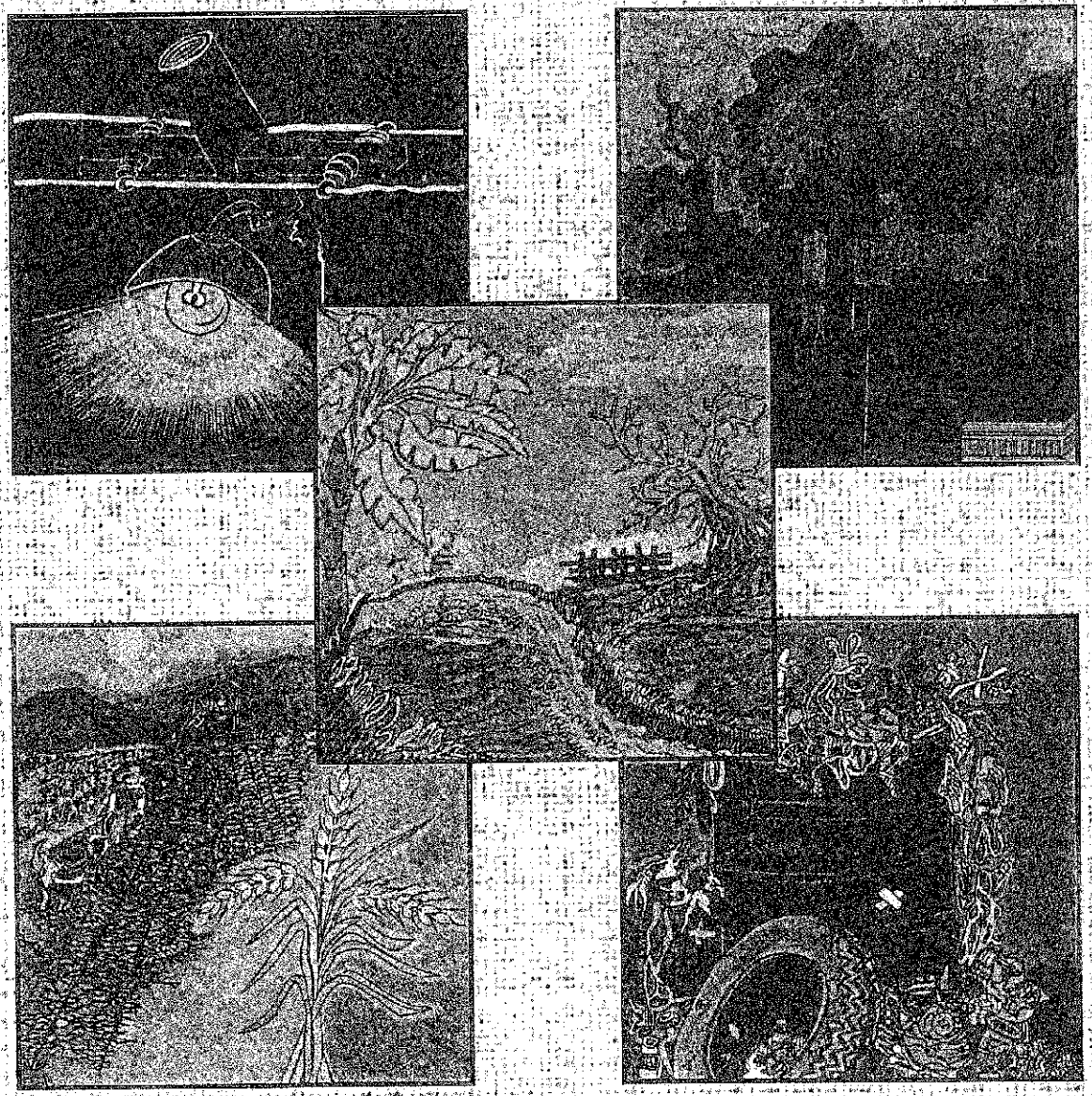
資料 3　現地収集資料

(2) Tracking Greenhouse Gases (抜粋: Executive Summary 及び Energy Sector)

DENR-EMB 提供

Tracking Greenhouse Gases

A Guide for Country Inventories



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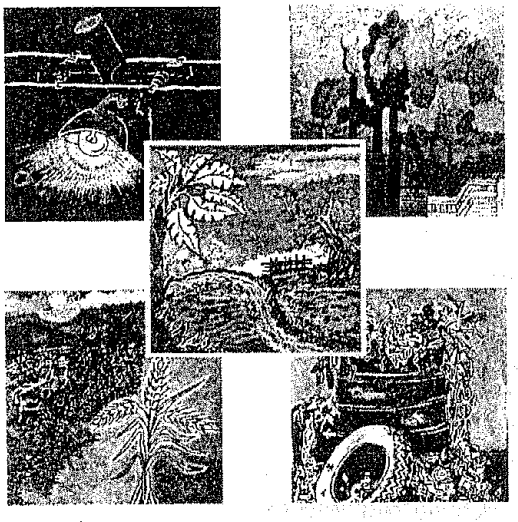

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THE 1994 PHILIPPINE GREENHOUSE GAS INVENTORY

Executive Summary

The presence of human-induced or anthropogenic greenhouse gases (GHGs) in our atmosphere can be attributed to activities and processes associated mainly with five important sectors: Energy, Industry, Agriculture, Waste, and Land Use Change and Forestry (LUCF). In 1994, the Philippines released a total equivalent amount of 102,957 kilotons (kt) of CO_2 into the atmosphere. This is due to the combination of GHGs emitted from various sources in the four sectors of Energy, Industry, Agriculture, and Waste, and the net uptake (sink) of GHGs from the LUCF sector. In the global context, this national amount is still minimal relative to the GHG emissions of other nations, especially those of developed country parties to the UNFCCC.

Discounting the contribution of the still controversial LUCF sector, national GHG emissions total about 103,085 kt of equivalent CO_2. Of the four non-LUCF sectors representing the country's sources of GHGs, the Energy sector is the most significant, accounting for about 49% of the national total. This is trailed closely by the Agriculture sector's contribution of about 32%. Industry and Waste follow with respective contributions of 10% and 9% of the total. Table ES-1 lists the GHG emission levels without the LUCF sector and Figure ES-1 shows the relative contributions of these four non-LUCF sectors to the national GHG emissions total. In contrast with these four sectors which act as GHG sources, activities and processes associated with the LUCF sector are able to sequester or remove about 127 kt of CO_2, an amount seemingly insignificant (0.1%) when compared with the national total (see Table ES-2 and Figure ES-2). However, as will be explained further below, the apparent insignificance of carbon sequestration from LUCF is actually the net sum of large and non-negligible sources and sinks in this sector.

Table ES-1. Non-LUCF emissions

Sector	CO_2 Emissions (Gg)
Energy	50,038
Industry	10,711
Agriculture	33,137
Waste	9,198
TOTAL	**103,085**

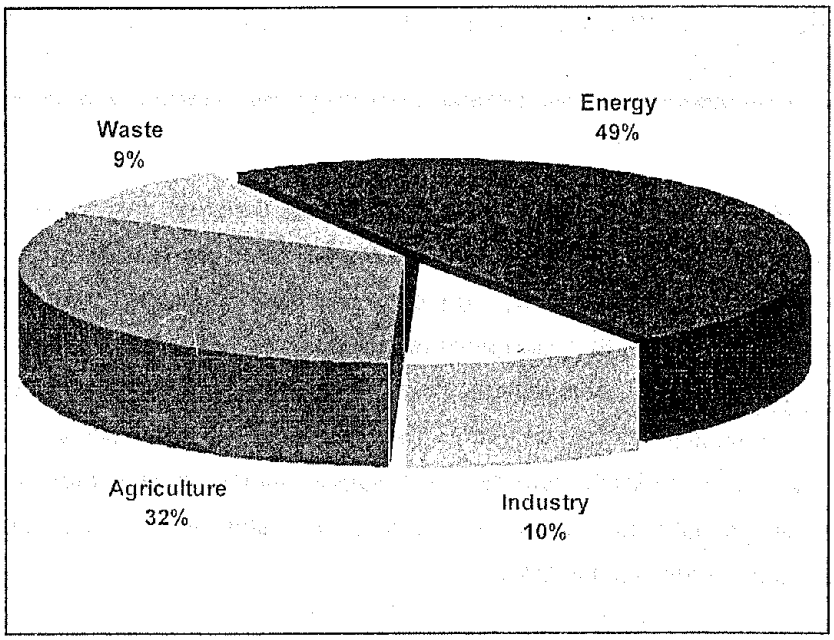

Figure ES-1. 1994 GHG emissions from the four non-LUCF sectors.

The GHGs of concern in the Philippines from these five sectors are mainly CO_2, methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs). To effectively compare the global warming impact of these non-CO_2 gases with that of CO_2, global warming potential (GWP) calculations are applied to each of these non-CO_2 GHGs. The GWP takes into account the varying efficacy of different GHGs in warming the planet relative to that of CO_2. For example, within a time horizon of 100 years, the current Intergovernmental Panel on Climate Change (IPCC) recommendation for the GWPs of CH_4 and N_2O are 21 and 310, respectively. The CO_2 equivalents are computed by multiplying the actual emissions of non-CO_2 GHGs (e.g. of CH_4 and N_2O) with their respective GWPs. Hence, for example, the potential global warming impact of 100 kt of CH_4 is equivalent to that of 2,100 kt of CO_2. The GHG emissions total cited above is in terms of equivalent CO_2 (to take into account the contribution of non-CO_2 GHGs).

Table ES-2. Total equivalent CO_2 emissions including LUCF sector

Sector	CO_2 Emissions (Gg)
GHG Emissions - LUCF	103,085
LUCF	-127
TOTAL	**102,957**

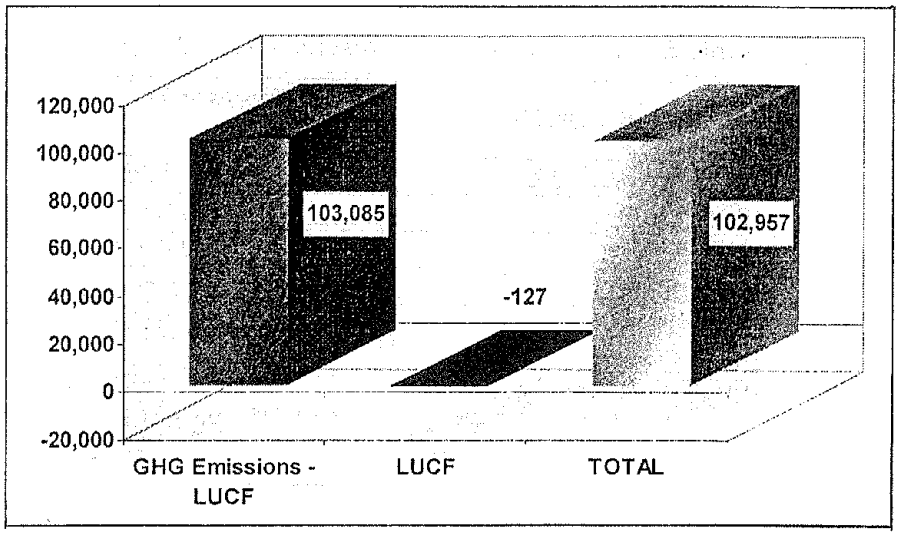

Figure ES-2. Net GHG emissions with the LUCF sector.

GHG emissions in the Energy sector (which is largely CO_2) comes mainly from fuel combustion. This sector alone emitted 50,038 kt of equivalent CO_2 in 1994. The subsector contributions to this total are tabulated in Table ES-3 and illustrated in Figure ES-3.

A significant portion (about 82%) of these emissions is from three major end users of fuel: the power generating industries, transportation, and the manufacturing industries. The main fuel types used in these subsectors are conventional fossil fuels such as oil and coal which are found to contribute substantially to GHG emissions. These conventional fuel types continue to dominate the current and projected energy mix of the country: 76% in 1994 and 67% by the year 2008. Non-conventional energy sources such as biomass, wind, and solar systems comprise only 10% and 21% of the energy mix for 1994 and 2008, respectively. Biomass contributes the greater share among these non-conventional energy systems. GHG emissions from these new and renewable energy systems are assumed to be insignificant.

In the Industry sector, 10,603 kt of CO_2 were released in 1994. A major fraction (86%) of the industrial CO_2 emissions comes from the cement and metal industries (see Table ES-4 and Figure ES-4).

Table ES-3. Equivalent CO_2 emissions from Energy

Subsector	CO_2 Emissions (Gg)
Energy Industries	15,508
Residential	4,359
Industries	9,497
Agriculture	1,189
Transport	15,888
Commercial	3,370
Fugitive Emissions	227
TOTAL	**50,038**

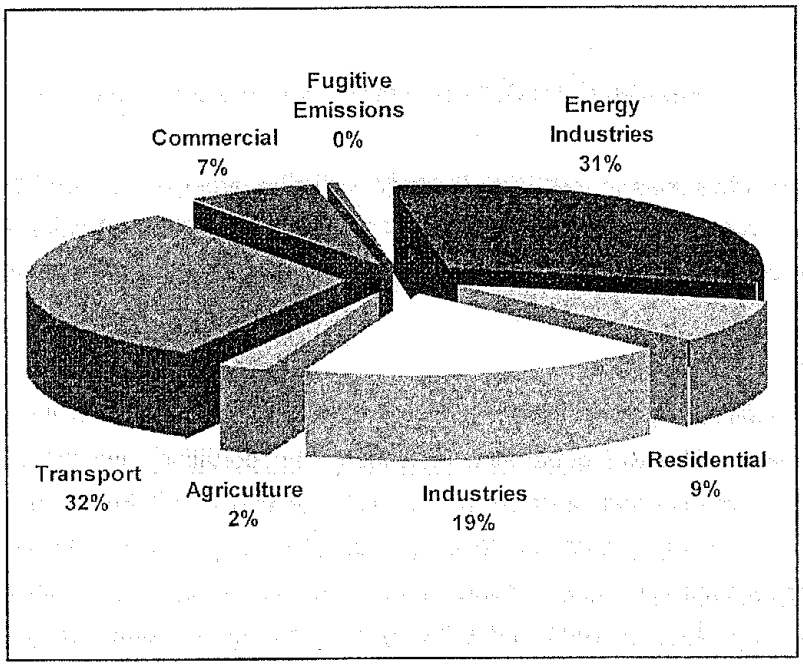

Figure ES-3: Subsector emissions from Energy.

These emissions arise directly from industrial processes associated with manufacturing cement and metals, and are not due to the power generation and consumption activities of these industries which are already accounted for in the Energy sector. In 1994, the Philippines produced around 239 million bags of cement and 2.669 million tons of steel corresponding to CO_2 emissions of 4,771 and 4,318 kt, respectively.

Table ES-4. Equivalent CO_2 emissions from Industrial Processes

Subsector	CO_2 Emissions (Gg)
Cement	4,771
Chemicals	99
Metals	4,334
Halocarbons	1,507
TOTAL	10,711

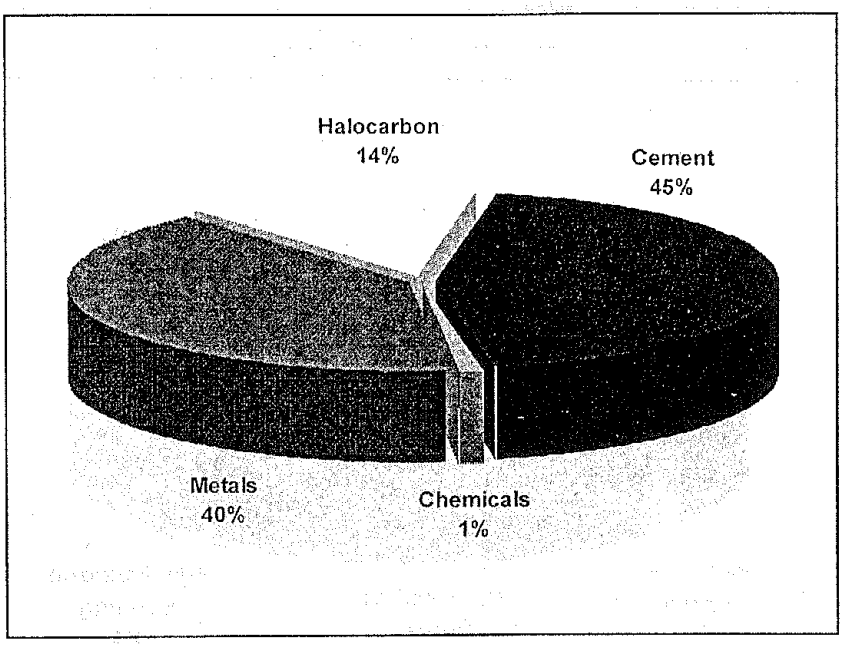

Figure ES-4. Subsector emissions from Industrial Processes.

In the other sectors of Agriculture and Waste, CH_4 and N_2O, rather than CO_2, are the significant GHGs emitted. Both Table ES-5 and Figure ES-5 show the equivalent CO_2 emissions attributed to Agriculture.

In this sector, non-CO_2 GHGs are emitted mostly from rice cultivation, domestic livestock, and agricultural soils. CH_4 emissions from rice paddies comprise about 40% of the Agriculture emissions and are due mostly to the anaerobic decomposition of organic matter in these aquaeous environments. Emissions from domestic livestock are derived mainly from enteric fermentation and manure management of animals such as buffalo, cattle, and swine. The total of 33,137 kt of equivalent CO_2 released from Agriculture (about 32% of the non-LUCF total of GHG emissions) indicates that next to Energy, this sector is an important source of GHGs in the atmosphere.

Table ES-5. Equivalent CO_2 emissions from Agriculture

Subsector	CO_2 Emissions (Gg)
Rice Cultivation	13,364
Domestic Livestock	10,497
Agricultural Residue Burning	583
Agricultural Soils	8,685
Grassland Burning	8
TOTAL	33,137

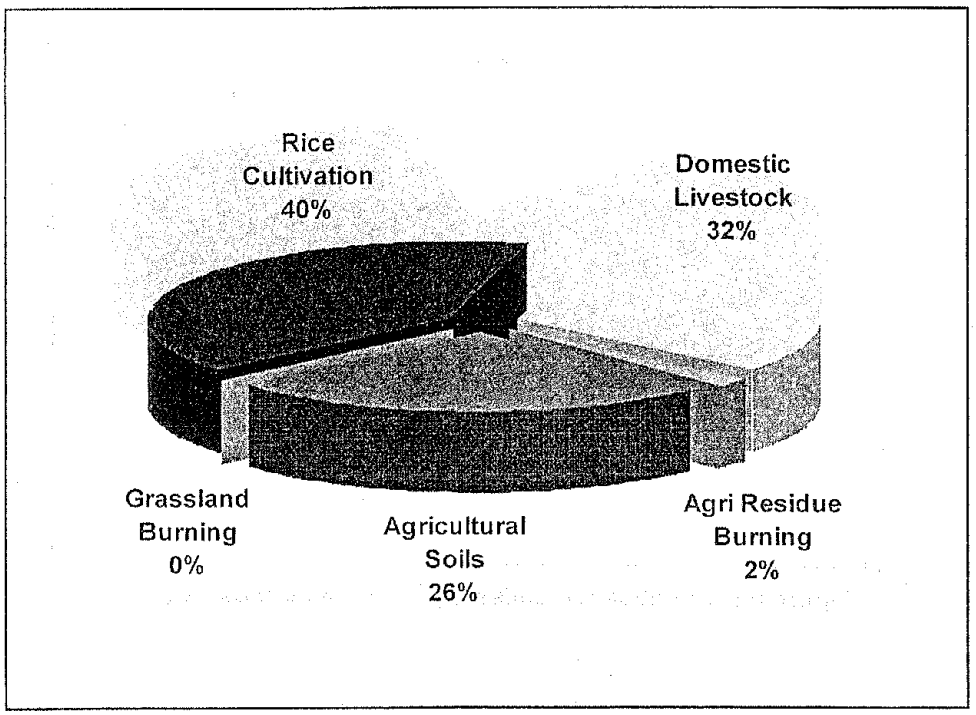

Figure ES-5. Subsector emissions from Agriculture.

GHG emissions from the Waste sector come from solid waste, domestic and industrial wastewater, and human sewage. About 60% of the CH_4 emissions in this sector is from solid waste as shown in Table ES-6 and Figure ES-6. In 1994, an estimated 4,200 kt of solid waste were brought to solid waste disposal sites. This amount does not consider the waste that was either uncollected or indiscriminately dumped in streams or urban waterways. The dumping of this amount of solid waste released about 203 kt of CH_4, equivalent to emitting around 4,253 kt of CO_2 into the atmosphere (using current GWP assumptions). Industrial wastewater, municipal wastewater, and human sewage share almost equally the other 40% of GHG emissions from this sector.

Table ES-6. Equivalent CO_2 emissions from Waste

Subsector	CO_2 Emissions (Gg)
Solid Waste	6,357
Domestic Wastewater	966
Industrial Wastewater	920
Human Sewage	954
TOTAL	**9,198**

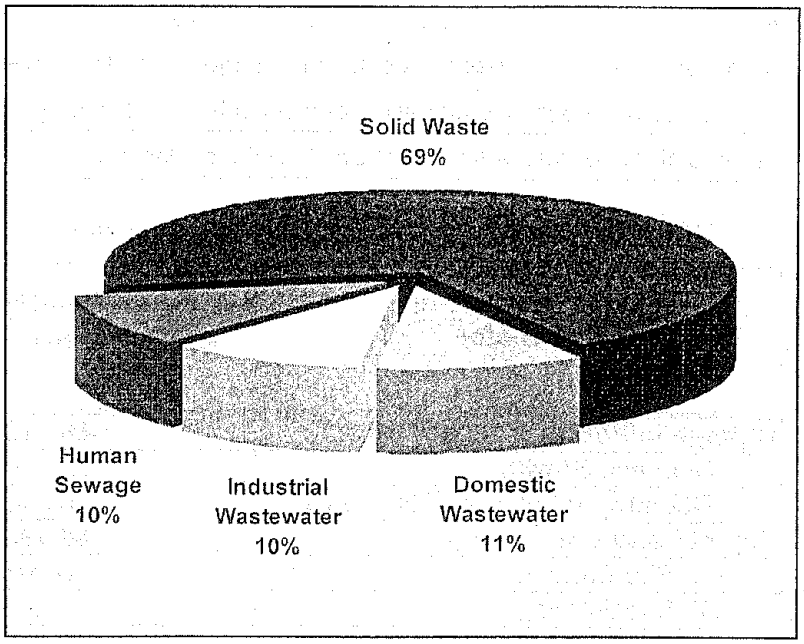

Figure ES-6. Subsector emissions from Waste.

The apparently insignificant total of 127 kt of CO_2 sequestered by the LUCF sector is due to the net impact of non-negligible changes in biomass growth and land use/forest conversion. As shown in Figure ES-7, LUCF sources and sinks individually rise to about 68% of the national total pf GHG emissions from the four non-LUCF sectors. Biomass growth alone from our forested lands and other land use categories is a major factor in bringing GHGs from the atmosphere back into the biosphere. This sink, however, is offset by biomass loss associated with forest harvest and deforestation. The land use area under consideration was about 16 Mha and the biomass growth of these land areas resulted in a cumulative uptake of 110,704 kt CO_2. However, carbon that is sequestered by the annual growth of these different vegetative types is offset by the yearly removal of biomass via harvest and deforestation. Roundwood/Fuelwood harvests in 1994 account for 42,381 kt of CO_2 emitted. Additionally, forest and land use conversion released a total of 68,197 kt CO_2. This includes emissions from activities

such as on site burning (for clearing purposes), off site burning (for domestic/industrial fuelwood), and biomass decay.

The net LUCF contribution is still not complete since biomass growth and loss are not the only determining components of this total. The still unknown impact of Philippine soil carbon and of biomass growth in abandoned lands together with uncertainties in local biomass densities and growth rates make it difficult to obtain a more complete value for the contribution of the LUCF sector to the national GHG emissions total. Despite the uncertainties, present calculations suggest that for the Philippines in 1994, the result of both carbon sequestration and release in LUCF suggests that this sector is still a net sink rather than a source of GHGs in the atmosphere.

Table ES-7. Equivalent CO_2 emissions from LUCF

Subsector	CO_2 Emissions(+) and Uptake(-) (Gg)
Change in Forest/Woody Biomass	**-68,323**
Biomass Growth	-110,704
Roundwood/Fuelwood Harvests	42,381
Forest/Land Use Change	**68,195**
On Site Burning	28,866
Off Site Burning	6,555
Decay	32,774
TOTAL	**-127**

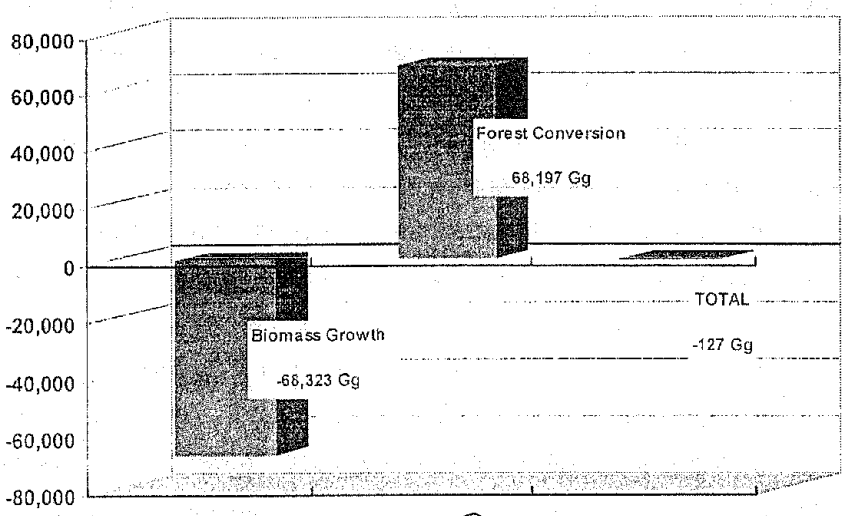

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Figure ES-7. Equivalent CO_2 sources and sinks in LUCF.

A summary of the inventory of sectoral sources and sinks; including the non-CO2 GHGs, is shown below in Table ES-8.

Table ES-8. 1994 GHG Inventory Summary

1994 PHILIPPINE GREENHOUSE GAS INVENTORY (Gg)							
SECTOR and SOURCE CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
I. ENERGY							
A. Fuel Combustion Activities							433.36
1. Energy Industries	15,458	0.51	0.13	38.47	2.83	0.91	
2. Manufacturing Industries	8,980	8.08	1.12	60.93	986.71	13.81	
3. Transport	15,801	2.15	0.14	167.37	719.44	136.77	
4. Commercial/Institutional	3,368	0.06	0.00	0.63	0.13	0.03	
5. Residential	2,544	72.83	0.92	29.22	1,356.21	133.02	
6. Agriculture	1,185	0.11	0.01	1.08	0.22	0.05	
B. Fugitive Emissions from Fuels							
1. Coal Mining		10.32					
2. Oil		0.47		0.62	16.83	7.61	8.94
C. Biomass Emissions *	48,490						
TOTAL EMISSIONS FROM ENERGY	47,335	94.53	2.31	298	3,082	292	442
CO_2 EQUIVALENT	47,335	1,985	717				
TOTAL CO_2 EQUIVALENT	50,038						
II. INDUSTRY							
A. Cement	4,771						2.87
B. Chemicals	94	0.24		0.01	0.22	1.46	9.81
C. Asphalt				0.00	0.00	0.00	0.00
D. Food and Beverages						16.35	
E. Pulp and Paper				0.12	0.44	0.29	0.56
F. Metals	4,334			0.11	0.00	0.08	0.12
G. Halocarbons	1,507						
TOTAL EMISSIONS FROM INDUSTRY	10,707	0.24	0.00	0.23	0.66	18.18	13.35
CO_2 EQUIVALENT	10,707	5	0				
TOTAL CO_2 EQUIVALENT	10,711						
III. AGRICULTURE							
A. Domestic Livestock		333.47	11.27				
B. Rice Cultivation		636.40					
C. Grassland Burning		0.30	0.00	0.14	7.94		
D. Agricultural Residue Burning		20.34	0.50	18.14	427.23		
E. Agricultural Soils			28.02				
TOTAL EMISSIONS FROM AGRICULTURE		990.51	39.80	18	435		
CO_2 EQUIVALENT		20,801	12,337				
TOTAL CO_2 EQUIVALENT	33,137						
IV. WASTE							
A. Solid Wastes		302.73					
B. Domestic/Commercial Wastewater		46.02					
C. Industrial Wastewater		43.83					
D. Human Sewage			3.08				
TOTAL EMISSIONS FROM WASTE		392.58	3.08				
CO_2 EQUIVALENT		8,244	954				
TOTAL CO_2 EQUIVALENT	9,198						
V. LAND USE CHANGE AND FORESTRY							
A. Change in Forest/Woody Biomass	-68,323						
B. Forest/Land Use Change	65,549	114.41	0.79	28.43	1,001.11		
TOTAL EMISSIONS FROM LUCF	-2,774	114	1				
CO_2 EQUIVALENT	-2,774	2,403	244				
TOTAL CO_2 EQUIVALENT	-127						
TOTAL NAT'L GREENHOUSE GAS EMISSIONS	55,268	1,592	46	317	3,518	310	456
EQUIVALENT CO_2	55,268	33,436	14,252				
TOTAL NAT'L EQUIVALENT CO_2 EMISSIONS	102,957						

*CO_2 emissions from biomass are not included in the total (IPCC, 1996)