Greenhouse Gas (GHG) Status on Land Use Change and Forestry Sector in Myanmar

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Location Map of Myanmar

Sino-Himalayan region in the north

Indochinese region in the east

Malayan peninsular in the south

This significant geo-position together with high variations in

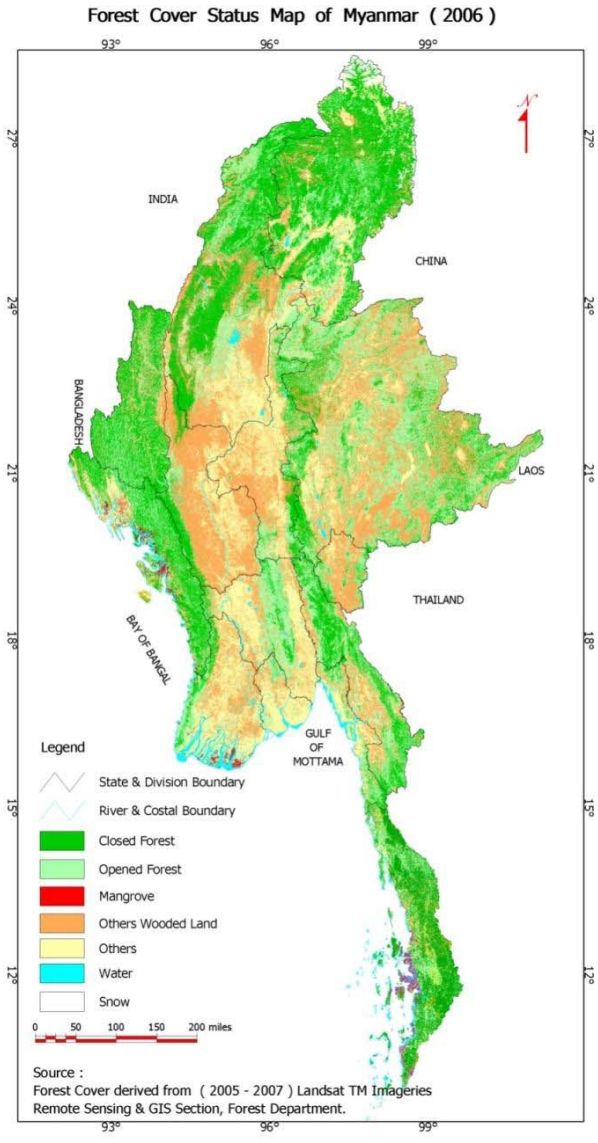
- **Rainfall**
- **Temperature**
- **Topography and**

create

Several diverse forest types in Myanmar, from sub-alpine forest in the north to tropical rain forest in the south.

Source: Remote Sensing & GIS Section, Forest Department

TABLE 1 FOREST TYPES AND AREAS IN MYANMAR FOR THE YEAR 2000



Forest type (Myanmar)	Forest Type (IPCC)	Area (ha)	% of total
Tropical ever green forest	Tropical rain forest	5528640	16
Mixed deciduous forest	Tropical moist deciduous forest	13476060	39
Dry forest	Tropical dry forest	3455400	10
Dipterocarps forest	Tropical dry forest	1727700	5
Hill and temperate evergreen forest	Subtropical mountain system	8984040	26
Beach and dune forest	Tropical rain forest	1382160	4
TOTAL		**34554000**	**100**

52% of the country's total area – 676,577 sq km

INTRODUCTION

The Land use change and forestry sector (forestry and forest industry, including the use of forest land) - important role in global climate change debate

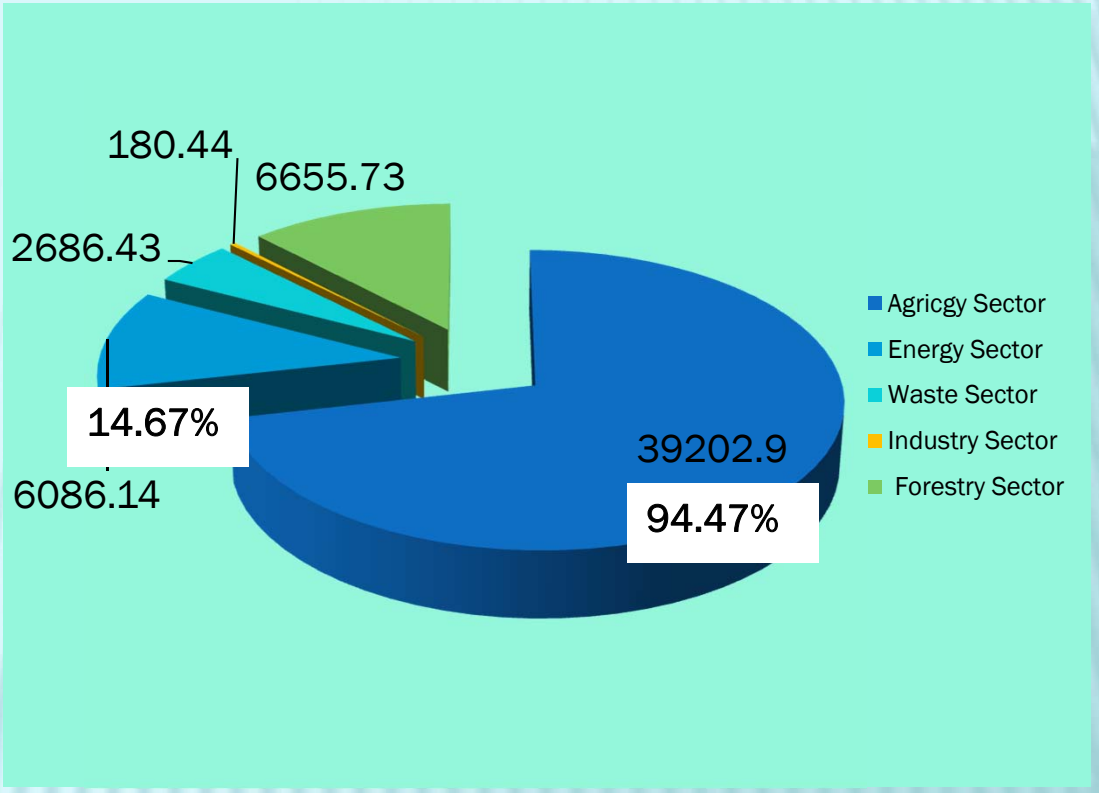
- influences the global carbon cycle,
- is influenced by possible global climate change caused by increased concentrations of greenhouse gases.
- Forests are, if properly managed, the main carbon sinks.
- The estimated total carbon in the forests (i.e. living biomass, dead wood, litter and soil) was 633 Gt, which is equivalent to 160 tons of carbon per hectare in 2005.
- On the other hand, the forests may become the source of carbon emissions: due to deforestation and forest degradation processes, the forests globally will become a significant net source of CO2 emissions by 2050 (IPCC, 2007).
- Therefore, the GHG inventory data in the land use change and forestry sector is crucial for future management plans for sustainable carbon sinks.

GHG INVENTORY IN MYANMAR

- Myanmar ratified UNFCCC on 25 November, 1994 as a non-Annex I Party.
- Article 12.5 - requires non-Annex I Parties to prepare their initial national communications.
- the preliminary GHG inventory and mitigation options assessment were undertaken during the **ALGAS** study in 1997, no other project activities relating to UNFCCC have been undertaken.
- A National GHG inventory for CO_2, CH_4 , N_2O for the base year 1990 in **Five Categories** - Energy, Agriculture, Industrial Process, Land Use Change and Forestry and Waste.

NET NATIONAL EMISSIONS OF CO_2 EQUIVALENT

Sources and Sinks	Net CO2 Emission (Gg)
Agriculture	39,202.9
Energy	6,086.14
Waste	2,686.43
Land Use Change and Forestry	6,655.73
Industrial Process	180.44
Total	41,500.20



GHG emission from Agriculture Sector for 2020, 62,733 Gg.

INC PROJECT IN MYANMAR

- National Commission for Environmental Affairs NCEA (now Environmental Conservation Department) of Myanmar launched an INC-project since 2008 with the financial assistance from GEF/UNEP.
- **Six Expert Groups**
- GHG Inventory and Mitigation Options Analysis
- Vulnerability and Adaptation Assessment
- Development and transfer of Environmentally Sound Technologies (ESTs)
- Research and Systematic Observation
- Education, Training and Public Awareness
- Compilation of National Communication

GHG STUDY TEAM

1) **Energy: Fuel combustion, Fugitive emissions from fuels, CO_2 transport and storage**
2) **Industrial Processes and Product Use: Mineral, chemical & metal industries, Non-energy products from fuels and solvent use, Electronics industry, Product uses as substitutes for O_3 depleting substances, Other product manufacture and use, Other**
3) **Agriculture: Agriculture and Livestock, Aggregate sources and non-CO_2 emissions sources in land**
4) **LUCF: CO_2 emissions/absorption by land, Identify the activities of emission sources in different land use categories**
5) **Waste: Solid waste disposal, Biological treatment of solid waste, Incineration and open burning waste, Waste water treatment and discharge**

SUMMARY OF EMISSIONS IN MYANMAR FOR THE YEAR 2000

Source/ Sink	CO_2 Emission	CO Emission	CH_4 Emission	N_2O Emission	NO_x Emission	CO_2 Equivalent Total Emission	CO_2 Removal	CO_2 Equivalent Total Net Emission
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Energy (Traditional Biomass burned)	**7,658.65 (27,833.09)**	- -	**5.62 (7.4553)**	**0.28 (0.9941)**	- -	**7,863.47 (28,297.82)**	- -	**7,863.47 (28,297.82)**
Industrial Processes	**248.59**	-		-	-	**463.29 ***	-	**463.29**
Agriculture		**0.81**	**963.58**	**8.2706**	**0.022**	**22,800.46**		**22,800.46**
A. Agri.	-	0.81	507.23	8.2706	0.022	13,217.11	-	13,217.11
B.Livestock	-	-	456.35	-	-	9,583.35	-	9,583.35
Forestry	**33,656.51**	**2,215.37**	**144.85**	**4.26**	**34.08**	**40,404.86**	**142,221.19**	**101,816.33**
Waste	-	-	**134.57**	-	-	**2,825.97**	-	**2,825.97**
TOTAL	**41,563.75**	**2,216.18**	**1,248.62**	**12.8106**	**34.102**	**74,358.05**	**142,221.19**	**- 67,863.14**

GHG INVENTORY IN FORESTRY SECTOR

- Land Use Categories
- Forest land: all land with woody vegetation (according to forest definition)
- Cropland: cropped land, rice fields, agro-forestry systems
- Grassland: rangelands and pasture land
- Wetland: areas of peat extraction and peat-lands; includes reservoirs, natural rivers and lakes
- Settlements: all developed land, transportation infrastructure and human settlement
- Other land: bare soil, rock, ice, all land that do not fall into any of the other 5 categories

LAND USE CONVERSIONS

FF	=	Forest Land Remaining Forest Land	LF	=	Land Converted to Forest Land
GG	=	Grassland Remaining Grassland	LG	=	Land Converted to Grassland
CC	=	Cropland Remaining Cropland	LC	=	Land Converted to Cropland
WW	=	Wetlands Remaining Wetlands	LW	=	Land Converted to Wetlands
SS	=	Settlements Remaining Settlements	LS	=	Land Converted to Settlements
OO	=	Other Land Remaining Other Land	LO	=	Land Converted to Other Land

The length of time that land remains in a conversion category after a change in a land use is by default 20 years.

5 CARBON POOLS

- Above-ground biomass: living vegetation, woody and herbaceous above the soil (stems, stumps, branches, bark, seed and foliage)
- Below-ground biomass: all biomass of live roots >2mm in diameter
- Dead wood: all non-living woody biomass, standing or lying or in the soil (d≥10cm)
- Litter: all non-living biomass (10 cm≤ d≥ 2mm)
- Soil organic matter: organic carbon at 30 cm depth

Above-ground biomass + Below-ground biomass = Biomass

Dead wood + Litter = Dead organic matter

Soil organic matter = Soil

METHODOLOGY FOR GHG INVENTORY IN THE FORESTRY SECTOR

Annual change in carbon stocks in biomass for a land use category was calculated by using Gain-loss Method (Equation 2.7 in IPCC guidelines, 2006):

$$\Delta C_B = \Delta C_G - \Delta C_L$$

ΔC_B = sum of aboveground biomass and belowground biomass

ΔC_G = biomass growth for each land subcategory

ΔC_L = biomass loss for each land subcategory

METHODOLOGY FOR GHG INVENTORY IN THE FORESTRY SECTOR

Annual increase in biomass carbon stocks due to biomass increment was calculated as follows: (Equation 2.9 in IPCC guidelines. 2006)

$$\Delta C_G = \Sigma (A_{ij} - G_{TOTAL\ ij} - CF_{ij})_{ij}$$

A= area of land remaining in the same land use category

G_{TOTAL} = mean annual biomass growth

CF = carbon fraction of dry matter

$$\Delta C_L = L_{wood\ removais} + L_{fuelwood} + L_{disturbance}$$

$L_{wood\ removais}$ = annual carbon loss due to wood removals

$L_{fuelwood}$ = annual carbon loss due to fuelwood removals

$L_{disturbance}$ = annual carbon losses due to disturbances

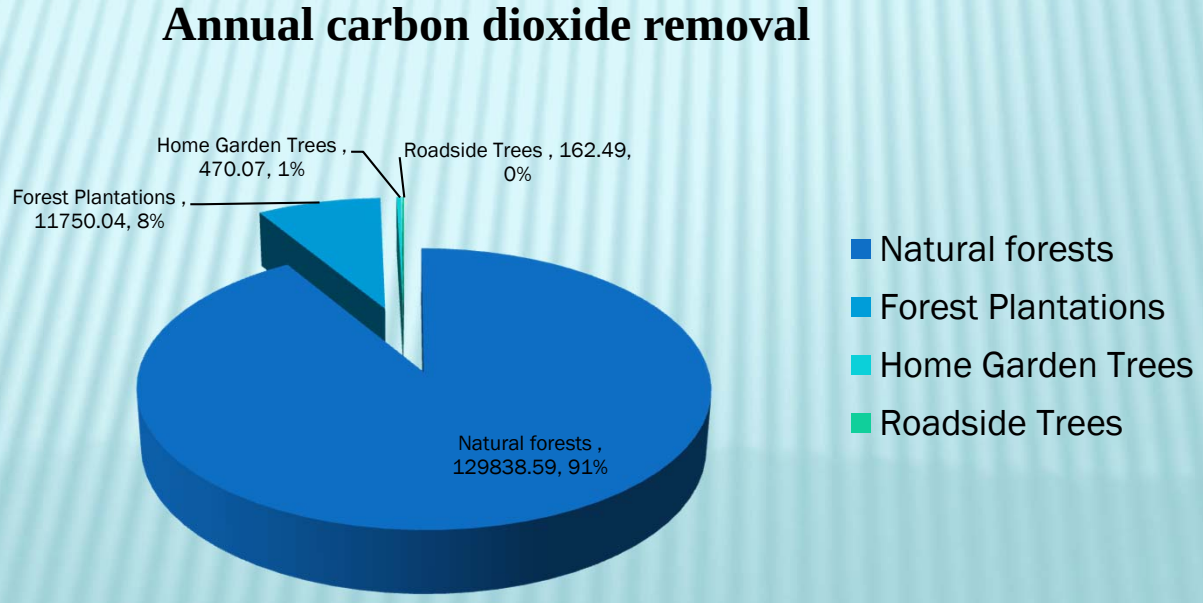
ANNUAL INCREASE IN BIOMASS CARBON STOCKS

The annual increases in biomass carbon stocks in the land use change and forestry sector were calculated for the following categories:

- Natural forests
- Forest plantations
- Home garden trees
- Roadside trees

TABLE 2. ANNUAL INCREASE IN CARBON STOCKS AND CARBON DIOXIDE REMOVALS FOR THE YEAR 2000

Activity	Annual increase in carbon stocks (Carbon, Gg)	Annual carbon dioxide removal (Carbon dioxide Gg)	Percentage to total CO_2 removal (%)
Natural forests	35410.53	129838.59	91.30
Forest Plantations	3204.56	11750.04	8.26
Home Garden Trees	128.20	470.07	0.33
Roadside Trees	44.32	162.49	0.11
TOTAL	**38 787.61**	**142 221.19**	**100.00**



ANNUAL DECREASE IN BIOMASS CARBON STOCKS

Annual decrease in biomass carbon stocks due to biomass losses for the year 2000 was calculated for the following activities:

1) Loss of carbon by wood removal
2) Loss of carbon by fuel wood removal
3) Loss of carbon by harvested wood products (HWP)
4) Biomass burning following land clearing
   - Site preparation for forest plantations
   - Shifting cultivation
   - Deforestation

LOSS OF CARBON BY WOOD REMOVAL

Annual carbon loss in biomass of wood removals (harvesting) was calculated using the following equation:

$L_{wood\ -removais} = H.\ BCEF_R\ .(1+R).\ CF$ (Equation 2.12, 2006- IPCC)

$L_{wood\ -removais}$ = annual carbon loss due to biomass removals, tons C yr^{-1}

H = annual wood removals, roundwood biomass, $m^3\ yr^{-1}$

R = ration of belowground to aboveground biomass, tons d.m. below-ground biomass (tons d.m. aboveground biomass)$^{-1}$

CF = carbon fraction of dry matter, tone C (tone d.m.)$^{-1}$

$BCEF_R$ = biomass conversion and expansion factor for conversion of removals in merchantable volume to biomass removal (including bark)

SITE PREPARATION FOR FOREST PLANTATIONS

- The total forest plantation area established in 2000 was 30731 ha.
- Forest plantations in Myanmar are established for different purposes viz. Commercial, local supply (Fuel-wood). Industrial, Watershed conservation, etc.
- During land preparation, not all the selected areas are burnt (eg. Watershed conservation plantations).
- The actual burnt area for site preparation in the year 2000 was 23 277 ha.
- Greenhouse gas emission from biomass burning for site preparation of the forest plantation for the year 2000 is estimated to be 1 863 207 tons of CO_2 equivalent.

DEFORESTATION

- GHG emissions from deforestation share the largest portion of the GHG emission in land use change and forestry sector of Myanmar.
- Deforestation in the year 2000 was 466 500 ha (FRA 2005). All the deforested areas are not burnt.
- However the reliable data on the land use change pattern (from forest land to grassland. Cropland, settlement, water body, etc) is not available.
- Therefore, all the deforested lands are assumed to be burnt in this study for conservative estimation.

SHIFTING CULTIVATION

GHG emission from biomass burning by shifting cultivation for the year 2000 is estimated to be 37 340 974 tons of CO_2 equivalent.

GHG EMISSIONS IN THE FORESTRY SECTOR FOR THE YEAR 2000

- The activities responsible for annual decrease in biomass carbon stocks in land use change and forestry sector can be divided into two groups.
- One is the activity which causes the annual decrease in carbon stocks but cannot be accounted for direct GHG emission (eg. Wood removal);
- Another is the activity which can be accounted for direct GHG emission (eg. Biomass burning).
- The greenhouse gas emission in the forestry sector for the year 2000 can be estimated to be 40 404.855 Gg CO_2e.
- The activities and their GHG emissions are shown in the Table.

TABLE 3. ANNUAL DECREASE IN CARBON STOCKS AND GHG EMISSIONS BY DIFFERENT ACTIVITIES

Activity	Loss of Carbon	GHG emission	Remark
Wood removal	2 176 888 tC	Not accounted	All the wood products are not burnt
Fuelwood removal	26 936 418 tC	Accounted	GHG emissions are further estimated in Energy sector
Harvested Wood Products	Not estimated	Not accounted	Not needed to calculate in Tier 1 level
Site preparation for forest plantations	-	1863207 tCO_2e	
Shifting cultivation	-	1 200 674 tCO_2e	
Deforestation	-	37 340 974 tCO_2e	

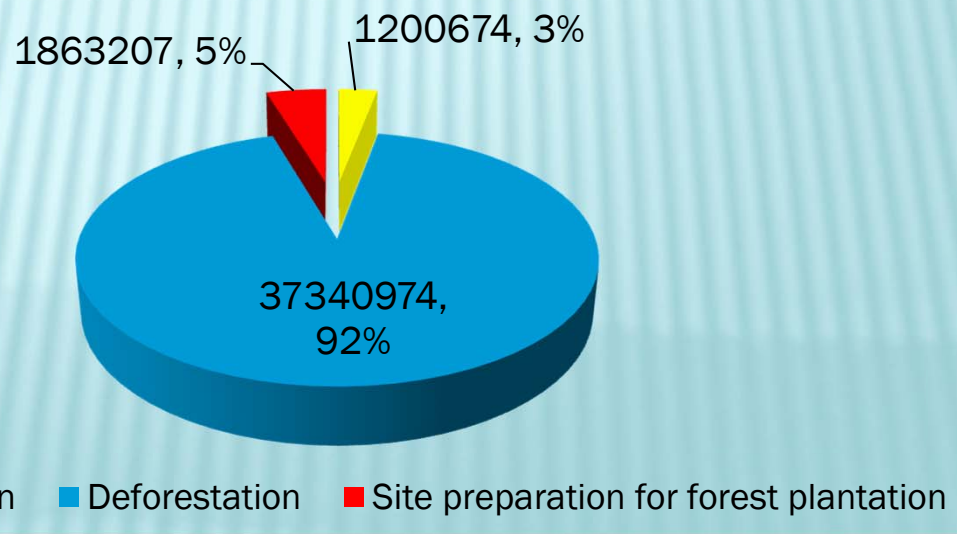


TABLE 4. GREENHOUSE GAS EMISSIONS BY DIFFERENT ACTIVITIES FOR THE YEAR 2000

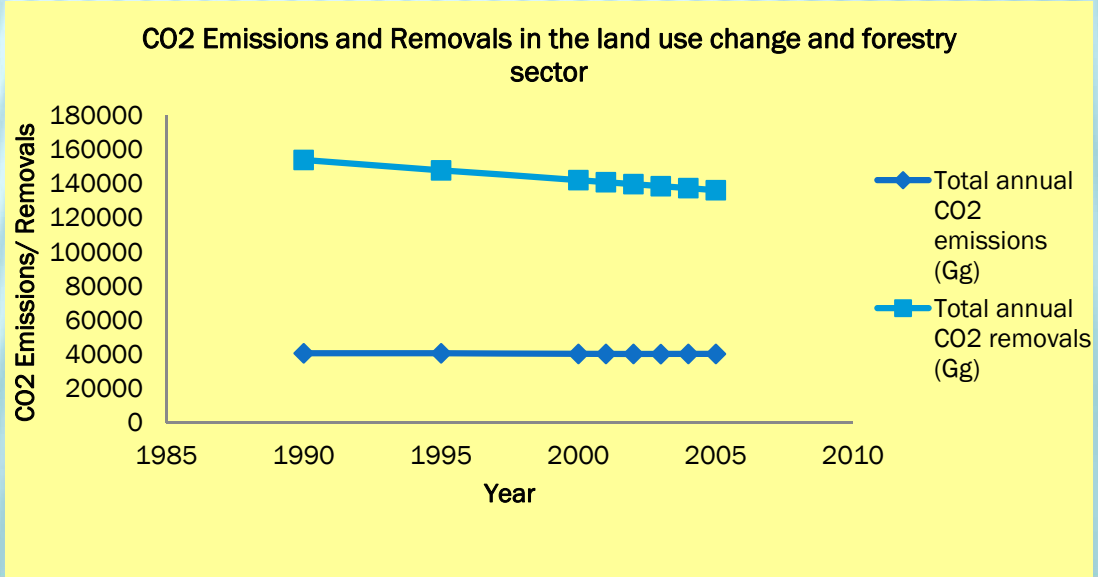
Activity	Emissions					Total (CO_2 equivalent Gg)
	CO_2 (Gg)	CO (Gg)	CH_4(Gg)	N_2O (Gg)	NO_x (Gg)	
Forest plantations	1552.017	102.158	6.680	0.196	1.572	1863.207
Shifting cultivation	1000.140	65.832	4.304	0.127	1.013	1200.674
Deforestation	31104.354	2047.375	133.867	3.937	310498	37340.974
Total	**33656.511**	**2215.365**	**144.851**	**4.260**	**34.083**	**40404.855**

TABLE 5. GHG EMISSIONS/ REMOVALS FROM LAND USE CHANGE AND FORESTRY SECTOR FOR THE YEAR 2000

Activity	CO_2 emissions (Gg)	CO_2 removals (Gg)	Net CO_2 emissions/ removals (Gg)
Natural forests	-	129 838.59	(-) 129 838. 59
Forest plantations	1 863.207	11 750.04	(-) 9 886. 833
Home garden trees	-	470.07	(-) 470.07
Roadside trees	-	162.49	(-) 162.49
Wood removal	-	-	-
Fuelwood removal	(Energy sector)	-	-
Harvested wood products (HWP)	-	-	-
Shifting cultivation	1200.674	-	(+) 1200.674
Deforestation	37340.974	-	(+) 37340.974
TOTAL	40404.855	142221.19	(-) 101816.38

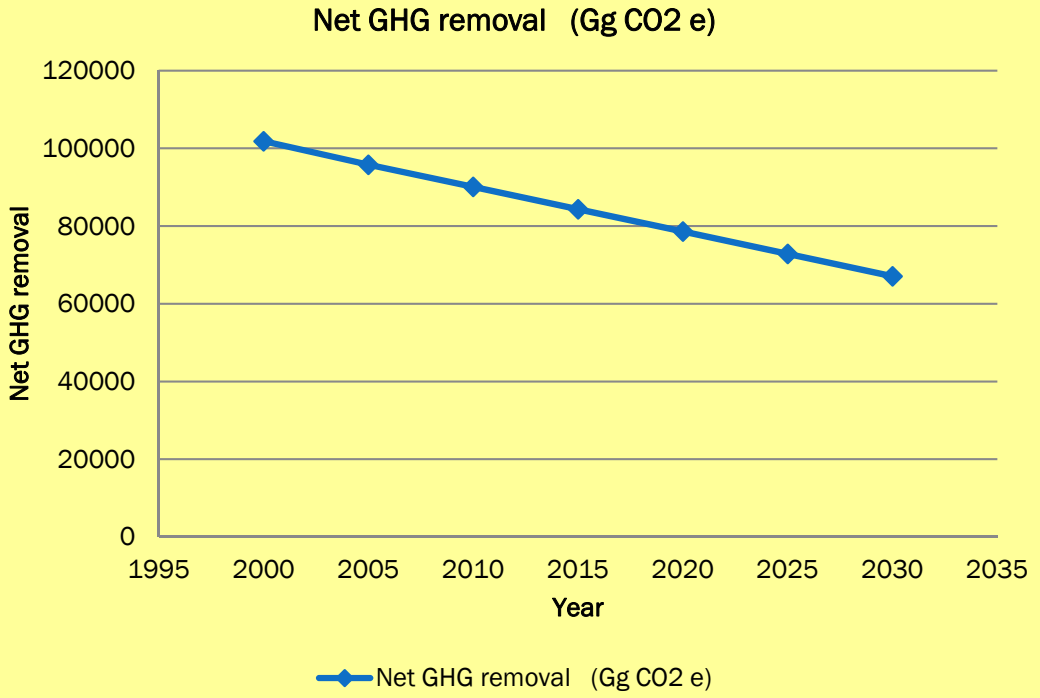
TABLE 6. SUMMARY FOR NET CO2 EMISSIONS/ REMOVALS DATABASE FOR THE FORESTRY SECTOR IN MYANMAR

Year	Total annual CO_2 emissions (Gg)	Total annual CO_2 removals (Gg)	Total net annual CO_2 emissions/ removals (Gg)
1990	40855.26	154034.90	(-) 113179.64
1995	40784.58	147906.36	(-) 107121.78
2000	40404.85	142221.23	(-) 101816.38
2001	40445.35	141015.22	(-) 100569.87
2002	40425.18	139825.50	(-) 99400.32
2003	40384.44	138674.57	(-) 98290.13
2004	40447.27	137473.85	(-) 97026.58
2005	40484.01	136258.74	(-) 95774.73



PREDICTION OF NET GHG REMOVAL BY LAND USE CHANGE AND FORESTRY SECTOR DURING 2000-2030

Year	Net GHG removal (Gg CO_2 e)
2000	101816
2005	95774
2010	90093
2015	84341
2020	78589
2025	72837
2030	67085



- The projection of net GHG removal in 2030 pointed our constant decline because of decrease in natural forest area.
- Net CO_2 removal in 2000 was estimated to be 101816.38 Gg which will be reduced to 78589.07 Gg in 2020 and 67085.05 Gg in 2030.

MYANMAR GREENHOUSE GAS MITIGATION OPTIONS ASSESSMENT AND STRATEGIES

- With vast and diverse natural forests, Myanmar is still green in terms of forest cover as well as low carbon emission.
- Natural forests of Myanmar can sequester substantial amount of carbon in the form of biomass.
- The mitigation strategies could be aimed at reducing carbon emission and increasing carbon sequestrations in forestry sector of Myanmar.
- Short-term (10 years) and long term (30 years) considerations could be taken into account to determine the effective mitigation strategies to achieve the sustainable carbon sequestration and socioeconomic responses.
- Forest mitigation practices that can restrain the rate of increase in atmospheric CO2 can be grouped into three categories:
  - (i) management for carbon conservation;
  - (ii) management for carbon sequestration and storage; and
  - (iii) management for carbon substitution.

MYANMAR GREENHOUSE GAS MITIGATION OPTIONS ASSESSMENT AND STRATEGIES

- Conservation practices include options such as
  - controlling deforestation,
  - protecting forests in reserves,
  - changing harvesting regimes, and
  - controlling other anthropogenic disturbances, such as fire and pest outbreak.
- Sequestration and storage practices include expanding forest ecosystems by increasing the area and/or biomass and soil carbon density of natural and plantation forests, and increasing storage in durable wood products.
- Substitution practices aim at increasing the transfer of forest biomass carbon into products rather than using fossil fuel-based energy and products, cement-based products and other non-wood building materials.

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2) U Sein Thet: Climate Change Information, Forestry Journal February 2011, pp 47-49
3) U Sein Thet (2014): Climate Change in Myanmar

Thank you for your kind attention