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Application of Kyoto Protocol in the Conservation of Bonobos (*Pan paniscus*)

The reforestation project designed for the Maringa-Lopori-Wamba region in Democratic Republic of Congo is an example of the possibile use of the Clean Development Mechanism, a flexibility mechanism of the Kyoto Protocol, for biodiversity conservation. This reforestation project was designed by applying the first and newly approved baseline and monitoring methodology for Clean Development Mechanism afforestation/ reforestation project activity. The project aims to enlarge the forest habitat of bonobos (*Pan paniscus*), a non-human primate species sharing almost 99% of the human genome. Bonobos are endemic to the Democratic Republic of Congo and are currently under a strong risk of extinction. Implementation of the present venture as a Clean Development Mechanism project activity provides an opportunity to participate in the emission trade with emissions reduction achieved by reforestation. The proposal envisions from a reforested area of 5,000 hectares are more than 4,000,000 tons of CO_2-e emissions reduction over the 30 years crediting period.

KEY WORDS: *Kyoto Protocol, Clean Development Mechanism, Pan paniscus, Reforestation,* CO_2

Introduction

Clean Development Mechanism (CDM) is one of the flexibility mechanisms of the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). The aim of CDM projects is to produce Certified Emission Reduction (CERs) and to support sustainable development in developing countries.

A/R CDM project activities are reforestation or afforestation projects, which are implemented as Clean Development Mechanism projects. For A/R CDM projects the estimation of the achieved emission reduction is problematical. For example, there is often a lack of country specific data for tree species and the actual absorption of CO_2 by the growing forest is difficult to forecast. Moreover, factors like forest fires or diseases can cause unintentional and unexpected emissions. Difficulties for implementing A/R CDM projects can also arise from unstable political situations in the developing countries selected for project implementation. Calculation guidelines for estimating emission reductions caused by A/R CDM project activities were developed after the Marrakesh COP7 meeting in 2001 (UNFCCC, 2002) and the first baseline and monitoring methodology were recently approved, in November 2005 (UNFCCC, 2005).

The baseline methodology of A/R CDM project activity is designed to ensure the eligibility of the land for the project and the additionallity of the proposed project activity. The project is also designed to estimate the measurable changes in carbon stocks with/

without the project activity as well as to estimate the green house gases (GHG) emissions caused by the project activity. Monitoring methodology checks that the implementation of the project activity is consistent with the Project Design Document (PDD), measures the produced emissions reduction as well as collects and archives monitoring data. The first approved baseline and monitoring methodology for A/R CDM project is applicable only under specific circumstances: the lands to be reforested should be severly degraded and still degrading, the project activity should not lead to a shift of pre-project activies outside project boundaries and the lands should be forested with direct planting (UN-FCCC, 2005).

In this study the first approved A/R CDM baseline and monitoring methodology was applied to a reforestation project for the Maringa-Lapori-Wamba region in Democratic Republic of Congo (DRC). This reforestation project aims to help conserve bonobos (*Pan paniscus*), a species of primates sharing almost 99% of the human genome. The bonobo is a species endemic to DRC and is currently under a strong extinction risk because its endemic territory is seriously degraded by forest exploitation (Hashimoto et al., 1998). The project aims, with creation of forest corridors by reforestation, to enlarge the natural forest habitat of bonobos and, at the same, to stock atmospheric carbon in planted forest biomass. The project is designed to use the flexibility mechanism of the Kyoto Protocol and has a pioneer role in understanding the possibilities of applying the Kyoto Protocol to protect overall biodiversity and in particular a great apes species.

Materials and Methods

The project site is in the Lopori River Basin in the Maringa-Lopori-Wamba region in the central area of the DRC. General project boundaries are between longitude E21°40'–E23°30' and latitude S01°10'–N01°30'. The total area to be reforested will be 5,000 hectares (Figure 1). This area is severly degraded (without growing trees). Planting will be done by 500 hectares standard units, and planting of each standard unit will be carried out over a period of 4 years. Consequently, the total area of 5,000 hectars will be planted in 14 years. The PDD and the estimation of the emission reductions were done with the assumption of the use of *Aucoumea klaineana* seedlings in the reforestation.

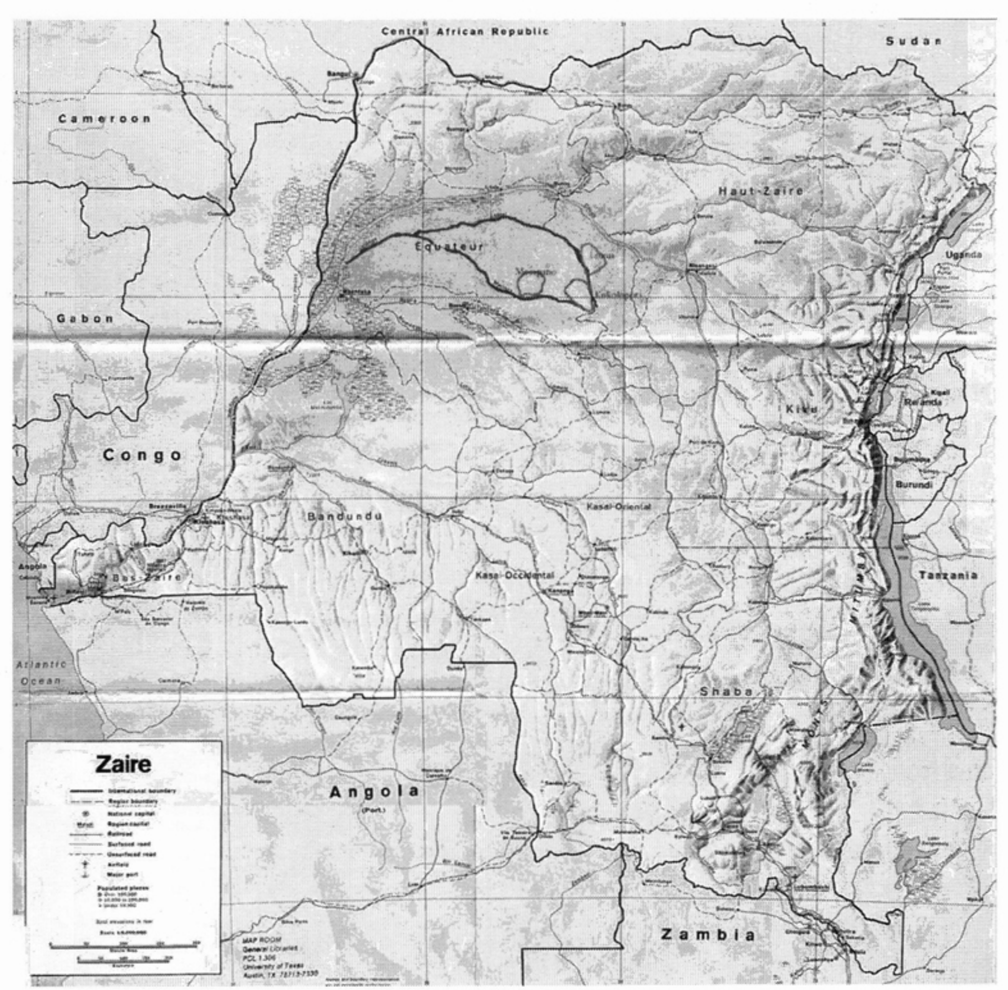

Figure 1. The map of Democratic Republic of Congo (DRC). The reforestation activities are implemented inside the three areas surrounded with the green lines

The first approved baseline and monitoring methodology for A/R CDM project activity (UNFCCC, 2005) was applied. The crediting period for the emissions reduction caused by the project activities was set as 30 years. The emissions reduction will be achieved by the photosynthetic sequestering of CO_2 in the above- and below-ground biomass of the planted trees. The areas to be reforested will be designed as a protected public reserve, including both new forest corridors and still existing forest islands, in order to assure the permanence and maintenance of carbon stocks achieved by the reforestation.

For areas without growing trees it was assumed that the carbon stock in the above- and below-ground biomass would, in the absence of the project activity, remain constant. Carbon stock of soil organic matter, dead wood and litter were omitted because it is assumed that the carbon stock of these pools will not decrease in the baseline scenario more than as a result of proposed project activity. According to these assumptions the baseline net GHG removals by sinks were set as zero.

The carbon stock change for the above- and below-ground biomass in living trees was estimated with the method using approximation of total carbon stock in biomass of living trees in two different moments of time (Equation No.1). Specific growth curves were used to estimate the biomass stock change achieved by the reforestation activity. Growth data (standing volume per hectare) were converted into biomass through wood density, biomass expansion factors and root-shoot ratio using the equations presented in the approved methodology (UNFCCC, 2005). Parameters used in the calculations were from Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF) guidelines and the DRC National Inventory (IPCC, 2003).

$$\Delta C_{ij,t} = (C_{2,ij} + C_{1,ij})/T \times 44/12 \quad (1)$$

$$C_{ij} = C_{AB,ij} + C_{BB,ij} \quad (2)$$

$$C_{AB,ij} = A_{ij} \times V_{ij} \times D_j \times BEF_{2,j} \times CF_j \quad (3)$$

$$C_{BB,ij} = C_{AB,ij} \times R \quad (4)$$

Where:

$C_{2,ij}$	total carbon stock in living biomass of trees for stratum i species j, cal culated at time 2 (tons C)
$C_{1,ij}$	total carbon stock in living biomass of trees for stratum i species j, cal culated at time 1 (tons C)
T	number of years between times 2 and 1
44/12	ratio of molecular weights of CO_2 and carbon
$C_{AB,ij}$	carbon stock in aboveground biomass for stratum i species j (tons C)
$C_{BB,ij}$	carbon stock in below-gound biomass for stratum i species j (tons C)
A_{ij}	area of stratum i species j (ha)
V_{ij}	merchantable volume of stratum i species j (m^3 ha^{-1})
D_j	basic wood density for species j, (tons d.m.m^{-3})
$BEF_{2,j}$	bimass expansion factor for conversion of merchantable volume to aboveground tree biomass for species j
CF_j	the carbon factor for species j (tons C (tonne d.m)$^{-1}$)
Rj	root-shoot ratio for species

The GHG emissions resulting from the implementation of the project activity within project boundaries are equal to GHG emissions of biomass loss of the non-tree vegetation caused by the site preparation within project boundaries. There will not be other significant emissions caused by the project activity while there will not be implementation of biomass burning (slash and burn activity), machinery use for site preparation or use of fertilization. The GHG emissions resulting from the implementation of the proposed project activity were estimated with the following equation (Equation No. 5):

$$GHG_E = E_{FuelBurn} + E_{Biomassloss} + E_{Non-O_2,Biomassloss} + N_2O_{Direct-N,fertilizer} \quad (5)$$

Where:

$E_{FuelBurn}$ the CO_2 emissions from combustion of fossil fuels within the project boundary (tons CO_2-e yr^{-1})

$E_{Biomassloss}$ the CO_2 emissions as a result of a decrease in carbon stock in living biomass of existing non-tree vegetation (tons CO_2) Note: this is an initial loss and therefore it is accounted only once, not per year.

$E_{Non-CO2, Biomassloss}$ non-CO_2 emissions as a result of biomass burning (for example, slash and burn) within the project boundary (tons CO_2-e yr^{-1})

$N_2O_{Direct-N,fertilizer}$ N_2O emissions as a result of direct nitrogen application within the project boundary tonnes (CO_2-e yr^{-1})

$$E_{biomasloss} = \sum_i A_i \times B_{non-tree,i} \times CF_{non-tree} \times 44/12 \quad (6)$$

Where:

A_i area of stratum i (ha)

$B_{non-tree,i}$ average non-tree biomass stock on land to be planted before the start of a proposed A/R CDM project activity for stratum i (tons d.m. ha^{-1})

$CF_{non-tree}$ the carbon stock fraction of dry biomass in non-tree vegetation (tons C (tons d.m.)$^{-1}$)

44/12 ratio of molecular weights of CO_2 and carbon

The implementation of the proposed project activity also produces GHG emission caused by vehicle use outside the project area. These emissions are called leakage. For this project, the estimated leakage come from staff transportation. Transportation of labor or seedlings are not needed because all labor will be from local villages and seedlings will be bred on-sites or collected from nearby forests and will be transported to the project site by manpower. For transportation of staff it is assumed that two medium size vehicles will be used (one using diesel and one gasoline) for the years of the plantation activities (between 1st to 4th year) for each standart unit. Moreover, for each standard unit, in the 5th, 10th and 15th years after the starting of the planting, there will be two additional vehicles (one using diesel and one gasoline) used for the thinning activities. Finally, for the period after the plantation activities it is foreseen that 6 cars (3 using diesel and using 3 gasoline) will be used for the total area of 5,000 ha for each year. The used emission factor for the medium sized vehicles are 2.653 kg CO_2/l for diesel and 2.480 kg CO_2/l for gasoline vehicles. These values are calculated from the data of the Intergovernmental Panel on Climat Change (IPCC) guidelines (IPCC, 1997). The estimation of leakage is made with the following equation (Equation No. 7):

$$K_{Vehicle,O\ 2} = \sum_i \sum_j (E_j \cdot FuelConsumption_j)/1000 \qquad (7)$$

Where:

$LK_{Vehickle,CO2}$	total GHG emissions due to fossil fuel combustion from vehicles (tons CO_2-e yr^{-1})
EF_{ij}	emission factor for vehicle type i with fuel type j (kgCO_2/litre)
$FuelConsumption_{ij}$	consumption of fuel type j of vehicle type i (litres)

To estimate the net anthropogenic GHG removals by sinks we first need to calculate the actual net GHG removals by sinks which are equal to the carbon stock change in above- and below-ground biomass in living trees minus GHG emissions by sources (Equation No.8). The net anthropogenic GHG removals by sinks caused by the project activity was calculated as a sum of actual GHG removals by sinks minus the baseline net GHG removals by sinks minus the leakage as presented in Equation No.9.

$$\Delta C_{ACTUAL} = \sum_i \sum_j \Delta C_j - GHG_E \qquad (8)$$

Where:

ΔC_{ACTUAL} actual net GHG removals by sinks (tons CO_2-e yr^{-1})
ΔC_{ij} average anual carbon stock cahange in living biomass of trees for stratum i species j (tonnes CO_2 yr^{-1})
GHG_E GHG emissions by sources within the project boundary as a result of the implementation of an A/R CDM project activity (tons CO_2-e yr^{-1})

$$C_{R-CDM} = C_{ACTUAL} - C_{BSL} - K \qquad (9)$$

Where:

C_{ACTUAL} actual net GHG removals by sinks

C_{BSL} baseline net GHG removals by sinks

LK leakage

Results

The estimated carbon stock changes in above- and below-ground biomass of living trees and GHG emissions within project boundaries over the total crediting period are listed in Table 1. The GHG emissions caused by the biomasloss for site preparation has been estimated to be equal to 6,415 tons CO_2/ha (Table 1). The actual net GHG removals by sinks are presented in the Table 2.

TABLE 1: The estimates of carbon stock changes in above- and below-ground biomass of living trees and GHG emissions caused by the site preparation before the plantation activities during the crediting period of 30 years. Minus signs inside the table indicates the GHG source.

Year No	Year	Annual carbon stock change (tons CO_2/year)	Accumulative carbon stock change (tons CO_2)	Annual GHG emission (tons CO_2-e/ year)	Accumulative GHG emission (tons CO_2-e)
1	2007	81,587	81,587	-14,759	-14,759
2	2008	61,740	143,327	-14,759	-29,517
3	2009	61,087	204,413	-14,759	-44,276
4	2010	80,109	284,522	-14,759	-59,034
5	2011	113,488	398,010	-14,759	-73,793
6	2012	131,276	529,286	-14,759	-88,551
7	2013	165,603	694,889	-14,759	-103,310
8	2014	200,616	895,505	-14,759	-118,068
9	2015	235,981	1,131,486.34	-14,759	-132,827
10	2016	233,300	1,364,786.82	-14,759	-147,585
11	2017	180,381	1,545,167.64	0	-147,585
12	2018	228,946	1,774,113.78	0	-147,585
13	2019	258,348	2,032,461.85	0	-147,585
14	2020	268,092	2,300,554.34	0	-147,585
15	2021	165,324	2,465,878.64	0	-147,585
16	2022	165,899	2,631,777.57	0	-147,585
17	2023	149,935	2,781,712.76	0	-147,585
18	2024	133,283	2,914,995.78	0	-147,585
19	2025	116,277	3,031,272.79	0	-147,585
20	2026	136,583	3,167,856.06	0	-147,585
21	2027	125,538	3,293,394.21	0	-147,585
22	2028	114,438	3,407,831.75	0	-147,585
23	2029	103,302	3,511,133.70	0	-147,585
24	2030	46,184	3,557,317.32	0	-147,585
25	2031	127,969	3,685,286.07	0	-147,585
26	2032	121,999	3,807,285.07	0	-147,585
27	2033	116,027	3,923,311.79	0	-147,585
28	2034	110,053	4,033,365.17	0	-147,585
29	2035	104,080	4,137,445.23	0	-147,585
30	2036	96,773	4,234,218.47	0	-147,585

TABLE 2: The estimates of actual net GHG removals during the crediting period of 30 years. Actual net GHG removals are equal to carbon stock changes in above- and below-gound biomass of living trees minus GHG emissions caused by the site preparation before the plantation activities caused by the project activites.

Year No	Year	Annual actual net GHG removals (tons CO_2-e/year)	Accumulative actual net GHG removals (tons CO_2-e)
1	2007	66,828	66,828
2	2008	46,981	113,810
3	2009	46,328	160,138
4	2010	65,350	225,488
5	2011	98,729	324,217
6	2012	116,518	440,735
7	2013	150,844	591,579
8	2014	185,858	777,437
9	2015	221,223	998,660
10	2016	218,542	1,217,201.82
11	2017	180,381	1,397,582.64
12	2018	228,946	1,626,528.78
13	2019	258,348	1,884,876.85
14	2020	268,092	2,152,969.34
15	2021	165,324	2,318,293.64
16	2022	165,899	2,484,192.57
17	2023	149,935	2,634,127.76
18	2024	133,283	2,767,410.78
19	2025	116,277	2,883,687.79
20	2026	136,583	3,020,271.06
21	2027	125,538	3,145,809.21
22	2028	114,438	3,260,246.75
23	2029	103,302	3,363,548.70
24	2030	46,184	3,409,732.32
25	2031	127,969	3,537,701.07
26	2032	121,999	3,659,700.07
27	2033	116,027	3,775,726.79
28	2034	110,053	3,885,780.17
29	2035	104,080	3,989,860.23
30	2036	96,773	4,086,633.47

The baseline net GHG removals by sinks are set as zero because the area to be planted is without living trees. Expected GHG emissions caused by vehicle use outside project boundaries are estimated to be 17,660.72 tons of CO_2-e for the entire crediting period (Table 3). By considering the total extent of the reforestation (5,000 ha), the planting activity of 500 hectares per year and a fixed crediting period of 30 years, sinks are expected to remove 4,068,972.75 tons of CO_2 (Table 4 and Figure 2).

TABLE 3: The estimates of GHG leakage caused by the project related vehicle use outside the project boundary. Minus signs inside the table indicates the GHG source.

Year No	Year	Annual leakage (tons CO_2-e/year)	Accumulative leakage (tons CO2-e)
1	2007	-3772	-3772
2	2008	-9766	-13538
3	2009	-17310	-30849
4	2010	-27077	-57925
5	2011	-42165	-1,001
6	2012	-55703	-1,558
7	2013	-70791	-2,266
8	2014	-88101	-3,147
9	2015	-1,070	-4,216
10	2016	-1,318	-5,535
11	2017	-1,309	-6,843
12	2018	-1,277	-8,120
13	2019	-1,230	-9,350
14	2020	-1,161	-10,511
15	2021	-1,047	-11,558
16	2022	-94029	-12,499
17	2023	-81770	-13,316
18	2024	-67289	-13,989
19	2025	-51258	-14,502
20	2026	-29233	-14,794
21	2027	-29233	-15,086
22	2028	-29233	-15,379
23	2029	-29233	-15,671
24	2030	-29233	-15,963
25	2031	-28290	-16,246
26	2032	-28290	-16,529
27	2033	-28290	-16,812
28	2034	-28290	-17,095
29	2035	-28290	-17,378
30	2036	-28290	-17,661

TABLE 4: The estimated net anthropogenic GHG removals caused by the proposed project activity during the crediting period of 30 years. The estimates of net anthropogenic GHG removals are calculated as a sum of actual GHG removals by sinks minus the baseline net GHG removals by sinks minus the leakage.

Year No	Year	Annual net anthropogenic GHG removals by sinks (tons CO_2-e/year)	Accumulative net anthropogenic GHG removals by sinks (tons CO2-e)
1	2007	66,791	66,791
2	2008	46,884	113,674
3	2009	46,155	159,829
4	2010	65,079	224,909
5	2011	98,308	323,216
6	2012	115,961	439,177
7	2013	150,137	589,314
8	2014	184,977	774,291
9	2015	220,153	994,443
10	2016	217,224	1,211,667.22
11	2017	179,072	1,390,739.31
12	2018	227,669	1,618,408.39
13	2019	257,118	1,875,526.55
14	2020	266,932	2,142,458.49
15	2021	164,277	2,306,735.40
16	2022	164,959	2,471,694.05
17	2023	149,117	2,620,811.53
18	2024	132,610	2,753,421.66
19	2025	115,764	2,869,186.10
20	2026	136,291	3,005,477.04
21	2027	125,246	3,130,722.86
22	2028	114,145	3,244,868.07
23	2029	103,010	3,347,877.69
24	2030	45,891	3,393,768.98
25	2031	127,686	3,521,454.84
26	2032	121,716	3,643,170.94
27	2033	115,744	3,758,914.76
28	2034	109,770	3,868,685.25
29	2035	103,797	3,972,482.41
30	2036	96,490	4,068,972.75

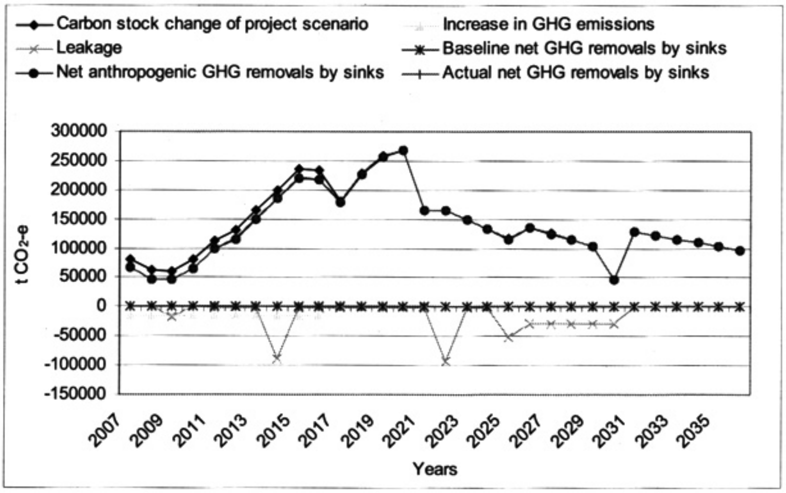

Figure 2. The estimated net anthropogenic GHG removals caused by the proposed project activity during the crediting period of 30 years.

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