2 NATIONAL GREENHOUSE GAS INVENTORY

2.1 Introduction

This section presents an outline of the first GHG inventory undertaken for the Republic of Maldives. This inventory serves as a baseline for the greenhouse gas emissions in the Maldives for 1994 and has been developed using IPCC Reference Approach.

An attempt was made to report the emission of all the three major GHGs; CO_2, CH_4 and N_2O from energy, transport, industry, agriculture, forestry and waste management sectors. However, the lack of data prevented the use of the sector approach to estimate the emissions of all the gases from all sectors. Emission of CO_2 from the energy sector has been taken as the main GHG for the Maldives. However CH_4 emissions from landfill have also been calculated depending on the availability of data.

Land use, land use changes and agriculture were considered insignificant in the development of this GHG inventory as the islands of the Maldives are sparsely vegetated. Hence, sinks of GHGs were not accounted in this inventory, as there was no available data to carry out the required estimation of sinks as described in the IPCC (1996) guidelines.

2.2 Methodology

The GHG inventory of the Maldives was developed using 1994 as the base year. The IPCC Reference Approach with default methods and factors were used to estimate CO_2 emission from the energy sector and the CH_4 emitted by solid waste. The emission of CO_2 from the energy sector for the internationally bunkered aviation and marine fuels has been reported separately in accordance with the guidelines for the preparation of the initial NC of the non-annex I countries.

In the Maldives only secondary fuels are used in the energy sector. Since an import duty is levied on fuels, the Maldives Customs Service keeps a detailed record of the amount of fuels that have been imported into the country. The quantities of fuels imported were obtained from the

Maldives Customs Statistical Year Book, 1994. Data on international aviation bunkering and marine bunkering were obtained from the Maldives Airports Company Limited and the State Trading Organisation respectively.

The availability of the data on the amount of solid waste at Thilafushi landfill, which is in operation for the central region made it possible to calculate the amount of CH_4 emitted by solid waste. Thilafushi is the only solid waste landfill operating in the Maldives.

Emission of CH_4 from landfills was calculated from the data provided by the Waste Management Section of the Ministry of Construction and Public Works. This data was based upon a study conducted by the Japan International Co-operation Agency (JICA) in 1999 on *Solid Waste Management for Malé City in the Maldives*. This study provided the data for the rate of solid waste generated and the composition of the municipal solid waste generated in the Maldives.

2.2.1 Assumptions

In applying the IPCC Reference Approach, it was assumed that the stock change for the fuels used in the Maldives was zero. The fuel in the stock is used as a reserve and it was therefore assumed that the fuel imported would be consumed in that particular year.

Although there exists one solid waste landfill in the Maldives, solid waste is disposed on open dumps throughout the country. Hence, the entire population was considered when CH_4 emissions from solid waste disposal were calculated. It was also assumed that the rate of decomposable component of the municipal solid waste generated in 1999 also applied to 1994 since only 1999 data on the waste composition was available.

The economy of the Maldives depends heavily on the tourism sector, which consumes a large proportion of the fuels imported to the country. However, no attempt was made, due to lack of availability of data, to estimate the percentage contribution of tourists to the reported emission of GHGs for the Republic of Maldives.

2.3 Results and analysis

2.3.1 Emission of CO_2 from the energy sector

The Table 2-1 shows the amount and the type of fuels consumed within the Maldives and respective emission of CO_2 from each fuel type.

Fuel type	Fuel consumed within Maldives (Mt)	Emission of CO_2 (Gg)
Gasoline	3.127	10.182
Jet Kerosene	3.541	11.175
Other Kerosene	0.013	0.043
Gas/Diesel	65.556	103.465
LPG	1.107	3.033
Bitumen	0.006	0.009
Lubricants	0.719	1.048
Total	115.246	128.995

Table 2-1: National CO_2 emissions by fuel type (1994)

In 1994, it is estimated that 129 Gg of CO_2 was emitted by the energy sector in the Maldives. This contributed 0.54 tonnes of CO_2 per capita.

2.3.2 Emission of CO_2 by fuel type

Figure 2-1 shows that diesel is the main fuel type consumed to meet the energy demand in the country. As mentioned in Chapter 1, diesel is primarily used to generate electricity and for marine vessels. Gasoline is used to power vehicles and speed boats. Although a large quantity of jet kerosene is imported, only 10% of the fuel is used within the country. 90% of the imported jet kerosene is used in intentional aviation bunkering. The large quantity of aviation fuel is internationally bunkered because a large number of tourists travel to and from the Maldives by air (MAC, 2000; STO, 2000; Villa, 2000).

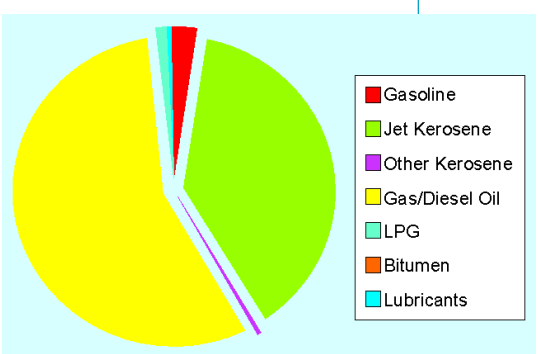

Figure 2-1: Relative contributions of fuels to meeting national energy demand

Table 2-2 shows that the consumption of diesel emits most of the CO_2 from the Maldives. This can again be linked to the importance of tourism to the Maldives. The resorts of the Maldives are self-contained and all the facilities, like the generation of electricity and production of freshwater from desalination, depends on burning of diesel. In 1994, 73 tourist resort islands were in operation (MoT, 2000). Each of these resorts would consume large amounts of diesel to provide the necessary services for the tourists in the resort islands.

Fuel Type	CO_2 (%)
Gasoline	7.90
Jet Kerosene	8.67
Other Kerosene	0.03
Gas/Diesel	80.23
LPG	2.35
Bitumen	0.01
Lubricants	0.81

Table 2.2: Relative contributions of fuels to emissions of CO_2

2.3.3 Methane emission from landfill

In 1999, it was estimated that daily generation of solid waste was at 0.518 kilogram per capita. The fraction of biodegradable organic carbon in the municipal solid waste was estimated to be at 0.12 (JICA, 1999). Using IPCC (1996) methodologies for the development of GHG inventories, it was calculated that 1.142 Gg of CH_4 was emitted from the disposal of municipal solid waste.

2.4 Bunkered fuels

According to the IPCC guidelines for the development of National GHG Inventory, the emission of GHG from internationally bunkered aviation and marine fuels is not counted in the national GHG emissions. Table 2-3 shows the amount of fuels bunkered and the emission of CO_2 from each of the fuel type bunkered.

Bunkered Type	Fuel Type	Fuel imported (Mt)	Fuel Bunkered (Mt)	CO_2 emission by bunkered fuel (Gg)
Aviation	Jet Kerosene	44.29	40.75	128.62
Marine	Gas/Diesel	65.98	0.43	1.36
	Total	110.27	41.18	129.98

Table 2-3: Internationally bunkered fuels

2.5 Shortcomings encountered when preparing the inventory

The lack of the detailed data required for the sector approach was the biggest shortfall of this initial National GHG Inventory for the Maldives. No data was available to estimate emissions of GHGs in all sectors. However, it is believed that the IPCC Reference Approach with the avail

able data is sufficient when estimating the emissions of CO_2 from the energy sector in the Maldives.

To strengthen the data analysis for any subsequent GHG inventories, it will be necessary to strengthen the relevant sections of the government departments and other agencies responsible for collecting the data necessary to prepare a more detailed GHG inventory. Institutional strengthening and other forms of capacity building will be required.

2.6 Confidence and uncertainty of data in the GHG inventory

Limitations in the statistical data on fuel imports, consumption and energy balances have led to uncertainty in emission estimates. Other sources of uncertainty may arise from the use of default emission factors not appropriate to the local circumstances. For this analysis the IPCC Reference Approach has been used, further elaboration of the uncertainties in the emission estimates is not possible until estimates using the sector based approach are also available. Such information will hopefully become available when the next inventory is prepared, and can thus be included in the next NC.

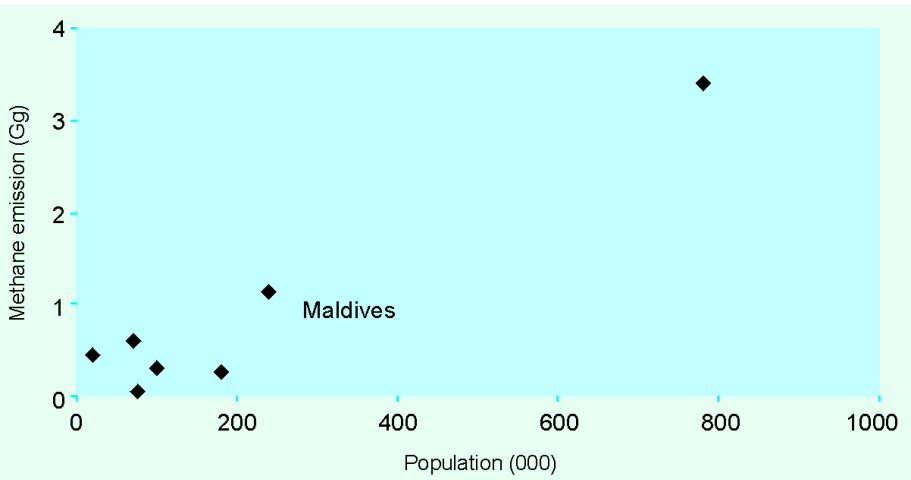

Figure 2-2: CH_4 emissions from solid waste disposal (SPREP, 2000 and Maldives GHG Inventory)

To develop an initial GHG inventory for the Maldives, the estimated amount of CO_2 emitted was validated using an inter-country comparison using CO_2 emitted from the small island countries in the Pacific. The basis of this comparison is that emission of GHGs depends on the population and the type of activities carried out in the given country. The analysis indicates that the amount of CO_2 emitted by the energy

sector in the Maldives is consistent with the range of values for the small island countries. Further, the value calculated for the CH_4 emission for the Maldives was plotted against population, along with similar data for the Pacific island countries. As seen from Figure 2-2 the calculated CH_4 emissions for the Maldives from the solid waste disposal is very similar to those values obtained for Pacific island countries.

As seen in Figure 2-3 the amount of CO_2 emitted by the energy sector in the Maldives is consistent with the range of values for the small island countries of the Pacific.

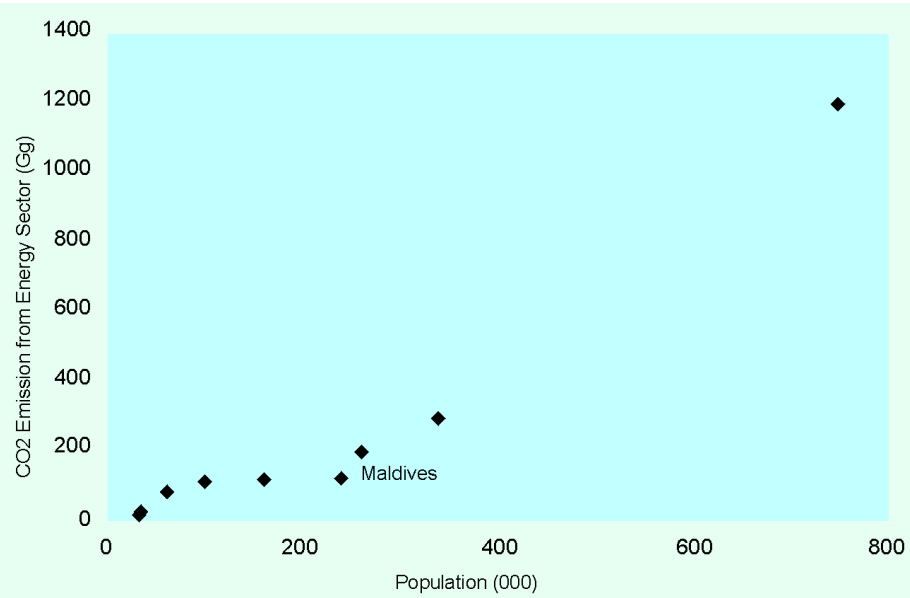

Figure 2-3: CO_2 emissions by energy sector (Gg)

2.7 Comparisons with other countries

2.7.1 The contribution of Maldives to global GHG emissions

Table 2-4 presents a comparison between the CO_2 emissions from the energy sector of the Maldives with those from groupings of other countries. The energy sector is the main contributor to GHG emissions by the Maldives. The Maldives emitted 0.13 Mt of CO_2, which is only 0.0012% of the global CO_2 emissions from the energy sector (see Table 2-5)

	Population (millions)	CO_2 emission per capita (t)	Total CO_2 emission (Mt)
Kiribati	0.08	0.23	0.19
Tuvalu	0.01	0.50	0.01
Maldives	0.24	0.54	0.13
Marshall Islands	0.04	3.54	0.16
Cook Islands	0.05	0.69	0.03
World	5624.4	4.02	22620.46
OECD	1092.3	11.09	12117.05

Table 2-4: Relative CO_2 emissions from the energy sector (Hay & Sems, 1999; GRMAIPA, 2000)

Table 2-5: Comparison of CO_2 emissions (Hay and Sems, 1999)

	% of Global Emissions	% of Global Population
Maldives	0.0012	0.004
OECD	54.0000	19.000

Table 2-6: Emission of GHG from various sectors for the Maldives

GHG source and sinks (Gg)	CO_2	CH_4	N_2O
Energy	129.0	-	-
Industrial Process	-	-	-
Agriculture	-	-	-
Land use change and forestry	-	-	-
Landfills	-	1.1	-
Total (Net) national emissions (Gg)	***129.0***	***1.1***	***-***