of forests	⑥ / ⑦
13. Maintenance and encouragement of productive functions of forests	⑥ / ⑦
14. Enhancement of biological diversity in forest ecosystems	⑤
15. Enhancement of socio-economic functions of forests	⑥
16. Providing adequate institutional frameworks for sustainable forest management	① / ⑦

Forest Policy Act, Netherlands (1993) International forestry policy: conservation, recovering or development of:	
1. Biological diversity	⑤
2. Sustainable forestry for production of timber and other forests products	⑦
3. Regulatory functions concerning the climate, water management and soil fertility	⑤
4. Living standards of rural population and people depending on forests	⑥

Ministry of Development, GAVIM principle (Netherlands)	
1 Good Governance	① / ⑤
2 Poverty Alleviation	④
3 Women	④
4 Institutional Development	①
5 Local Environment	③

International organisations

World Bank	
1 Consistency with the UNFCCC and/or the Kyoto Protocol	④
2 Consistency with Relevant National Criteria	④
3 Consistency with the Bank's Country Assistance Strategy	④
4 Funding Alternatives/Complementarity with the Global Environment Facility ('GEF')	②
5 National and Local Environmental Benefits	⑤
6 Consistency with the Fund's Strategic Objectives and Operating Principles	①
7 Consistency with the Guidance Provided by Participants	①
8 Additional Characteristics of Fund Projects	②

GEF (Global Environment Facility)	
1 Coverage without duplication	②
2 Appropriate overall sequencing of activities	①
3 Best practice	①
4 Cost-effectiveness	④
5 Consistency of approach and procedures	①

Convention on Biological Diversity	
• Conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources	⑤
• Measures have to be taken to preserve biological diversity and to promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas	⑤
• Procedures requiring environmental impact assessment of its proposed projects that are likely to have	⑤
• significant adverse effects on biological diversity with a view to avoiding or minimising such effects and, where appropriate, allow for public participation in such procedures	
• Identification and monitoring of the components of biodiversity that require urgent conservation measures or offer the greatest potential for sustainable use	③/ ⑤
• Integrate consideration of the conservation and sustainable use of biological resources into decision-making and adopt measures relating to the use of biological resources to avoid or minimise adverse impacts on biological diversity	①/ ⑤
• Provide in the special needs of developing countries through programmes for scientific and	⑤/ ⑥
• technical education and training, developing educational and public	
• awareness programmes and access and transfer of technology	

Prof. C.W. Stortenbeker Working Group, UNCED (1992)	
1. The integrity of the forest's ecological functions should be garanteed	⑤
2. The continuity of the forest's socio-ecological functions should be guaranteed	⑥
3. The continuity of the forest's socio-cultural functions should be guaranteed	⑥

Annex D Criteria and their indicators

Indicator have been added to each criterion to concretise the eight generic criteria. The indicators are copied from several Forest Certification institutes, so the structure of the sentences may vary. The indicators provide also insight in the formulation of criteria sets of the institutes. Every criterion has its own set of indicators which van be put to use when determining whether a CDM project satisfies the criteria or not.

Criterion 1: Project framework

- The project should contain a comprehensive **management plan** in which the following issues are arranged:
  - Management objectives
  - Description of the forest resources to be managed, environmental limitations, land use and ownership status, socio-economic conditions, and a profile of adjacent lands
  - Description of silvicultural and/or other management system, based on the ecology of the forest in question and information gathered through resource inventories
  - Rationale for rate of annual harvest and species selection
  - Provision for monitoring of forest growth and dynamics
  - Environmental safeguards based on environmental assessments
  - Plans for the identification and protection of rare, threatened and endangered species
  - Maps describing the forest resource base including protected areas, planned management activities and land ownership
  - Description and justification of harvesting techniques and equipment to be used
- The management plan shall be periodically **revised** to incorporate the results of monitoring or new scientific and technical information, as well as to respond to changing environmental, social and economic circumstances.
- Clear evidence of long-term forest **use rights** to the land (e.g. land title, customary rights, or lease agreements) shall be demonstrated.
- Appropriate mechanisms shall be employed to resolve disputes over tenure claims and use rights. The circumstances and status of any outstanding disputes will be explicitly considered in the certification evaluation. Disputes of substantial magnitude involving a significant number of interests will normally disqualify an operation from being certified.
- There is sustained and adequate **funding** for the management of forests.
- Reinvestment in forest-use options must be demonstrated.
- The on-the-ground (managerial) **infrastructure and technological capacity** must be sufficient and appropriate to implement and manage the proposed project.
- **Forest workers** shall receive adequate **training and supervision** to ensure proper implementation of the management plan.

- Appropriate overall sequencing of activities
- Cost-effectiveness
- Consistency of approach and procedures

Criterion 2: Additionality

- No project can claim emission reductions unless project proponents make reasonable demonstration that the project's practices are **'additional' to 'business as usual'** (also called the 'reference case' or 'baseline') circumstances.
  - Determination of the **baseline** should be done on the basis of historical series and the prediction of future trends, and should remain fixed for the duration of the project.
  - Determination of the **additionality** should be done by demonstrating that the project results in direct impacts on relative emissions in comparison to the baseline. The specific measures that lead to these reductions must be readily identifiable and documented.
- The additionality must be corrected for **slippage and leakage**. Slippage is the geographic relocation of GHG emission causing activities, as a result of the project's implementation. Leakage is increased GHG emissions indirectly incentivised by the project: e.g. increased down-stream processing activities.
- There must be the element of **Intent or Programme Additionality**. This means that the project was initiated with the specific intent of lowering GHG emissions.
- To ensure that existing projects and behavioural shifts are not simply repackaged as carbon offsets, they must be **financial additional**.
- Coverage without duplication

Criterion 3: Verifiability

- An effective **monitoring and control system** audits management's conformity with planning.
- Forest management should include the research and data collection needed to **monitor**, at a minimum, the following indicators:
  - Emissions and sequestration of carbon and other greenhouse gases.
  - Yield of all forest products harvested
  - Growth rates, regeneration and condition of the forest
  - Composition and observed changes in the flora and fauna
  - Environmental and social impacts of harvesting and other operations
  - Costs, productivity and efficiency of forest management
- Monitoring procedures should be **consistent and replicable over time** to allow comparison of results and assessment of change.
- The **scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment should determine the frequency and intensity of monitoring**.
- The **results of monitoring** shall be incorporated into the implementation and revision of the management plan.

- Documentation shall be provided by the forest manager to enable monitoring and certifying organisations to trace each forest product from its origin ('chain of custody').

Criterion 4: Compliance

- In signatory countries, the provisions of all binding **international agreements** such as CITES, ILO Conventions, ITTA, and Convention on Biological Diversity, shall be respected.
- Sustainable Forest Management shall respect all **national and local laws** and administrative requirements.
- All applicable and legally prescribed **fees, royalties, taxes and other charges** shall be paid.
- **Host country's acceptability of SFM** (development objectives and economic priorities, AIJ regulations and priorities).
- Forest managers shall demonstrate a **long-term commitment** to adhere to the principles and criteria set for such projects.
- **Conflicts between laws, regulations and principles and criteria** shall be evaluated beforehand for the purposes of project implementation, on a case by case basis, by the involved, affected and third parties.
- The management shall aim for best practice and good governance during the time span of the project.

Criterion 5: Environmental sustainability

- **Plantations** as well as **natural forests** are eligible.
- Management shall take (precautionary) measures to decrease impacts of **production activities** at plantations and natural forests.
- Maintenance, conservation and appropriate enhancement of **biological diversity** in forest ecosystems.
- Maintenance of **ecosystem function, health and vitality**.
- **Representative samples of existing ecosystems** within the landscape shall be **protected** in their natural state **and recorded** on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources.
- Safeguards shall exist which **protect rare, threatened and endangered species and their habitats** (e.g., nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.
- Conservation of the processes that maintain **genetic variation**.
- The use of **exotic species** shall be carefully controlled and actively monitored to avoid adverse ecological impacts.
- Measures shall be taken to maintain or improve **soil structure, fertility, water quality, and biological activity**.
- Management systems shall promote the development and adoption of environmentally friendly **non-chemical methods of pest management** and strive to avoid the use of chemical pesticides. If chemicals are used, proper

equipment and training shall be provided to minimise health and environmental risks.

- Use of **biological control agents** shall be documented, minimised, monitored and strictly controlled in accordance with national laws and internationally accepted scientific protocols. Use of genetically modified organisms shall be prohibited.
- Chemicals, containers, liquid and solid non-organic wastes including fuel and oil shall be disposed of in an environmentally appropriate manner at off-site locations.

Criterion 6: Socio-economic sustainability

- Forest management shall not threaten or diminish, either directly or indirectly, the resources or **tenure rights of indigenous peoples**.
- **Sites of special cultural, ecological, economic or religious significance to indigenous peoples** shall be clearly **identified** in co-operation with such peoples, and recognised and **protected** by forest managers.
- Indigenous peoples shall **control forest management** on their lands and territories unless they delegate control with free and informed consent to other agencies.
- The communities within, or adjacent to, the forest management area should be given opportunities for **employment, training and other services**.
- The **rights of workers** to organise and voluntarily negotiate with their employers shall be guaranteed.
- **Agreement** exists on rights and responsibilities of relevant stakeholders.
- Local stakeholders have **detailed, reciprocal knowledge** pertaining to forest resource use (including user groups and gender roles), as well as forest management plans prior to implementation.
- Effective mechanisms exist for **two-way communication** related to forest management among stakeholders.
- **Consultations** shall be maintained with people and groups directly affected by management operations.
- People link their and their children’s **future** with management of forest resources.
- Forest management should meet or exceed all applicable laws and/or regulations covering health and safety of employees and their families.
- Indigenous peoples shall be compensated for the application of their traditional knowledge regarding the use of forest species or management systems in forest operations. This **compensation** shall be formally agreed upon with their free and informed consent before forest operations commence.
- Forest actors have a reasonable share in the economic benefits derived from forest use.
- Appropriate mechanisms shall be employed for resolving grievances and for providing fair compensation in the case of loss or damage affecting the legal or customary rights, property, resources, or livelihoods of local peoples. Measures shall be taken to avoid such loss or damage.

Criterion 7: Sustainable Forest Management (SFM)

- Sustainable Forest Management areas should be **protected from illegal harvesting, settlement and other unauthorised (non-forestry) activities**.
- Plantations as well as natural forests are **eligible.**
- The design and layout of **plantations** should promote the protection, restoration and conservation of natural forests, not increase pressures on natural forests and minimise environmental impact.
- Management of **plantations** should decrease impact on the environment and promote environmental and socio-economic sustainability.
- Trees planted in natural forests may **supplement natural regeneration**, fill gaps or contribute to the conservation of genetic resources. Such plantings shall not replace or significantly alter the natural ecosystem.
- A **proportion of the overall forest management area**, appropriate to the scale of the plantation and to be determined in regional standards, **shall be managed so as to restore the site to a natural forest cover**.
- The selection of species for planting in plantations or natural forests shall be based on their overall suitability for the site and their appropriateness to the management objectives. In order to enhance the **conservation of biological diversity**, native species are preferred over exotic species in the establishment of plantations and the restoration of degraded ecosystems.
- A functioning **buffer zone** exists between the managed forest and its 'natural' environment.
- **Maintenance and encouragement of productive functions of forests (wood and non-wood).**
- Forest management and marketing operations should **encourage the optimal use and local processing of the forest's diversity of products**.
- **Yield and quality** of forest goods and services shall be sustainable.
- Forest management should strive toward **economic viability**, while taking into account the full environmental, social and operational costs of production, and ensuring the investments necessary to maintain the ecological productivity of the forest.
- Forest management should strive to **strengthen and diversify the local economy.**
- Measures shall be taken to **prevent and minimise outbreaks of pests, diseases, fire and invasive plant introductions**, with primary reliance on prevention and biological control methods rather than chemical pesticides and fertilisers.
- Forest management shall **minimise waste** associated with harvesting and on-site processing operations and avoid damage to other forest resources.
- Forest management operations shall recognise, maintain and, where appropriate, enhance the **value of forest services and resources** such as watersheds and fisheries.

Criterion 8: Transparency

- Rules shall be developed governing the provision of information to the public. Procedures shall exist to ensure **ready public access to information on the certification process**.
- While respecting the confidentiality of information, forest managers shall make publicly available a **summary of the results of monitoring indicators**.
- The project concept must allow GHG benefits to be estimated within a **tolerable level of certainty**.

Annex E Important items of the Executive Summary of Chapter 5 of the IPCC Special Report on LULUCF with regards to this project

Land use, land-use change, and forestry (LULUCF) activities aimed at mitigating greenhouse gas emissions are often organized as projects. An LULUCF project may integrate one or more activities aimed at reducing greenhouse gas emissions or enhancing greenhouse gas sinks in terrestrial ecosystems and related sectors. LULUCF projects are confined to a specific geographic location, time period, and institutional framework to allow changes in carbon stocks or greenhouse gas emissions to be monitored and verified. There are three broad types of LULUCF projects:

- avoiding emissions via conservation of existing carbon stocks
- increasing carbon storage by sequestration
- substituting carbon for fossil fuel and energy-intensive products

Each of these types of project has a variety of subtypes.

Concerns

LULUCF projects have raised specific concerns regarding *duration*, *additionality*, *leakage*, *risks*, *accounting*, *measuring and monitoring*, and *verification* of greenhouse gas benefits. These concerns include the ability to construct reasonable, empirically based, without-project baselines; the ability to quantify and reduce potential leakage of greenhouse gases across project borders to other areas or markets; and the ability to cope with natural or human-induced risks that may reduce or eliminate accrued greenhouse gas benefits. Many of these issues are also applicable to climate mitigation projects in other sectors. There are further questions about the degree to which projects can be designed to contribute to sustainable development and improved rural livelihoods. Chapter 5 of the IPCC Special Report on LULUCF addresses each of these concerns.

Assessment of the experience of LULUCF projects is constrained by the small number of such projects, their limited activity and geographic scope, and the short period of field operations since the first greenhouse gas mitigation project began in 1988. About 3.5 Mha of land are currently included in 27 LULUCF greenhouse gas mitigation projects being implemented in 19 countries. In addition, LULUCF project experience to date has focused only on mitigating carbon (as carbon dioxide) emissions.

Because no internationally agreed set of guidelines or methods yet exists to quantify carbon benefits, costs, and the carbon and financial efficiency of project activities, projects have used a wide range of methods to estimate changes in carbon stocks or greenhouse gas emissions and financial indicators. Few of the results of these projects have been independently verified, which makes comparative assessments difficult. Using data reported by projects that have been reviewed, average carbon sequestration or emissions avoidance per unit area ranges from about 4-440 t C ha^{-1}; there is wide variation across regions and specific project types. The cost of greenhouse gas mitigation effects in these projects ranges from $0.1-28 per t C, based on dividing the total financial commitment by the estimated long-term greenhouse gas mitigation effect.

Additionality

A fundamental component of project assessment is to determine whether changes in carbon stocks or greenhouse gas emissions associated with a project are 'additional' to 'business as usual'. The first step in determining additionality has been to develop a without-project (baseline) scenario against which carbon stocks in the project can be compared. Currently there is no standard method for developing baselines. Approaches for developing and applying baselines include: *project specific* –established through a case-by-case exercise, or *generic* –based on regional, national, or sectoral aggregated data. These baselines may remain fixed throughout the duration of a project, or they may be periodically adjusted in light of new data or evidence. Methods to quantify (or estimate) carbon stocks in the baseline scenario include the use of models to project the fate of land in the project area in combination with data on carbon stocks from proxy or control areas or from the literature.

Leakage

Experience shows that reducing access to food or fiber resources without offering alternatives or substituting for the activity leading to greenhouse gas emissions may result in project leakage as people move elsewhere to find needed supplies. A few pilot projects to date have been designed to reduce leakage by explicitly incorporating components that supply the resource needs of local communities (e.g., planting fuelwood plantations to reduce pressures on other forests) and provide socio-economic benefits that create incentives to maintain the project.

Accounting

Project accounting and monitoring methods could be matched with project conditions to address leakage issues. For example, if flows of LULUCF products or people across project boundaries are negligible, leakage is likely to be small, and the monitoring area can be roughly equal to the project area. Conversely, where flows are significant and leakage is likely to be large, the monitoring area will need to be expanded beyond the project area to account for the leakage. Alternative approaches for accounting and monitoring leakage may be required where monitoring and project areas cannot be easily matched. Potential options include national or regional LULUCF sectoral benchmarks (empirically derived values that relate leakage levels to activities and/or regions) that could capture and report leakage outside the project area, and standard risk coefficients developed by project or activity type and region, with adjustments to project greenhouse gas benefits made accordingly. However, the effectiveness of these approaches is untested.

Implementation of projects in countries without assigned amounts for national emissions presents specific concerns regarding baselines, greenhouse gas accounting, leakage, and monitoring. Unlike Annex I countries, non-Annex I countries are not required to account for emissions on a national level. Therefore, leakage and emissions arising after the project has been completed will not be detected.

Several approaches have been used to account for changes in carbon stocks or greenhouse gas emissions over the lifetimes of LULUCF projects. Three main accounting methods are distinguished in the SR:

- One method is base on calculating the difference in carbon stocks between a project and its baseline at a given point in time –the ***carbon stock method***. The values provided by this method vary depending on the decision of when to account for the project's benefits.
- The ***average storage method*** has been used to account for dynamic systems in which planting, harvesting, and replanting operations take place. The advantage of this method is that it accounts for the dynamics of carbon storage over the whole project duration, not only at the times chosen for accounting.
- Another approach is to credit only a fraction of the total changes in carbon stocks or greenhouse gas emissions for each year that the project is maintained – the ***ton-year method***.

A variety of methods have been proposed for establishing an equivalency factor by analogy to Global Warming Potentials (GWPs). Depending on the accounting method used, the year-to-year distribution of changes in carbon stocks or greenhouse gas emissions over the project lifetime varies.

Duration

The Kyoto Protocol requires that LULUCF projects result in long-term impacts on carbon dioxide concentrations in the atmosphere. The definition of 'long-term' varies, however, and there is no consensus on minimum time frames for project duration. Different approaches have been proposed to define the duration of projects.

- According to one view, the changes in carbon stocks or greenhouse gas emissions must be maintained in perpetuity. This argument is based on the assumption that 'reversal' of changes in carbon stocks or greenhouse gas emissions of a project at any point in time would invalidate a project.
- A second view is that the changes in carbon stocks or greenhouse gas emissions must be maintained for a period of 100 years to be consistent with the time frames adopted in the Kyoto Protocol for the calculation of GWP values.
- Under a third view, the changes in carbon stocks or greenhouse gas emissions must be maintained until they counteract the effect of an equivalent amount of greenhouse gases emitted to the atmosphere.
- A fourth view holds that the changes in carbon stocks or greenhouse gas emissions may vary over different time frames, acknowledging that different projects may have different operational time frames; this approach has been adopted during the Activities Implemented Jointly (AIJ) Pilot Phase.

Eventually, guidelines will be needed on how to calculate the changes in carbon stocks or greenhouse gas emissions of projects that are conducted over different lifetimes.

Monitoring

Quantification of greenhouse gas emissions or removals in LULUCF projects is subject to a variety of risks and uncertainties. Some of these factors (such as fires, pest and disease, storms) are inherent to certain land-use activities, particularly forestry; others (such as political and economic factors) may be generic and applicable to any greenhouse gas mitigation project in LULUCF and other sectors. These risks and uncertainties could be estimated and the changes in carbon stocks or greenhouse gas emissions adjusted or mitigated through project design, diversification of project portfolios, or insurance methods.

The changes in carbon stocks or greenhouse gas emissions associated with individual LULUCF projects are likely to be more readily quantified and monitored to desired precision levels than national inventories of greenhouse gas emissions and removals because of the clearly defined boundaries of project activities, the ease of stratification of project area, sampling efficiency, and measurement of only a selection of carbon pools. Techniques and methods for measuring carbon in vegetation and soils in LULUCF projects to relatively high levels of precision exist. These techniques have not been universally applied to all projects, however, and methods for accounting of the changes in carbon stocks have not been standardized. A selective accounting system could be used to choose which carbon pools to measure; the choice must include all pools that are expected to decrease and a selection of pools that are expected to increase as a result of the project. The requirements for verifiability in the Protocol suggest that only carbon pools that can be measured and monitored could be claimed.

The costs of measuring and monitoring carbon pools in LULUCF projects are mainly related to the desired precision level, which varies by project type, size of project, distribution of project lands (contiguous or dispersed), and natural variations within the various carbon pools. Different levels of sampling intensity can be used to balance the costs of estimating, monitoring, and verifying the change in carbon stocks. In a few forestry projects in tropical counties, project developers in the early stages of project implementation have measured and monitored relevant aboveground and below-ground carbon pools to precision levels of about 10 percent of the mean at a cost of about US$1-5 ha^{-1} and US$0.10-0.50 per t C. The attainable accuracy and precision of carbon measurements and monitoring is likely to be similar among LULUCF project types, but differing measuring and monitoring costs will result from decisions about which particular carbon pools are to be measured and monitored, as well as their variability.

Verification

Qualified independent third-party verification plays an essential role in ensuring unbiased monitoring. Although there is growing experience in verification of baseline and project design, there is no experience with verification of monitored data. Guidelines are needed to help establish a procedure and institutional structure for verification.

LULUCF projects may provide significant socio-economic and environmental benefits to host countries and local communities, though some types of projects pose significant risk of negative impacts. Experience from many pilot projects to date indicates that the involvement of local stakeholders in the design and management of project activities is often critical for success. Critical factors affecting the capacity of projects to provide greenhouse gas and other benefits include consistency with nationally defined sustainable development goals, institutional and technical capacity to develop and implement project guidelines and safeguards, and the extent and effectiveness of local community participation in project development and implementation.

Annex F Tabulated results of af-/reforestation and forest conservation simulations, potentials and costs

Table 49. Potential area, carbon sequestration and costs for af-/reforestation projects without adoption of criteria, a 25% precision level and with banking from 2002 onwards

Af-/Reforestation without adoption of criteria, rotation length 35 years								
Countries	**Planted area (2001-2012)**	**Total seques-tration per year**	**Total seques-tration 2008-2012**	**costs 2008-2012**	**Total seques-tration 2000-2050**	**costs 2000-2050**	**Total seques-tration 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C y^{-1})	(Mt C)	(x 10^6 $)	(Mt C)	(x 10^6 $)	(Mt C)	(x 10^6 $)
C. America/Caribbean	267	0	3	11	34	131	100	387
Africa Developing	368	0	4	10	74	202	214	577
Asia Developing	8080	6	64	173	541	1447	1065	2882
Oceania Developing	19	0	0	0	1	2	2	6
South America	1466	2	25	136	365	2020	924	5214
Total (excl. Macedonia)*	**10201**	**10**	**95**	**330**	**1014**	**3801**	**2305**	**9067**
Angola	0	0	0	0	0	0	0	0
Argentina	378	0	2	21	52	452	123	1071
Bangladesh	66	0	0	1	4	10	6	15
Belize	0	0	0	0	0	1	0	1
Benin	3	0	0	0	1	3	4	9
Bhutan	3	0	0	0	1	2	1	3
Bolivia	3	0	0	0	1	3	3	9
Botswana	0	0	0	0	0	0	0	0
Brazil	405	1	8	45	171	943	515	2841
Burundi	6	0	0	0	2	5	5	12
Cambodia	9	0	0	0	1	3	4	9
Cameroon	1	0	0	0	0	0	0	1
Central African Republic	1	0	0	0	0	0	0	1
Chile	191	1	6	32	23	124	73	399
China	3462	2	20	53	354	927	503	1317
Colombia	21	0	0	1	8	30	25	90
Congo	18	0	0	1	8	20	24	61
Costa Rica	33	0	1	3	3	13	10	41
Cote d'Ivore	15	0	0	0	4	10	12	32
Cuba	78	0	1	3	4	13	13	41
Democratic Republic of Congo	0	0	0	0	0	0	0	1
Ecuador	12	0	0	1	4	12	11	35
El Salvador	6	0	0	0	1	3	2	5
Equatorial Guinea	1	0	0	0	0	1	1	2
Fiji	6	0	0	0	0	1	1	2
French Guyana	0	0	0	0	0	0	0	0
Gabon	18	0	0	1	5	25	10	53
Gambia	6	0	0	0	0	0	0	0
Ghana	6	0	0	0	1	3	3	8

Af-/Reforestation without adoption of criteria, rotation length 35 years								
Countries	**Planted area (2001-2012)**	**Total seques-tration per year**	**Total seques-tration 2008-2012**	**costs 2008-2012**	**Total seques-tration 2000-2050**	**costs 2000-2050**	**Total seques-tration 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C y^{-1})	(Mt C)	(x 10^6 $)	(Mt C)	(x 10^6 $)	(Mt C)	(x 10^6 $)
Guatemala	3	0	0	0	2	7	7	21
Guinea	3	0	0	0	1	2	2	5
Guinea Bissau	6	0	0	0	0	1	0	1
Guyana	0	0	0	0	0	0	0	0
Honduras	21	0	0	1	3	7	5	12
India	3018	3	27	64	100	241	318	768
Indonesia	745	1	10	30	43	126	138	406
Kenya	6	0	0	0	1	1	2	4
Laos	18	0	0	0	0	1	1	2
Madagaskar	18	0	0	1	7	16	22	49
Macedonia	0	0	0	0	0	0	0	0
Malawi	6	0	0	0	2	4	5	12
Malaysia	105	0	2	11	9	52	30	167
Mexico	105	0	1	3	11	53	35	161
Mongolia	0	0	0	0	0	0	0	0
Mozambique	3	0	0	0	0	1	1	2
Myanmar	111	0	1	2	5	14	11	32
Nepal	15	0	0	0	3	7	7	16
New Caledonia	1	0	0	0	0	0	0	1
Nicaragua	12	0	0	0	4	9	12	28
Nigeria	69	0	1	3	26	59	78	180
Panama	9	0	0	1	6	26	17	76
Papua New Guinea	11	0	0	0	0	1	1	2
Paraguay	6	0	0	0	1	3	2	8
Peru	150	0	4	14	63	241	88	341
Philippines	90	0	1	3	12	36	21	62
Rwanda	6	0	0	0	2	5	5	11
Senegal	33	0	0	0	2	5	4	9
Sierra Leone	0	0	0	0	0	0	0	0
Solomon Islands	2	0	0	0	0	0	0	0
South Africa	36	0	0	1	6	27	18	84
Sudan	90	0	0	0	2	5	7	15
Surinam	0	0	0	0	0	0	0	0
Thailand	338	0	1	6	5	20	15	62
Tanzania	3	0	0	0	0	1	1	2
Uganda	3	0	0	0	1	2	3	7
Uruguay	150	0	1	6	4	28	14	91
Venezuela	150	0	3	16	39	184	69	329
Vietnam	101	0	1	2	3	8	10	24
Zambia	6	0	0	0	1	3	4	9
Zimbabwe	6	0	0	0	1	2	2	5
Total	**10201**	**10**	**95**	**330**	**1014**	**3801**	**2305**	**9067**

Table 50. Potential area, carbon sequestration and costs for forest conservation scenario 1, without adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 1, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	149	23	96	566	90	380	678	105	445
Africa Developing	531	30	111	2373	133	496	4583	257	968
Asia Developing	165	10	40	748	48	180	1408	86	315
Oceania Developing	53	2	6	239	9	27	478	18	53
South America	770	76	394	3498	347	1792	6966	691	3574
Total (excl. Macedonia)*	**1667**	**142**	**647**	**7423**	**627**	**2874**	**14113**	**1158**	**5355**
Angola	62	2	7	282	10	32	564	20	65
Argentina	287	13	119	1307	58	539	2613	116	1077
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	79	11	46	266	37	154	266	37	154
Benin	3	0	1	11	1	3	11	1	3
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	54	6	18	243	29	83	486	58	166
Botswana	260	11	51	1180	48	234	2360	97	468
Brazil	100	14	79	454	62	360	907	123	719
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	2	0	0	10	0	1	20	1	2
Cameroon	8	1	2	37	3	8	74	6	16
Central African Republic	26	2	5	120	9	21	239	18	42
Chile	44	8	45	200	35	202	400	70	405
China	0	0	0	0	0	0	0	0	0
Colombia	24	3	11	107	14	50	214	27	101
Congo	33	5	12	151	21	55	301	42	110
Costa Rica	16	2	10	74	11	45	148	21	90
Cote d'Ivore	7	1	2	17	1	4	17	1	4
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	2	0	1	10	2	3	21	3	7
Ecuador	14	1	5	65	6	21	100	10	32
El Salvador	2	0	0	4	0	1	4	0	1
Equatorial Guinea	24	2	7	110	11	32	220	23	65
Fiji	4	0	1	20	1	3	40	2	6
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	22	2	11	100	9	48	200	18	96
Gambia	0	0	0	0	0	0	0	0	0
Ghana	2	0	0	9	1	1	9	1	1
Guatemala	6	1	4	26	6	20	27	7	21
Guinea	8	1	2	37	3	7	74	5	14
Guinea Bissau	2	0	0	11	0	0	22	0	1
Guyana	78	13	35	356	59	161	713	117	323
Honduras	6	0	1	26	2	5	47	3	9
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 1, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	4	0	1	19	2	5	30	3	8
Kenya	3	0	0	13	0	1	25	1	2
Laos	8	0	0	36	1	2	72	1	4
Madagaskar	4	0	1	17	2	5	34	4	10
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	1	0	0	2	0	0	2	0	0
Malaysia	30	4	23	135	18	104	218	29	169
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	101	5	13	460	24	58	920	48	117
Mozambique	2	0	0	11	0	1	21	1	2
Myanmar	6	0	1	29	1	3	39	1	4
Nepal	1	0	0	3	0	0	3	0	0
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	4	0	1	11	1	3	11	1	3
Nigeria	1	0	0	3	0	1	3	0	1
Panama	35	7	33	158	33	152	174	36	167
Papua New Guinea	39	1	4	179	7	19	358	13	39
Paraguay	63	2	9	288	11	41	577	22	82
Peru	53	8	34	242	39	155	484	77	310
Philippines	2	0	0	9	1	2	12	1	3
Rwanda	0	0	0	1	0	0	1	0	0
Senegal	5	0	0	23	0	1	46	1	2
Sierra Leone	1	0	0	3	0	1	3	0	1
Solomon Islands	9	0	1	40	2	4	80	3	8
South Africa	18	1	5	80	4	21	160	8	41
Sudan	9	0	0	42	0	1	54	0	1
Surinam	0	0	0	0	0	0	0	0	0
Thailand	10	0	1	47	1	4	95	2	8
Tanzania	2	0	0	10	0	1	20	1	2
Uganda	1	0	0	6	1	1	6	1	1
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	52	8	39	236	36	179	473	72	358
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	14	1	2	46	3	8	46	3	8
Zimbabwe	10	0	1	44	2	4	52	2	5
Total	**1667**	**142**	**647**	**7423**	**627**	**2874**	**14113**	**1158**	**5355**

* The Forest conservation 1 scenario describes the conservation of a fixed percentage of the initial deforestation rate each year relative to the BAU_0 baseline assumption (1990-1995 deforestation rate, FAO, 1999).

Table 51. Potential area, carbon sequestration and costs for forest conservation scenario 1, with adoption of criteria, a 5% precision level and banking from 2002 onwards

Forest Conservation scenario 1*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 \$)	(1000 ha)	(Mt C)	(10^6 \$)	(1000 ha)	(Mt C)	(10^6 \$)
C. America / Caribbean	32	5	74	122	19	292	146	23	342
Africa Developing	115	7	79	512	29	353	990	56	695
Asia Developing	36	2	29	162	10	130	304	19	221
Oceania Developing	11	0	3	52	2	16	103	4	32
South America	166	16	333	756	75	1512	1505	149	3019
Total (excl. Macedonia)*	**360**	**31**	**517**	**1603**	**135**	**2303**	**3048**	**250**	**4308**
Angola	13	0	5	61	2	21	122	4	42
Argentina	62	3	118	282	12	537	565	25	1074
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	17	2	35	58	8	118	58	8	118
Benin	1	0	0	2	0	2	2	0	2
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	12	1	10	53	6	48	105	12	95
Botswana	56	2	42	255	10	192	510	21	385
Brazil	22	3	70	98	13	318	196	27	636
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	0	0	0	2	0	0	4	0	1
Cameroon	2	0	1	8	1	4	16	1	8
Central African Republic	6	0	2	26	2	10	52	4	19
Chile	10	2	39	43	8	179	86	15	357
China	0	0	0	0	0	0	0	0	0
Colombia	5	1	8	23	3	36	46	6	71
Congo	7	1	6	33	5	29	65	9	57
Costa Rica	4	1	8	16	2	35	32	5	70
Cote d'Ivore	2	0	1	4	0	2	4	0	2
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	0	0	0	2	0	1	4	1	3
Ecuador	3	0	3	14	1	13	22	2	21
El Salvador	1	0	0	1	0	0	1	0	0
Equatorial Guinea	5	1	4	24	2	18	48	5	37
Fiji	1	0	1	4	0	2	9	0	5
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	5	0	9	22	2	41	43	4	83
Gambia	0	0	0	0	0	0	0	0	0
Ghana	0	0	0	2	0	1	2	0	1
Guatemala	1	0	3	6	1	13	6	1	14
Guinea	2	0	1	8	1	4	16	1	7
Guinea Bissau	1	0	0	2	0	0	5	0	0
Guyana	17	3	19	77	13	88	154	25	176
Honduras	1	0	1	6	0	3	10	1	5
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 1*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 \$)	(1000 ha)	(Mt C)	(10^6 \$)	(1000 ha)	(Mt C)	(10^6 \$)
Indonesia	1	0	1	4	0	3	7	1	5
Kenya	1	0	0	3	0	0	5	0	1
Laos	2	0	0	8	0	1	16	0	2
Madagaskar	1	0	0	4	0	2	7	1	4
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	0	0	0	0	0	0	0	0	0
Malaysia	6	1	20	29	4	92	47	6	149
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	22	1	6	99	5	27	199	10	54
Mozambique	1	0	0	2	0	0	5	0	1
Myanmar	1	0	0	6	0	2	8	0	2
Nepal	0	0	0	1	0	0	1	0	0
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	1	0	1	2	0	1	2	0	1
Nigeria	0	0	0	1	0	0	1	0	0
Panama	8	2	27	34	7	122	38	8	134
Papua New Guinea	9	0	2	39	1	11	77	3	22
Paraguay	14	1	6	62	2	29	125	5	59
Peru	11	2	25	52	8	116	104	17	232
Philippines	0	0	0	2	0	1	3	0	2
Rwanda	0	0	0	0	0	0	0	0	0
Senegal	1	0	0	5	0	1	10	0	1
Sierra Leone	0	0	0	1	0	0	1	0	0
Solomon Islands	2	0	1	9	0	2	17	1	5
South Africa	4	0	4	17	1	17	35	2	34
Sudan	2	0	0	9	0	0	12	0	0
Surinam	0	0	0	0	0	0	0	0	0
Thailand	2	0	1	10	0	3	20	0	6
Tanzania	0	0	0	2	0	0	4	0	1
Uganda	0	0	0	1	0	1	1	0	1
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	11	2	33	51	8	149	102	15	298
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	3	0	1	10	1	4	10	1	4
Zimbabwe	2	0	0	10	0	2	11	0	3
Total	**360**	**31**	**517**	**1603**	**135**	**2303**	**3048**	**250**	**4308**

* The Forest conservation 1 scenario describes the conservation of a fixed percentage of the initial deforestation rate each year relative to the BAU_0 baseline assumption (1990-1995 deforestation rate, FAO, 1999).

Table 52. Potential area, carbon sequestration and costs for forest conservation scenario 2, without adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 2*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	14	2	9	14	2	9	14	2	9
Africa Developing	48	3	10	48	3	10	48	3	10
Asia Developing	15	1	4	15	1	4	15	1	4
Oceania Developing	5	0	1	5	0	1	5	0	1
South America	70	7	36	70	7	36	70	7	36
Total (excl. Macedonia)*	**152**	**13**	**59**	**152**	**13**	**59**	**152**	**13**	**59**
Angola	6	0	1	6	0	1	6	0	1
Argentina	26	1	11	26	1	11	26	1	11
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	7	1	4	7	1	4	7	1	4
Benin	0	0	0	0	0	0	0	0	0
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	5	1	2	5	1	2	5	1	2
Botswana	24	1	5	24	1	5	24	1	5
Brazil	9	1	7	9	1	7	9	1	7
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	0	0	0	0	0	0	0	0	0
Cameroon	1	0	0	1	0	0	1	0	0
Central African Republic	2	0	0	2	0	0	2	0	0
Chile	4	1	4	4	1	4	4	1	4
China	0	0	0	0	0	0	0	0	0
Colombia	2	0	1	2	0	1	2	0	1
Congo	3	0	1	3	0	1	3	0	1
Costa Rica	1	0	1	1	0	1	1	0	1
Cote d'Ivore	1	0	0	1	0	0	1	0	0
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	0	0	0	0	0	0	0	0	0
Ecuador	1	0	0	1	0	0	1	0	0
El Salvador	0	0	0	0	0	0	0	0	0
Equatorial Guinea	2	0	1	2	0	1	2	0	1
Fiji	0	0	0	0	0	0	0	0	0
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	2	0	1	2	0	1	2	0	1
Gambia	0	0	0	0	0	0	0	0	0
Ghana	0	0	0	0	0	0	0	0	0
Guatemala	1	0	0	1	0	0	1	0	0
Guinea	1	0	0	1	0	0	1	0	0
Guinea Bissau	0	0	0	0	0	0	0	0	0
Guyana	7	1	3	7	1	3	7	1	3
Honduras	1	0	0	1	0	0	1	0	0
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 2*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	0	0	0	0	0	0	0	0	0
Kenya	0	0	0	0	0	0	0	0	0
Laos	1	0	0	1	0	0	1	0	0
Madagaskar	0	0	0	0	0	0	0	0	0
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	0	0	0	0	0	0	0	0	0
Malaysia	3	0	2	3	0	2	3	0	2
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	9	0	1	9	0	1	9	0	1
Mozambique	0	0	0	0	0	0	0	0	0
Myanmar	1	0	0	1	0	0	1	0	0
Nepal	0	0	0	0	0	0	0	0	0
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	0	0	0	0	0	0	0	0	0
Nigeria	0	0	0	0	0	0	0	0	0
Panama	3	1	3	3	1	3	3	1	3
Papua New Guinea	4	0	0	4	0	0	4	0	0
Paraguay	6	0	1	6	0	1	6	0	1
Peru	5	1	3	5	1	3	5	1	3
Philippines	0	0	0	0	0	0	0	0	0
Rwanda	0	0	0	0	0	0	0	0	0
Senegal	0	0	0	0	0	0	0	0	0
Sierra Leone	0	0	0	0	0	0	0	0	0
Solomon Islands	1	0	0	1	0	0	1	0	0
South Africa	2	0	0	2	0	0	2	0	0
Sudan	1	0	0	1	0	0	1	0	0
Surinam	0	0	0	0	0	0	0	0	0
Thailand	1	0	0	1	0	0	1	0	0
Tanzania	0	0	0	0	0	0	0	0	0
Uganda	0	0	0	0	0	0	0	0	0
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	5	1	4	5	1	4	5	1	4
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	1	0	0	1	0	0	1	0	0
Zimbabwe	1	0	0	1	0	0	1	0	0
Total	**152**	**13**	**59**	**152**	**13**	**59**	**152**	**13**	**59**

* The Forest conservation 2 scenario is basically the same as Forest conservation 1, but with a single forest conservation activity in the first year and no additional conservation activities in consecutive years.

Table 53. Potential area, carbon sequestration and costs for forest conservation scenario 2, with adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 2*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	3	0	7	3	0	7	3	0	7
Africa Developing	10	1	7	10	1	7	10	1	7
Asia Developing	3	0	3	3	0	3	3	0	3
Oceania Developing	1	0	0	1	0	0	1	0	0
South America	15	1	30	15	1	30	15	1	30
Total (excl. Macedonia)*	**33**	**3**	**47**	**33**	**3**	**47**	**33**	**3**	**47**
Angola	1	0	0	1	0	0	1	0	0
Argentina	6	0	11	6	0	11	6	0	11
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	2	0	3	2	0	3	2	0	3
Benin	0	0	0	0	0	0	0	0	0
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	1	0	1	1	0	1	1	0	1
Botswana	5	0	4	5	0	4	5	0	4
Brazil	2	0	6	2	0	6	2	0	6
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	0	0	0	0	0	0	0	0	0
Cameroon	0	0	0	0	0	0	0	0	0
Central African Republic	1	0	0	1	0	0	1	0	0
Chile	1	0	4	1	0	4	1	0	4
China	0	0	0	0	0	0	0	0	0
Colombia	0	0	1	0	0	1	0	0	1
Congo	1	0	1	1	0	1	1	0	1
Costa Rica	0	0	1	0	0	1	0	0	1
Cote d'Ivore	0	0	0	0	0	0	0	0	0
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	0	0	0	0	0	0	0	0	0
Ecuador	0	0	0	0	0	0	0	0	0
El Salvador	0	0	0	0	0	0	0	0	0
Equatorial Guinea	0	0	0	0	0	0	0	0	0
Fiji	0	0	0	0	0	0	0	0	0
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	0	0	1	0	0	1	0	0	1
Gambia	0	0	0	0	0	0	0	0	0
Ghana	0	0	0	0	0	0	0	0	0
Guatemala	0	0	0	0	0	0	0	0	0
Guinea	0	0	0	0	0	0	0	0	0
Guinea Bissau	0	0	0	0	0	0	0	0	0
Guyana	2	0	2	2	0	2	2	0	2
Honduras	0	0	0	0	0	0	0	0	0
India	0	0	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0	0	0
Kenya	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 2*, with adoption of all criteria

Countries	forest area saved 2008-2012	Total sink gained in 2008-2012	costs 2008-2012	forest area saved 2000-2050	Total sink gained in 2000-2050	costs 2000-2050	forest area saved 2000-2100	Total sink gained in 2000-2100	costs 2000-2100
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Laos	0	0	0	0	0	0	0	0	0
Madagaskar	0	0	0	0	0	0	0	0	0
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	0	0	0	0	0	0	0	0	0
Malaysia	1	0	2	1	0	2	1	0	2
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	2	0	1	2	0	1	2	0	1
Mozambique	0	0	0	0	0	0	0	0	0
Myanmar	0	0	0	0	0	0	0	0	0
Nepal	0	0	0	0	0	0	0	0	0
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	0	0	0	0	0	0	0	0	0
Nigeria	0	0	0	0	0	0	0	0	0
Panama	1	0	2	1	0	2	1	0	2
Papua New Guinea	1	0	0	1	0	0	1	0	0
Paraguay	1	0	1	1	0	1	1	0	1
Peru	1	0	2	1	0	2	1	0	2
Philippines	0	0	0	0	0	0	0	0	0
Rwanda	0	0	0	0	0	0	0	0	0
Senegal	0	0	0	0	0	0	0	0	0
Sierra Leone	0	0	0	0	0	0	0	0	0
Solomon Islands	0	0	0	0	0	0	0	0	0
South Africa	0	0	0	0	0	0	0	0	0
Sudan	0	0	0	0	0	0	0	0	0
Surinam	0	0	0	0	0	0	0	0	0
Thailand	0	0	0	0	0	0	0	0	0
Tanzania	0	0	0	0	0	0	0	0	0
Uganda	0	0	0	0	0	0	0	0	0
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	1	0	3	1	0	3	1	0	3
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	0	0	0	0	0	0	0	0	0
Zimbabwe	0	0	0	0	0	0	0	0	0
Total	**33**	**3**	**47**	**33**	**3**	**47**	**33**	**3**	**47**

* The Forest conservation 2 scenario is basically the same as Forest conservation 1, but with a single forest conservation activity in the first year and no additional conservation activities in consecutive years.

Table 54. Potential area, carbon sequestration and costs for forest conservation scenario 3, without adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 3*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	615	96	404	4995	834	3438	7197	1086	4405
Africa Developing	2151	122	427	20206	1107	3570	46762	2610	8220
Asia Developing	751	50	204	9086	659	2983	22344	1539	7020
Oceania Developing	257	10	29	3163	119	348	8561	323	939
South America	3760	377	1936	46015	4958	24994	132072	15012	75749
Total (excl. Macedonia)*	**7535**	**655**	**2999**	**83465**	**7677**	**35333**	**216936**	**20570**	**96333**
Angola	321	11	37	3850	135	444	9821	345	1131
Argentina	1292	57	533	11450	506	4721	25677	1135	10586
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	264	36	153	1188	163	687	1188	163	687
Benin	19	2	6	191	24	59	191	24	59
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	291	35	99	3997	475	1366	11172	1329	3818
Botswana	867	35	172	5428	222	1077	11328	464	2247
Brazil	591	80	469	10860	1475	8612	40410	5490	32044
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	13	1	1	236	11	25	883	40	94
Cameroon	48	4	11	898	76	199	3370	287	748
Central African Republic	123	9	22	1159	85	205	2654	195	468
Chile	147	26	149	920	160	931	1920	334	1942
China	0	0	0	0	0	0	0	0	0
Colombia	136	17	64	2288	291	1077	7694	980	3621
Congo	117	16	43	771	107	282	1621	224	593
Costa Rica	73	10	45	644	92	393	1443	206	881
Cote d'Ivore	42	4	10	219	19	50	219	19	50
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	14	2	4	260	38	84	1024	150	332
Ecuador	83	8	27	1421	139	455	3098	304	993
El Salvador	13	1	3	29	2	6	29	2	6
Equatorial Guinea	81	8	24	506	52	148	1056	108	310
Fiji	15	1	2	92	3	14	192	7	29
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	73	7	35	460	41	221	960	85	462
Gambia	0	0	0	0	0	0	0	0	0
Ghana	12	1	2	221	13	31	239	14	33
Guatemala	33	8	26	572	138	446	615	148	479
Guinea	45	3	9	684	51	131	2065	153	394
Guinea Bissau	14	0	0	240	3	7	805	10	24
Guyana	302	50	137	2162	356	979	4612	758	2088
Honduras	33	2	6	570	39	106	1680	115	312
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 3*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	25	2	7	482	43	129	1220	108	326
Kenya	17	1	1	310	10	23	1176	37	88
Laos	45	1	2	744	15	37	2432	49	121
Madagaskar	23	3	7	419	53	122	1582	199	461
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	4	0	1	38	4	8	38	4	8
Malaysia	171	23	132	2874	383	2221	6746	899	5214
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	382	20	49	2669	139	339	5669	295	720
Mozambique	14	0	1	257	9	21	967	35	77
Myanmar	38	1	4	731	27	80	1260	47	137
Nepal	3	0	1	64	5	10	64	5	10
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	26	3	7	158	17	41	158	17	41
Nigeria	5	1	1	45	5	12	45	5	12
Panama	172	36	165	1833	384	1759	2084	436	2000
Papua New Guinea	213	8	23	2887	109	314	7985	301	870
Paraguay	327	13	47	3876	149	554	9820	377	1402
Peru	301	48	193	4689	747	3005	14604	2326	9357
Philippines	12	1	3	231	17	53	385	28	88
Rwanda	2	0	1	6	1	2	6	1	2
Senegal	29	1	1	501	10	25	1707	33	86
Sierra Leone	6	1	1	39	3	8	39	3	8
Solomon Islands	29	1	3	184	7	19	384	14	40
South Africa	59	3	15	368	19	95	768	40	198
Sudan	55	0	1	1051	8	19	1708	13	31
Surinam	0	0	0	0	0	0	0	0	0
Thailand	61	1	5	1057	20	89	3686	69	309
Tanzania	13	1	1	243	9	22	929	36	82
Uganda	8	1	2	130	14	33	130	14	33
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	291	44	220	4352	659	3297	13065	1979	9897
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	84	6	14	837	57	138	837	57	138
Zimbabwe	58	2	6	1074	39	104	1479	54	143
Total	**7535**	**655**	**2999**	**83465**	**7677**	**35333**	**216936**	**20570**	**96333**

* Forest conservation 3 scenario is the most ambitious scenario, in that it aims for a maximum reduction in the deforestation rates in time. In this scenario the actual deforestation rate decreases by a fixed percentage each year relative to the BAU_0 baseline scenario.

Table 55. Potential area, carbon sequestration and costs for forest conservation scenario 3, with adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 3*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America / Caribbean	176	27	406	2021	334	5018	3083	473	7000
Africa Developing	624	35	419	8525	473	5393	23478	1303	14513
Asia Developing	199	13	167	3111	208	2950	8658	548	7650
Oceania Developing	65	2	20	1066	40	321	3623	137	1080
South America	950	94	1900	15581	1565	31310	51948	5328	106158
Total (excl. Macedonia)*	**2013**	**172**	**2911**	**30305**	**2619**	**44992**	**90791**	**7789**	**136401**
Angola	78	3	27	1330	47	460	4556	160	1575
Argentina	349	15	664	5333	236	10149	16304	721	31027
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	89	12	183	690	95	1419	690	95	1419
Benin	4	1	3	43	5	28	43	5	28
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	68	8	61	1207	144	1092	4325	514	3911
Botswana	292	12	221	3574	146	2697	9218	377	6957
Brazil	129	18	419	2465	335	7997	9626	1308	31233
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	3	0	1	53	2	12	208	9	45
Cameroon	11	1	6	202	17	106	792	67	413
Central African Republic	32	2	12	506	37	187	1590	117	586
Chile	50	9	205	606	106	2503	1562	272	6456
China	0	0	0	0	0	0	0	0	0
Colombia	30	4	47	567	72	874	2158	275	3330
Congo	38	5	33	484	67	425	1282	177	1125
Costa Rica	20	3	43	301	43	659	920	132	2009
Cote d'Ivore	9	1	5	48	4	27	48	4	27
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	3	0	2	56	8	33	223	33	131
Ecuador	18	2	18	345	34	330	797	78	764
El Salvador	3	0	2	7	0	4	7	0	4
Equatorial Guinea	27	3	21	333	34	257	859	88	663
Fiji	5	0	3	61	2	32	156	6	83
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	25	2	47	303	27	580	781	70	1495
Gambia	0	0	0	0	0	0	0	0	0
Ghana	3	0	1	49	3	15	53	3	16
Guatemala	7	2	17	139	34	322	150	36	347
Guinea	10	1	5	188	14	83	695	51	308
Guinea Bissau	3	0	0	58	1	3	219	3	13
Guyana	92	15	105	1245	205	1422	3451	568	3940
Honduras	7	0	3	137	9	63	439	30	202
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 3*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	5	0	4	104	9	78	265	23	198
Kenya	4	0	1	69	2	11	272	8	42
Laos	10	0	1	189	4	20	714	14	77
Madagaskar	5	1	3	94	12	53	368	46	209
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	1	0	0	8	1	3	8	1	3
Malaysia	38	5	120	713	95	2249	1811	241	5714
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	118	6	32	1574	82	429	4309	224	1176
Mozambique	3	0	0	58	2	8	227	8	33
Myanmar	8	0	2	160	6	47	277	10	82
Nepal	1	0	0	14	1	4	14	1	4
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	6	1	3	35	4	19	35	4	19
Nigeria	1	0	1	10	1	5	10	1	5
Panama	43	9	154	711	149	2532	842	176	2998
Papua New Guinea	50	2	14	884	33	256	3154	119	914
Paraguay	79	3	37	1354	52	638	4621	177	2176
Peru	68	11	151	1252	199	2775	4660	742	10332
Philippines	3	0	2	51	4	33	86	6	56
Rwanda	0	0	0	1	0	1	1	0	1
Senegal	7	0	1	123	2	14	469	9	55
Sierra Leone	1	0	0	9	1	3	9	1	3
Solomon Islands	10	0	3	121	5	32	312	12	83
South Africa	20	1	20	242	13	239	625	33	617
Sudan	12	0	0	230	2	8	374	3	14
Surinam	0	0	0	0	0	0	0	0	0
Thailand	13	0	4	253	5	78	974	18	298
Tanzania	3	0	0	54	2	9	212	8	36
Uganda	2	0	1	29	3	15	29	3	15
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	66	10	194	1208	183	3530	4444	673	12988
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	18	1	6	183	12	65	183	12	65
Zimbabwe	13	0	3	240	9	56	333	12	78
Total	**2013**	**172**	**2911**	**30305**	**2619**	**44992**	**90791**	**7789**	**136401**

* Forest conservation 3 scenario is the most ambitious scenario, in that it aims for a maximum reduction in the deforestation rates in time. In this scenario the actual deforestation rate decreases by a fixed percentage each year relative to the BAU_0 baseline scenario.

Table 56. Potential area, carbon sequestration and costs for forest conservation scenario 4, without adoption of criteria, a 25% precision level and with banking from 2002 onwards

Forest Conservation scenario 4*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	87	14	57	157	25	102	170	26	105
Africa Developing	302	17	58	622	35	105	755	43	125
Asia Developing	111	8	32	296	22	103	404	30	142
Oceania Developing	39	1	4	96	4	11	114	4	13
South America	570	58	295	1442	162	813	2000	238	1200
Total (excl. Macedonia)*	**1109**	**98**	**447**	**2613**	**248**	**1134**	**3443**	**341**	**1585**
Angola	50	2	6	112	4	13	123	4	14
Argentina	186	8	77	283	12	117	285	13	117
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	33	5	19	36	5	21	36	5	21
Benin	3	0	1	10	1	3	10	1	3
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	46	5	16	126	15	43	154	18	52
Botswana	108	4	21	118	5	23	118	5	23
Brazil	98	13	78	413	56	327	751	102	596
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	2	0	0	9	0	1	17	1	2
Cameroon	8	1	2	34	3	8	63	5	14
Central African Republic	18	1	3	30	2	5	30	2	5
Chile	18	3	18	20	3	20	20	3	20
China	0	0	0	0	0	0	0	0	0
Colombia	22	3	10	82	10	39	129	16	61
Congo	15	2	5	17	2	6	17	2	6
Costa Rica	11	2	6	16	2	10	16	2	10
Cote d'Ivore	7	1	2	16	1	4	16	1	4
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	2	0	1	10	1	3	20	3	7
Ecuador	14	1	4	52	5	17	71	7	23
El Salvador	2	0	0	3	0	1	3	0	1
Equatorial Guinea	10	1	3	11	1	3	11	1	3
Fiji	2	0	0	2	0	0	2	0	0
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	9	1	4	10	1	5	10	1	5
Gambia	0	0	0	0	0	0	0	0	0
Ghana	2	0	0	9	0	1	9	1	1
Guatemala	5	1	4	21	5	16	21	5	17
Guinea	7	1	1	23	2	4	31	2	6
Guinea Bissau	2	0	0	9	0	0	14	0	0
Guyana	40	7	18	49	8	22	49	8	22
Honduras	5	0	1	21	1	4	32	2	6
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 4*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 \$)	(1000 ha)	(Mt C)	(10^6 \$)	(1000 ha)	(Mt C)	(10^6 \$)
Indonesia	4	0	1	19	2	5	30	3	8
Kenya	3	0	0	12	0	1	22	1	2
Laos	7	0	0	26	1	1	40	1	2
Madagaskar	4	0	1	16	2	5	30	4	9
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	1	0	0	2	0	0	2	0	0
Malaysia	28	4	22	103	14	80	143	19	111
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	50	3	6	60	3	8	60	3	8
Mozambique	2	0	0	10	0	1	18	1	1
Myanmar	6	0	1	28	1	3	37	1	4
Nepal	1	0	0	2	0	0	2	0	0
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	4	0	1	11	1	3	11	1	3
Nigeria	1	0	0	3	0	1	3	0	1
Panama	26	5	25	50	10	48	50	11	48
Papua New Guinea	34	1	4	90	3	10	108	4	12
Paraguay	50	2	7	112	4	16	122	5	17
Peru	49	8	31	160	26	103	225	36	144
Philippines	2	0	0	9	1	2	11	1	3
Rwanda	0	0	0	1	0	0	1	0	0
Senegal	5	0	0	18	0	1	29	1	1
Sierra Leone	1	0	0	3	0	1	3	0	1
Solomon Islands	4	0	0	4	0	0	4	0	0
South Africa	7	0	2	8	0	2	8	0	2
Sudan	9	0	0	41	0	1	52	0	1
Surinam	0	0	0	0	0	0	0	0	0
Thailand	10	0	1	39	1	3	64	1	5
Tanzania	2	0	0	9	0	1	18	1	2
Uganda	1	0	0	5	1	1	5	1	1
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	47	7	35	145	22	110	194	29	147
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	14	1	2	45	3	7	45	3	7
Zimbabwe	10	0	1	41	1	4	48	2	5
Total	**1109**	**98**	**447**	**2613**	**248**	**1134**	**3443**	**341**	**1585**

* In Forest conservation 4 scenario, the actual deforestation rate decreases by a fixed percentage each year, but the baseline is redefined every year according to the results gained in the previous year.

Table 57. Potential area, carbon sequestration and costs for forest conservation scenario 4, with adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 4*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America / Caribbean	28	4	65	78	13	188	88	14	205
Africa Developing	99	6	66	285	16	171	375	21	210
Asia Developing	32	2	27	108	7	110	155	11	168
Oceania Developing	11	0	3	38	1	11	62	2	18
South America	154	15	309	555	56	1121	886	93	1835
Total (excl. Macedonia)*	**324**	**28**	**470**	**1065**	**94**	**1602**	**1566**	**141**	**2435**
Angola	13	0	4	48	2	17	78	3	27
Argentina	56	2	107	180	8	343	246	11	469
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	14	2	28	29	4	60	29	4	60
Benin	1	0	0	2	0	1	2	0	1
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	11	1	10	45	5	41	77	9	70
Botswana	45	2	34	105	4	79	117	5	88
Brazil	21	3	70	96	13	311	188	26	610
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	0	0	0	2	0	0	4	0	1
Cameroon	2	0	1	8	1	4	15	1	8
Central African Republic	5	0	2	17	1	6	25	2	9
Chile	8	1	32	18	3	74	20	3	82
China	0	0	0	0	0	0	0	0	0
Colombia	5	1	8	22	3	34	41	5	63
Congo	6	1	5	15	2	13	17	2	15
Costa Rica	3	0	7	10	1	22	14	2	30
Cote d'Ivore	2	0	1	4	0	2	4	0	2
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	0	0	0	2	0	1	4	1	3
Ecuador	3	0	3	13	1	13	20	2	19
El Salvador	1	0	0	1	0	0	1	0	0
Equatorial Guinea	4	0	3	10	1	8	11	1	8
Fiji	1	0	0	2	0	1	2	0	1
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	4	0	7	9	1	17	10	1	19
Gambia	0	0	0	0	0	0	0	0	0
Ghana	0	0	0	2	0	1	2	0	1
Guatemala	1	0	3	5	1	12	6	1	13
Guinea	2	0	1	7	1	3	13	1	6
Guinea Bissau	1	0	0	2	0	0	4	0	0
Guyana	15	2	17	39	6	45	47	8	54
Honduras	1	0	1	5	0	2	9	1	4
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 4*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	1	0	1	4	0	3	7	1	5
Kenya	1	0	0	3	0	0	5	0	1
Laos	2	0	0	7	0	1	13	0	1
Madagaskar	1	0	0	4	0	2	7	1	4
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	0	0	0	0	0	0	0	0	0
Malaysia	6	1	20	27	4	86	43	6	135
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	19	1	5	49	3	13	58	3	16
Mozambique	1	0	0	2	0	0	4	0	1
Myanmar	1	0	0	6	0	2	8	0	2
Nepal	0	0	0	1	0	0	1	0	0
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	1	0	1	2	0	1	2	0	1
Nigeria	0	0	0	1	0	0	1	0	0
Panama	7	1	25	25	5	90	27	6	96
Papua New Guinea	8	0	2	33	1	10	56	2	16
Paraguay	13	0	6	49	2	23	79	3	37
Peru	11	2	25	48	8	105	87	14	192
Philippines	0	0	0	2	0	1	3	0	2
Rwanda	0	0	0	0	0	0	0	0	0
Senegal	1	0	0	5	0	1	9	0	1
Sierra Leone	0	0	0	1	0	0	1	0	0
Solomon Islands	2	0	0	4	0	1	4	0	1
South Africa	3	0	3	7	0	7	8	0	8
Sudan	2	0	0	9	0	0	11	0	0
Surinam	0	0	0	0	0	0	0	0	0
Thailand	2	0	1	10	0	3	19	0	6
Tanzania	0	0	0	2	0	0	4	0	1
Uganda	0	0	0	1	0	1	1	0	1
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	11	2	32	46	7	133	82	12	239
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	3	0	1	10	1	3	10	1	3
Zimbabwe	2	0	0	9	0	2	11	0	3
Total	**324**	**28**	**470**	**1065**	**94**	**1602**	**1566**	**141**	**2435**

* In Forest conservation 4 scenario, the <u>actual</u> deforestation rate decreases by a fixed percentage each year, but the baseline is redefined every year according to the results gained in the previous year.

Table 58. Potential area, carbon sequestration and costs for forest conservation scenario 5, without adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 5*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	270	43	178	496	80	322	533	83	331
Africa Developing	944	54	185	1948	109	333	2347	134	394
Asia Developing	336	23	93	911	68	315	1235	91	431
Oceania Developing	116	4	13	298	11	33	353	13	39
South America	1699	171	877	4441	498	2494	6123	725	3661
Total (excl. Macedonia)*	**3366**	**294**	**1346**	**8093**	**765**	**3497**	**10592**	**1046**	**4855**
Angola	146	5	17	346	12	40	380	13	44
Argentina	572	25	236	902	40	372	910	40	375
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	111	15	64	124	17	72	124	17	72
Benin	9	1	3	29	4	9	29	4	9
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	134	16	46	387	46	132	470	56	161
Botswana	365	15	72	406	17	80	406	17	80
Brazil	277	38	220	1241	169	984	2260	307	1792
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	6	0	1	27	1	3	50	2	5
Cameroon	23	2	5	103	9	23	190	16	42
Central African Republic	55	4	10	93	7	16	95	7	17
Chile	62	11	63	69	12	70	69	12	70
China	0	0	0	0	0	0	0	0	0
Colombia	63	8	30	248	32	117	389	50	183
Congo	50	7	18	58	8	21	58	8	21
Costa Rica	32	5	20	51	7	31	51	7	31
Cote d'Ivore	20	2	4	47	4	11	47	4	11
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	6	1	2	31	4	10	60	9	20
Ecuador	39	4	12	156	15	50	212	21	68
El Salvador	6	0	1	9	0	2	9	0	2
Equatorial Guinea	34	3	10	38	4	11	38	4	11
Fiji	6	0	1	7	0	1	7	0	1
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	31	3	15	34	3	17	34	3	17
Gambia	0	0	0	0	0	0	0	0	0
Ghana	5	0	1	26	1	4	26	1	4
Guatemala	16	4	12	63	15	49	64	15	50
Guinea	21	2	4	70	5	13	94	7	18
Guinea Bissau	7	0	0	26	0	1	42	1	1
Guyana	130	21	59	162	27	73	162	27	73
Honduras	15	1	3	63	4	12	97	7	18
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 5*, without adoption of criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	12	1	3	57	5	15	90	8	24
Kenya	8	0	1	36	1	3	67	2	5
Laos	21	0	1	79	2	4	120	2	6
Madagaskar	11	1	3	48	6	14	90	11	26
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	2	0	0	6	1	1	6	1	1
Malaysia	80	11	62	312	42	241	430	57	333
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	164	9	21	200	10	25	200	10	25
Mozambique	7	0	1	30	1	2	55	2	4
Myanmar	18	1	2	85	3	9	110	4	12
Nepal	2	0	0	7	1	1	7	1	1
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	12	1	3	31	3	8	31	3	8
Nigeria	2	0	1	8	1	2	8	1	2
Panama	78	16	74	156	33	149	157	33	151
Papua New Guinea	98	4	11	277	10	30	332	13	36
Paraguay	149	6	21	346	13	49	378	14	54
Peru	140	22	89	487	78	312	684	109	438
Philippines	6	0	1	27	2	6	34	3	8
Rwanda	1	0	0	2	0	0	2	0	0
Senegal	14	0	1	55	1	3	87	2	4
Sierra Leone	3	0	1	7	1	2	7	1	2
Solomon Islands	12	0	1	14	1	1	14	1	1
South Africa	25	1	6	27	1	7	27	1	7
Sudan	26	0	0	123	1	2	155	1	3
Surinam	0	0	0	0	0	0	0	0	0
Thailand	28	1	2	117	2	10	193	4	16
Tanzania	6	0	1	28	1	2	53	2	5
Uganda	4	0	1	16	2	4	16	2	4
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	134	20	102	442	67	335	590	89	447
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	39	3	7	132	9	22	132	9	22
Zimbabwe	27	1	3	124	5	12	143	5	14
Total	**3366**	**294**	**1346**	**8093**	**765**	**3497**	**10592**	**1046**	**4855**

* In Forest conservation scenario 5, the actual deforestation rate decreases by a fixed percentage each year as in scenario 4, but the baseline is redefined after every commitment period (5 years), instead of annually.

Table 59. Potential area, carbon sequestration and costs for forest conservation scenario 5, with adoption of criteria, a 25% precision level and banking from 2002 onwards

Forest Conservation scenario 5*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
C. America/Caribbean	81	13	187	237	38	571	265	42	620
Africa Developing	287	16	192	868	48	523	1138	63	641
Asia Developing	92	6	78	328	22	332	468	32	503
Oceania Developing	30	1	9	115	4	35	188	7	56
South America	442	44	884	1680	170	3391	2678	281	5540
Total (excl. Macedonia)*	**932**	**80**	**1350**	**3229**	**284**	**4852**	**4737**	**425**	**7359**
Angola	36	1	13	146	5	50	235	8	81
Argentina	162	7	308	548	24	1042	749	33	1426
Bangladesh	0	0	0	0	0	0	0	0	0
Belize	41	6	84	88	12	182	88	12	182
Benin	2	0	1	7	1	4	7	1	4
Bhutan	0	0	0	0	0	0	0	0	0
Bolivia	32	4	29	135	16	122	233	28	211
Botswana	133	5	101	324	13	245	360	15	272
Brazil	61	8	196	288	39	935	564	77	1831
Burundi	0	0	0	0	0	0	0	0	0
Cambodia	1	0	0	6	0	1	12	1	3
Cameroon	5	0	3	24	2	12	46	4	24
Central African Republic	15	1	6	53	4	19	75	6	28
Chile	23	4	93	55	10	227	61	11	252
China	0	0	0	0	0	0	0	0	0
Colombia	14	2	22	65	8	101	123	16	190
Congo	17	2	15	45	6	39	51	7	45
Costa Rica	9	1	20	31	4	68	42	6	92
Cote d'Ivore	4	0	2	10	1	6	10	1	6
Cuba	0	0	0	0	0	0	0	0	0
Democratic Republic of Congo	1	0	1	7	1	4	13	2	8
Ecuador	9	1	8	40	4	38	59	6	57
El Salvador	1	0	1	2	0	1	2	0	1
Equatorial Guinea	12	1	10	30	3	23	34	3	26
Fiji	2	0	1	5	0	3	6	0	3
French Guyana	0	0	0	0	0	0	0	0	0
Gabon	11	1	22	27	2	53	31	3	58
Gambia	0	0	0	0	0	0	0	0	0
Ghana	1	0	0	6	0	2	6	0	2
Guatemala	3	1	8	16	4	37	16	4	38
Guinea	5	0	2	21	2	9	39	3	17
Guinea Bissau	1	0	0	7	0	0	13	0	1
Guyana	42	7	48	120	20	137	144	24	164
Honduras	3	0	2	16	1	7	28	2	13
India	0	0	0	0	0	0	0	0	0

Forest Conservation scenario 5*, with adoption of all criteria									
Countries	**forest area saved 2008-2012**	**Total sink gained in 2008-2012**	**costs 2008-2012**	**forest area saved 2000-2050**	**Total sink gained in 2000-2050**	**costs 2000-2050**	**forest area saved 2000-2100**	**Total sink gained in 2000-2100**	**costs 2000-2100**
	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)	(1000 ha)	(Mt C)	(10^6 $)
Indonesia	3	0	2	12	1	9	20	2	15
Kenya	2	0	0	8	0	1	16	0	2
Laos	5	0	1	22	0	2	41	1	4
Madagaskar	2	0	1	11	1	6	22	3	12
Macedonia	0	0	0	0	0	0	0	0	0
Malawi	0	0	0	1	0	1	1	0	1
Malaysia	18	2	56	82	11	260	128	17	402
Mexico	0	0	0	0	0	0	0	0	0
Mongolia	54	3	15	150	8	41	178	9	48
Mozambique	1	0	0	7	0	1	13	0	2
Myanmar	4	0	1	19	1	6	25	1	7
Nepal	0	0	0	2	0	1	2	0	1
New Caledonia	0	0	0	0	0	0	0	0	0
Nicaragua	3	0	1	7	1	4	7	1	4
Nigeria	1	0	0	2	0	1	2	0	1
Panama	20	4	72	76	16	271	81	17	290
Papua New Guinea	23	1	7	99	4	29	169	6	49
Paraguay	37	1	17	148	6	70	237	9	112
Peru	32	5	71	143	23	317	261	42	578
Philippines	1	0	1	6	0	4	8	1	5
Rwanda	0	0	0	0	0	0	0	0	0
Senegal	3	0	0	14	0	2	27	1	3
Sierra Leone	1	0	0	2	0	1	2	0	1
Solomon Islands	5	0	1	11	0	3	12	0	3
South Africa	9	0	9	22	1	22	24	1	24
Sudan	6	0	0	27	0	1	34	0	1
Surinam	0	0	0	0	0	0	0	0	0
Thailand	6	0	2	29	1	9	56	1	17
Tanzania	1	0	0	6	0	1	12	0	2
Uganda	1	0	0	4	0	2	4	0	2
Uruguay	0	0	0	0	0	0	0	0	0
Venezuela	31	5	91	137	21	401	246	37	719
Vietnam	0	0	0	0	0	0	0	0	0
Zambia	9	1	3	29	2	10	29	2	10
Zimbabwe	6	0	1	28	1	7	33	1	8
Total	**932**	**80**	**1350**	**3229**	**284**	**4852**	**4737**	**425**	**7359**

* In Forest conservation scenario 5, the actual deforestation rate decreases by a fixed percentage each year as in scenario 4, but the baseline is redefined after every commitment period (5 years), instead of annually.

Table 60. Costs for af-/reforestation and forest conservation projects, expressed in US$ per tonne C

Countries	Af-/reforestation costs (20% precision, no criteria, US$ tonne^{-1} C)	Af-/reforestation costs (20% precision, with criteria, US$ tonne^{-1} C)	Af-/reforestation costs (20% precision, project failure rates, US$ tonne^{-1} C)	Forest conservation costs (20% precision, no criteria, US$ tonne^{-1} C)	Forest conservation costs (20% precision, with criteria, US$ tonne^{-1} C)	Forest conservation costs (20% precision, project failure rates, US$ tonne^{-1} C)
C. America/Caribbean	3.57	13.06	7.20	3.71	12.10	7.48
Africa Developing	2.68	7.31	17.35	2.74	6.80	17.72
Asia Developing	2.89	8.63	7.05	2.96	8.02	7.24
Oceania Developing	3.19	10.55	11.89	3.29	9.79	12.27
South America	5.91	28.25	14.13	6.27	26.10	14.98
Total (excl. Macedonia)*	**3.43**	**12.14**	**14.27**	**3.56**	**11.26**	**14.63**
Angola	3.20	10.64	24.60	3.30	9.87	25.40
Argentina	8.76	46.73	21.91	9.38	43.11	23.46
Bangladesh	2.40	5.44	8.88	2.43	5.09	8.99
Belize	4.06	16.23	13.53	4.24	15.02	14.15
Benin	2.42	5.59	14.23	2.45	5.22	14.42
Bhutan	2.45	5.78	3.18	2.48	5.39	3.23
Bolivia	2.82	8.19	9.73	2.89	7.62	9.97
Botswana	4.64	19.96	8.92	4.87	18.46	9.37
Brazil	5.55	25.89	12.61	5.87	23.92	13.35
Burundi	2.24	4.41	18.65	2.25	4.13	18.77
Cambodia	2.36	5.20	15.73	2.39	4.86	15.91
Cameroon	2.58	6.60	16.10	2.62	6.15	16.39
Central African Republic	2.39	5.39	23.89	2.42	5.04	24.18
Chile	5.52	25.72	8.37	5.84	23.76	8.85
China	2.64	7.00	4.47	2.69	6.52	4.56
Colombia	3.58	13.10	8.73	3.72	12.14	9.07
Congo	2.61	6.82	23.73	2.66	6.36	24.18
Costa Rica	4.11	16.54	9.34	4.30	15.30	9.76
Cote d'Ivore	2.68	7.29	12.19	2.74	6.78	12.44
Cuba	3.27	11.08	23.34	3.38	10.28	24.12
Democratic Republic of Congo	2.22	4.27	22.17	2.23	4.01	22.30
Ecuador	3.18	10.54	15.92	3.29	9.78	16.43
El Salvador	3.41	11.99	8.73	3.53	11.11	9.05
Equatorial Guinea	2.81	8.10	18.71	2.87	7.53	19.16
Fiji	3.90	15.21	15.61	4.07	14.08	16.29
French Guyana	22.92	138.52	24.64	24.85	127.65	26.72
Gabon	5.15	23.29	23.41	5.43	21.53	24.70
Gambia	2.39	5.39	23.90	2.42	5.04	24.19
Ghana	2.42	5.60	8.97	2.45	5.23	9.09
Guatemala	3.15	10.35	9.56	3.25	9.60	9.86
Guinea	2.55	6.43	16.99	2.59	5.99	17.28
Guinea Bissau	2.31	4.85	23.06	2.33	4.54	23.28
Guyana	2.71	7.48	13.55	2.77	6.96	13.85
Honduras	2.68	7.27	11.16	2.73	6.77	11.39
India	2.43	5.64	5.06	2.46	5.27	5.13
Indonesia	2.96	9.10	11.84	3.04	8.45	12.17

Countries	Af-/reforestation costs (20% precision, no criteria, US$ tonne^{-1} C)	Af-/reforestation costs (20% precision, with criteria, US$ tonne^{-1} C)	Af-/reforestation costs (20% precision, project failure rates, US$ tonne^{-1} C)	Forest conservation costs (20% precision, no criteria, US$ tonne^{-1} C)	Forest conservation costs (20% precision, with criteria, US$ tonne^{-1} C)	Forest conservation costs (20% precision, project failure rates, US$ tonne^{-1} C)
Kenya	2.38	5.33	9.92	2.41	4.99	10.04
Laos	2.44	5.75	24.44	2.48	5.37	24.78
Madagaskar	2.30	4.84	23.04	2.33	4.53	23.25
Macedonia	2.93	8.89	5.18	3.01	8.26	5.32
Malawi	2.25	4.51	11.86	2.27	4.23	11.95
Malaysia	5.52	25.67	9.35	5.84	23.72	9.89
Mexico	4.63	19.95	8.13	4.87	18.44	8.55
Mongolia	2.43	5.63	3.49	2.46	5.26	3.54
Mozambique	2.23	4.36	11.74	2.24	4.09	11.81
Myanmar	2.89	8.63	18.05	2.96	8.02	18.52
Nepal	2.28	4.70	8.45	2.30	4.40	8.52
New Caledonia	3.27	11.08	32.67	3.38	10.28	33.77
Nicaragua	2.44	5.72	15.25	2.47	5.34	15.46
Nigeria	2.31	4.89	12.84	2.33	4.57	12.96
Panama	4.40	18.42	9.77	4.61	17.04	10.25
Papua New Guinea	2.84	8.29	10.13	2.91	7.71	10.38
Paraguay	3.60	13.27	12.02	3.75	12.30	12.49
Peru	3.88	15.06	9.95	4.05	13.95	10.38
Philippines	3.02	9.46	7.02	3.10	8.79	7.22
Rwanda	2.29	4.73	45.75	2.31	4.43	46.14
Senegal	2.55	6.44	11.09	2.59	6.00	11.28
Sierra Leone	2.24	4.45	24.94	2.26	4.17	25.11
Solomon Islands	2.73	7.63	18.23	2.80	7.10	18.64
South Africa	4.69	20.31	9.19	4.93	18.77	9.67
Sudan	2.32	4.97	23.24	2.35	4.65	23.47
Surinam	2.84	8.33	4.78	2.91	7.75	4.90
Thailand	4.27	17.57	8.54	4.47	16.26	8.94
Tanzania	2.27	4.61	11.35	2.29	4.32	11.44
Uganda	2.38	5.32	10.81	2.41	4.97	10.93
Uruguay	6.73	33.57	13.20	7.17	30.99	14.05
Venezuela	4.78	20.91	13.28	5.03	19.33	13.98
Vietnam	2.36	5.18	8.13	2.38	4.85	8.22
Zambia	2.42	5.61	15.15	2.46	5.24	15.35
Zimbabwe	2.63	6.94	16.42	2.68	6.46	16.74
Total	**3.43**	**12.14**	**14.27**	**3.56**	**11.26**	**14.63**

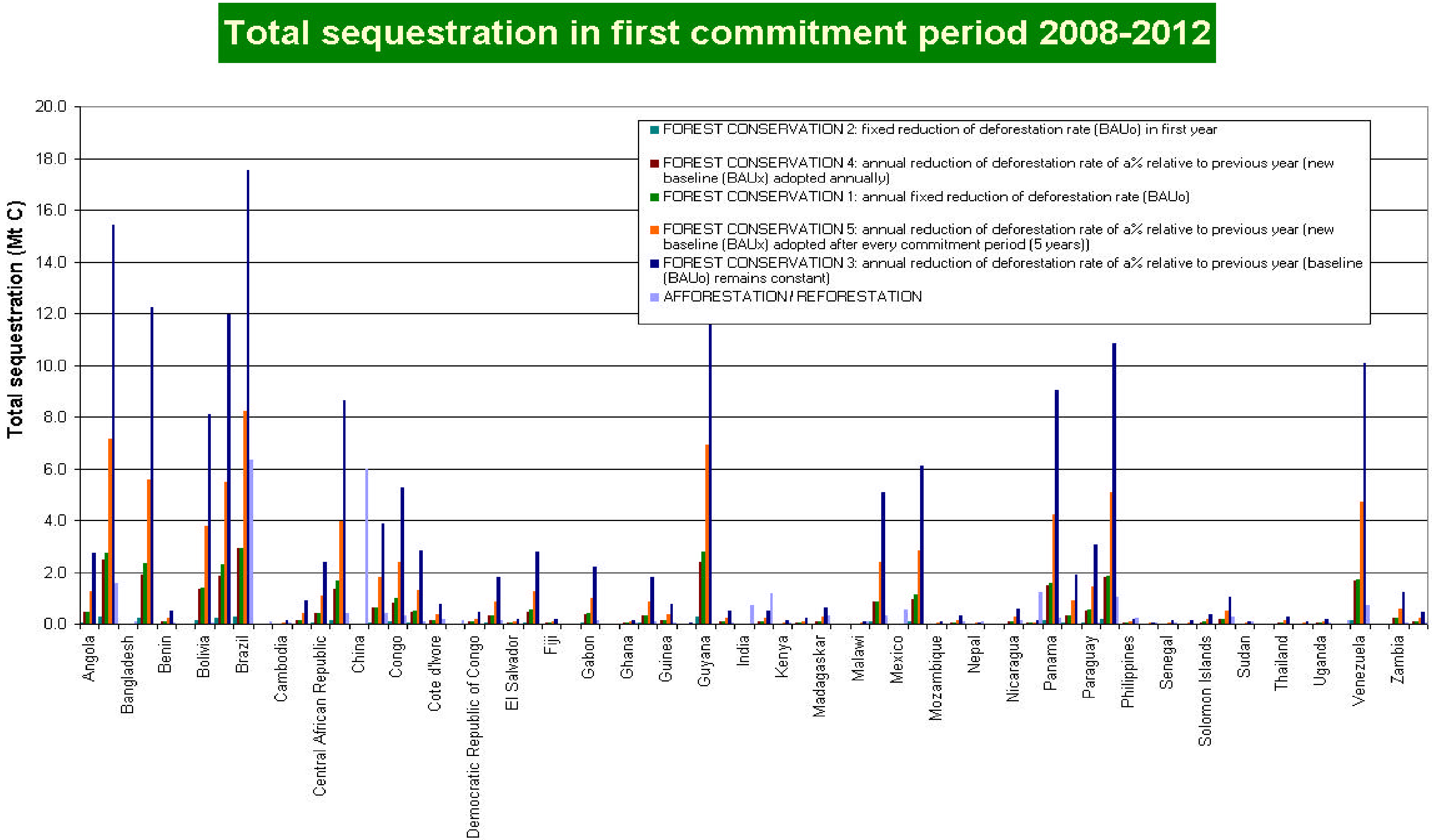

Figure 11. Carbon sequestration potentials for the different countries in the first commitment period, all criteria applied and banking from 2002 onwards.

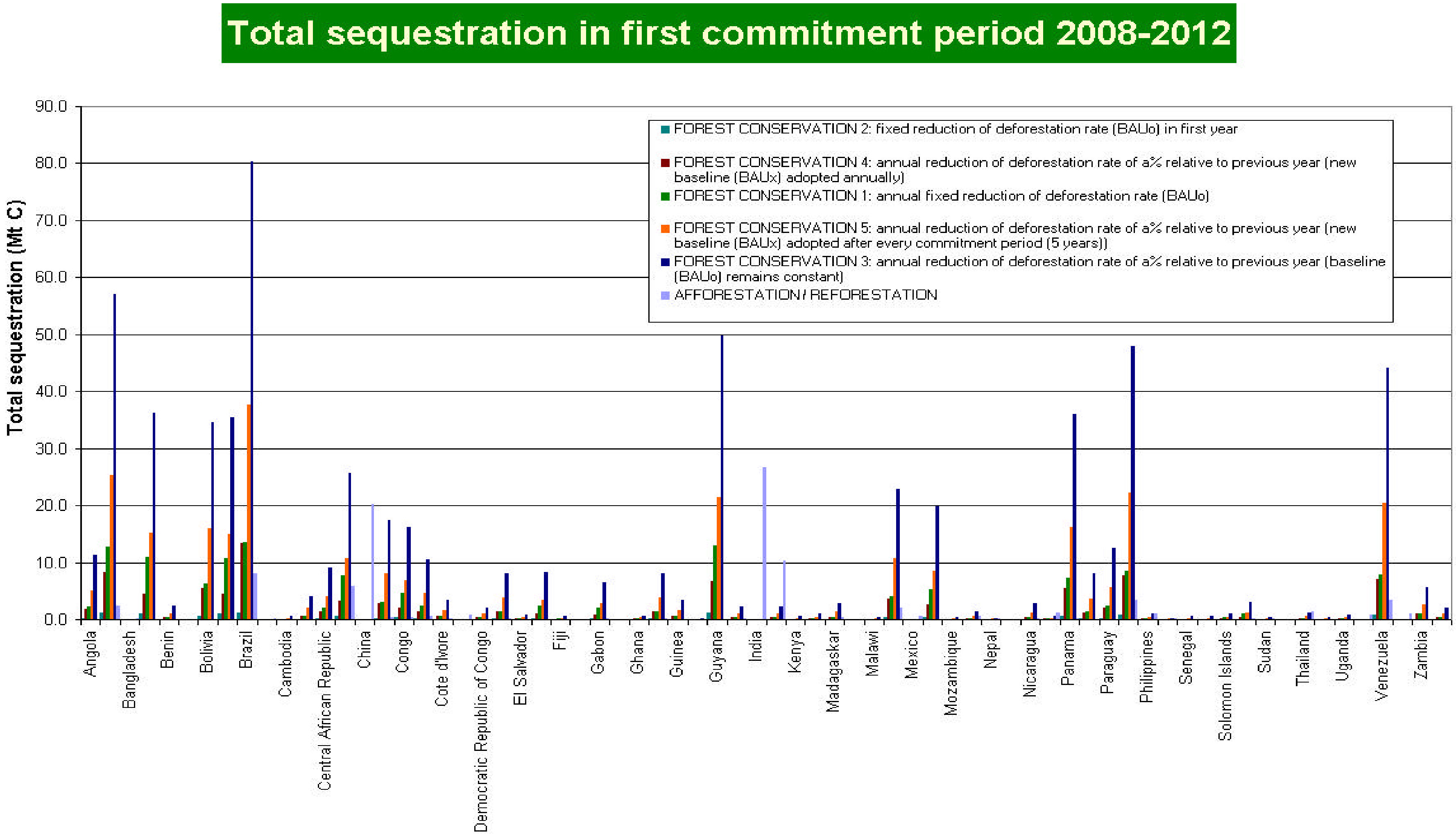

Figure 12. Carbon sequestration potentials for the different countries in the first commitment period, no riteria applied and banking from 2002 onwards.