CHAPTER 2

WASTE GENERATION, COMPOSITION AND MANAGEMENT DATA

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2 WASTE GENERATION, COMPOSITION AND MANAGEMENT DATA

2.1 INTRODUCTION

The starting point for the estimation of greenhouse gas emissions from solid waste disposal, biological treatment and incineration and open burning of solid waste is the compilation of activity data on waste generation, composition and management. General guidance on the data collection for solid waste disposal, biological treatment and incineration and open burning of waste is given in this chapter in order to ensure consistency across these waste categories. More detailed guidance on choice of activity data, emission factors and other parameters needed to make the emission estimates is given under Chapter 3, Solid Waste Disposal, Chapter 4, Biological Treatment of Solid Waste, and in Chapter 5, Incineration and Open Burning of Waste.

Solid waste generation is the common basis for activity data to estimate emissions from solid waste disposal, biological treatment, and incineration and open burning of waste. Solid waste generation rates and composition vary from country to country depending on the economic situation, industrial structure, waste management regulations and life style. The availability and quality of data on solid waste generation as well as subsequent treatment also vary significantly from country to country. Statistics on waste generation and treatment have been improved substantially in many countries during the last decade, but at present only a small number of countries have comprehensive waste data covering all waste types and treatment techniques. Historical data on waste disposal at SWDS are necessary to estimate methane (CH_4) emissions from this category using the First Order Decay method (see Chapter 3 Solid Waste Disposal, Section 3.2.2). Very few countries have data on historical waste disposal going back several decades.

Solid waste is generated from households, offices, shops, markets, restaurants, public institutions, industrial installations, water works and sewage facilities, construction and demolition sites, and agricultural activities (emissions from manure management as well as on-site burning of agricultural residues are treated in the Agriculture, Forestry and Other Land Use (AFOLU) Volume). It is *good practice* to account for all types of solid waste when estimating waste-related emissions in the greenhouse gas inventory.

Solid waste management practices include: collection, recycling, solid waste disposal on land, biological and other treatments as well as incineration and open burning of waste. Although recycling (material recovery)[1] activities will affect the amounts of waste entering into other management and treatment systems, the impact on emissions due to recycling (e.g., changes in emissions in production processes and transportation) is covered under other sectors and will not be addressed here in more detail.

2.2 WASTE GENERATION AND MANAGEMENT DATA

Guidance on how to collect data on waste generation and management practices is given separately for municipal solid waste (MSW), sludge, industrial and other waste. Default definitions for these categories are given below. These default definitions are used in the subsequent methodological guidance. The definitions are transparent to allow for country-specific modifications, as waste categorisation varies much from country to country, and can encompass different waste components.[2] If the available data used in the inventory cover only certain waste types or sources (e.g., municipal waste), this limited availability should be documented clearly in the inventory report and efforts should be made to complement the data to cover all waste types.

In the Section 2.3 Waste Composition, default compositions are given for these default waste categories. The default compositions are used as the basis for the calculations for Tier 1 methods.

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[1] Recycling is often defined to encompass also waste-to-energy activities and biological treatment. For practical reasons a more narrow definition is used here: Recycling is defined as recovery of material resources (typically paper, glass, metals and plastics, sometimes wood and food waste) from the waste stream.

[2] Some countries do not use these broad waste categories but a more detailed classification, e.g., the Regulation of the European Parliament and Council on waste statistics (EC no 2150/2002) that does not include municipal solid waste as a category.

2.2.1 Municipal Solid Waste (MSW)

Municipal waste is generally defined as waste collected by municipalities or other local authorities. However, this definition varies by country. Typically, MSW includes:

- Household waste;
- Garden (yard) and park waste; and
- Commercial/institutional waste.

The regional default composition data for MSW is given in Section 2.3.1.

Default data

Region-specific default data on per capita MSW generation and management practices are provided in Table 2.1. These data are estimated based on country-specific data from a limited number of countries in the regions (see Annex 2A.1). These data are based on weight of wet waste[3] and can be assumed to be applicable for the year 2000. Waste generation per capita for subsequent or earlier years can be estimated using the guidance on how to estimate historical emissions from SWDS in Chapter 3, Section 3.2.2, and the methods for extrapolation and interpolation using drivers in Chapter 6, Time Series Consistency, in Volume 1, General Guidance and Reporting.

TABLE 2.1
MSW GENERATION AND TREATMENT DATA - REGIONAL DEFAULTS

Region	MSW Generation Rate[1, 2, 3] (tonnes/cap/yr)	Fraction of MSW disposed to SWDS	Fraction of MSW incinerated	Fraction of MSW composted	Fraction of other MSW management, unspecified[4]
Asia					
Eastern Asia	0.37	0.55	0.26	0.01	0.18
South-Central Asia	0.21	0.74	-	0.05	0.21
South-East Asia	0.27	0.59	0.09	0.05	0.27
Africa[5]	0.29	0.69	-	-	0.31
Europe					
Eastern Europe	0.38	0.90	0.04	0.01	0.02
Northern Europe	0.64	0.47	0.24	0.08	0.20
Southern Europe	0.52	0.85	0.05	0.05	0.05
Western Europe	0.56	0.47	0.22	0.15	0.15
America					
Caribbean	0.49	0.83	0.02	-	0.15
Central America	0.21	0.50	-	-	0.50
South America	0.26	0.54	0.01	0.003	0.46
North America	0.65	0.58	0.06	0.06	0.29
Oceania[6]	0.69	0.85	-	-	0.15

[1] Data are based on weight of wet waste.

[2] To obtain the total waste generation in the country, the per-capita values should be multiplied with the population whose waste is collected. In many countries, especially developing countries, this encompasses only urban population.

[3] The data are default data for the year 2000, although for some countries the year for which the data are applicable was not given in the reference, or data for the year 2000 were not available. The year for which the data are collected, where available, is given in the Annex 2A.1.

[4] Other, unspecified, includes data on recycling for some countries.

[5] A regional average is given for the whole of Africa as data are not available for more detailed regions within Africa.

[6] Data for Oceania are based only on data from Australia and New Zealand.

[3] Wet waste is not treated before measuring, while dry weight is estimated after drying waste under certain temperature, ventilation and time conditions before measuring. In the conversions in this Volume (see e.g., Table 2.4) the assumption is that no moisture is left in the dry matter.

Country-specific data

It is *good practice* that countries use data on country-specific MSW generation, composition and management practices as the basis for their emission estimation.

Country-specific data on MSW generation and management practices can be obtained from waste statistics, surveys (municipal or other relevant administration, waste management companies, waste association organisations, other) and research projects (World Bank, OECD, ADB, JICA, U.S.EPA, IIASA, EEA, etc.).

Large countries with differences in waste generation and treatment within the domestic regions are encouraged to use data from these regions to the extent possible. Additional guidance on data collection in general and on waste surveys is given in Chapter 2, Approaches to Data Collection, in Volume 1.

Data from waste stream analyses

MSW treatment techniques are often applied in a chain or in parallel. A more accurate but data intensive approach to data collection is to follow the streams of waste from one treatment to another taking into account the changes in composition and other parameters that affect emissions. Waste stream analyses should be combined with high quality country-specific data on waste generation and management. The approach is often complemented with modelling. When using this approach, it is *good practice* to verify the data using separately collected data on MSW generation, treatment and disposal, especially in cases where they are based largely on modelling. This method is only more accurate than the approaches given above if countries have good quality, detailed data on each end point and have verified the information.

An example of applying the approach for estimating the amount of paper waste disposed at SWDS is given in Box 2.1, Example of Activity Data Collection for Estimation of Emissions from Solid Waste Treatment Based on Waste Stream Analysis by Waste Type. Using this approach following all waste streams in the country would provide activity data for all solid waste treatment and disposal (including waste incineration and open burning of waste). The data needed for the approach could be estimated based on surveys to industry, households and waste management companies/facilities, complemented with statistical data on MSW generation, treatment and disposal.

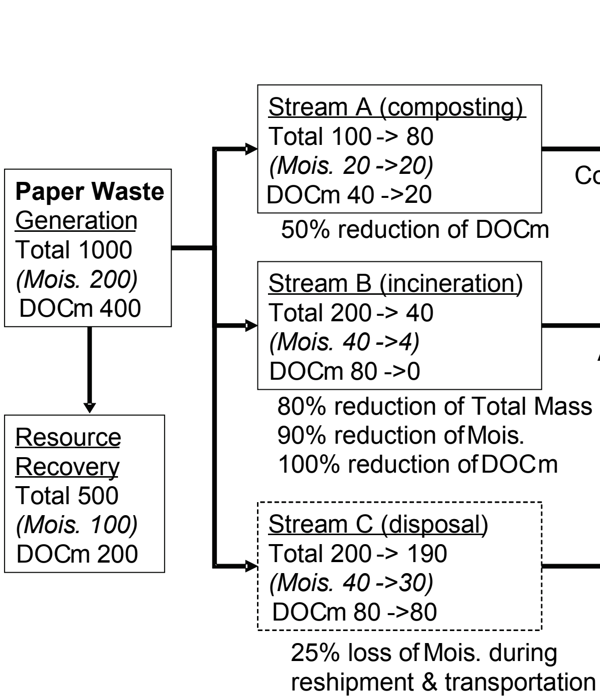
BOX 2.1
EXAMPLE OF ACTIVITY DATA COLLECTION FOR ESTIMATION OF EMISSIONS FROM SOLID WASTE TREATMENT BASED ON WASTE STREAM ANALYSIS BY WASTE TYPE

Waste streams begin at the point of generation, flow through collection and transportation, separation for resource recovery, treatment for volume reduction, detoxification, stabilisation, recycling and/or energy recovery and terminate at SWDS. Waste streams are country-specific. Traditionally most solid waste has been disposed at SWDS in many countries. Recent growing recognition of the need for resource conservation and environmental protection has increased solid waste recycling and treatment before disposal in developed countries. In developing countries, recovery of valuable material at collection, during transportation and at SWDSs has been common.

Degradable organic carbon (DOC) is one of the main parameters affecting the CH_4 emissions from solid waste disposal. DOC is estimated based on the waste composition, and varies for different waste fractions. Accurate estimates of the amount of waste and amount of DOC in waste (DOCm) disposed at SWDS could be achieved by sampling waste at the gate of SWDS and measuring DOCm in that waste, or specifying the waste stream for each waste type and/or source. Intermediate processes in the waste stream can significantly change physical and chemical properties of waste, including moisture and DOCm. DOCm in waste at SWDS will differ considerably from that at generation, depending on the treatment before the disposal. For those countries that do not have reliable data based on measurements on DOCm disposed at SWDS, the analysis on the change in mass of moisture and DOCm during earlier treatment for each waste type, could provide a method to avoid over-/under-estimating the CH_4 emissions at SWDS.

BOX 2.1 (CONTINUED)

EXAMPLE OF ACTIVITY DATA COLLECTION FOR ESTIMATION OF EMISSIONS FROM SOLID WASTE TREATMENT BASED ON WASTE STREAM ANALYSIS BY WASTE TYPE



Note 1: 'Mois.' means moisture and DOCm is the mass of degradable organic carbon.

Note 2: Values in each box give the weight of the total mass (Total), moisture (Mois.) and DOCm in mass units (tonnes or kilograms or other).

The figure above shows an example of a paper waste flow chart for analysis of change in DOCm in waste during the treatment before disposal. Some portion of paper waste would be recovered as material, and be diverted from the waste management flow. The DOCm in paper waste is reduced by intermediate processes, such as composting and incineration before disposal at the SWDS. Mass of total waste, DOCm and moisture at the exit of each process can be given by multiplying mass of these components at the entrance by reduction rates of the process. In this figure the changes of mass are studied for paper waste solely, although the treatment steps would usually include also other waste types. Incineration will remove most of the moisture, but the ash will be re-wetted to avoid the fly loss during transportation and loading into SWDS. Greenhouse gas emissions from other categories than SWDS (i.e., resource recovery, composting, incineration and use on land) should be estimated under guidelines in relevant chapters. The estimates in this figure are based on expert judgement only as an example.

To apply this approach national statistics on municipal waste generation and treatment streams, country-specific parameters on waste composition and fraction moisture as well as DOC estimates for each waste type are needed for precise estimation. It may be difficult to obtain all these data and parameters in many countries. If country-specific reduction rates of moisture and DOCm at each intermediate treatment step before disposal at SWDS can be obtained, estimated DOCm disposed into SWDS will be more precise than when based on data measured at generation.

2.2.2 Sludge

Sludge from domestic and industrial wastewater treatment plants is addressed as a separate waste category in this Volume. In some countries, sludge from domestic wastewater treatment is included in MSW and sludge from industrial wastewater treatment in industrial waste. Countries may also include all sludge in industrial waste. When country-specific categorisation is used, it should be documented transparently.

The emissions from sludge treatment at wastewater treatment facilities are treated in Chapter 6, Wastewater Treatment and Discharge. Chapters 3, 4 and 5 consider disposal, composting (and anaerobic digestion of sludge with other organic solid waste) and incineration of sludge, respectively. Sludge that is applied on agricultural land is considered in Volume 4, Agriculture, Forestry and Other Land Use, Chapter 11, Section 11.2, N_2O Emissions from Managed Soils. Double counting of the emissions between the different categories should be avoided. The amount of organic matter removed from wastewater treatment as sludge (see Equation 6.1 in Chapter 6) due to disposal into SWDS, composting, incineration or use in agriculture should be consistent with the amounts reported under these categories.

Default data for sludge generation, disposal into SWDS, composting or incineration are not given here.[4] If no country-specific data are available, the reporting of the emissions is covered by the methodology in Chapter 6. Default values for degradable organic carbon content in sludge are given in Section 2.3 Waste Composition, in this chapter.

2.2.3 Industrial waste

In some countries, significant quantities of organic industrial solid waste are generated.[5] Industrial waste generation and composition vary depending on the type of industry and processes/technologies in the concerned country. Countries apply various categorisations for industrial waste. For example, construction and demolition waste can be included in industrial waste, in MSW, or defined as a separate category. The default categorisation used here assumes construction and demolition waste are part of the industrial waste. In many countries industrial solid waste is managed as a specific stream and the waste amounts are not covered by general waste statistics. OECD (see e.g., OECD, 2002) collects statistical data on industrial waste generation and treatment. These statistics are published periodically. In most developing countries industrial wastes are included in the municipal solid waste stream, therefore, it is difficult to obtain data of the industrial waste separately.

Industrial solid waste disposal data may be obtained by surveys or from national statistics. Only those industrial wastes which are expected to contain DOC and fossil carbon should be considered for the purpose of emission estimation from waste. Construction and demolition waste is mainly inert (concrete, rubble, etc.) but may contain some DOC (see Section 2.3.3) in wood and some fossil carbon in plastics. Recycling and reduction using different technologies applied to industrial waste prior to disposal in SWDS or incineration should be taken into account, where data are available.

Default data

Industrial waste generation data (total industrial waste generation and data for manufacturing industries and construction waste) are given in Table 2.2 for some countries. The total amount includes also other waste types than those from manufacturing industries and construction. The data are based on weight of wet waste. Although significant amounts of industrial waste are generated, the rates of recycling/reuse are often high, and the fraction of degradable organic material from industrial waste disposed at solid waste disposal sites is often less than that of MSW. Incineration of industrial waste may take place in significant amounts, however this will vary from country to country. Composting or other biological treatment is restricted to waste from industries producing food and other putrescible waste. Countries for which no national data on industrial waste generation can be obtained and whose data are not given in Table 2.2, are encouraged to use data from countries, or a cluster of countries, with similar circumstances. Chapter 2, Approaches to Data Collection, in Volume 1 gives general guidance on data collection.

The data in Table 2.2 do not include data on industrial waste management practices. When country-specific data on industrial waste management are not available from other sources, the management can be assumed to follow the same pattern as management of MSW (see Table 2.1). For more accurate data, the inventory compilers are encouraged to contact relevant sources of information in the country, such as governmental agencies and local authorities responsible for industrial waste management as well as industrial organisations.

4 For some European countries, data on sewage waste disposal is collected by Eurostat (2005).

5 The default values provided in Table 2.1 do not include industrial solid waste.

TABLE 2.2
INDUSTRIAL WASTE GENERATION IN SELECTED COUNTRIES
(1,000 tonnes per year)

Region/ Country	Total	Manufacturing Industries	Construction
Asia			
China	1 004 280		
Japan		120 050	76 240
Singapore	1 423.5		
Republic of Korea		39 810	28 750
Israel	1 000		
Europe			
Austria		14 284	27 500
Belgium		14 144	9 046
Bulgaria		3 145	7
Croatia		1 600	142
Czech Republic		9 618	5 083
Denmark		2 950	3 220
Estonia	1 261.5		
Finland		15 281	1 420
France		98 000	
Germany		47 960	231 000
Greece		6 680	1 800
Hungary		2 605	707
Iceland		10	
Ireland		5 361	3 651
Italy		35 392	27 291
Latvia	1 103	422	7
Malta		25	206
Netherlands		17 595	23 800
Norway		415	4
Poland		58 975	143
Portugal		8 356	85
Romania		797	
Slovakia		6 715	223
Slovenia		1 493	
Spain		20 308	
Sweden		18 690	
Switzerland		1 470	6 390
Turkey		1 166	
UK		50 000	72 000
Oceania			
Australia		37 040	10
New Zealand		1 750	NR

Data are based on weight of wet waste.
The data are default data for the year 2000, although for some countries the year for which the data are applicable was not given in the reference, or data for the year 2000 were not available.
References:
Environmental Statistics Yearbook of China (2003)
Eurostat (2005)
Latvian Environment Agency (2004)
OECD (2002)
National environmental agency, Singapore (2001)
Estonian Environment Information Centre (2003)
Statistics Finland (2005)
Milleubalans (2005)

Country-specific industrial waste generation data

Some countries have statistical data on industrial waste generation and management. It is *good practice* to use country-specific data on industrial waste generation, waste composition (see Section 3.2.2) as well as management practices as the basis for the emission estimation. The data should to the extent possible be collected by industry types. If the available data cover only part of industry or industrial waste types, this limited availability should be documented clearly in the inventory report, as well as efforts made to complement the data to cover all industrial waste.

Data for the waste stream analyses

Approaches following the streams of waste from one treatment to another taking the changes in composition and other parameters affecting the emissions discussed in Section 2.2.1 could be used also for industrial waste. Data could be collected using surveys or be collected plant-by-plant.

2.2.4 Other waste

Clinical waste: These wastes include materials like plastic syringes, animal tissues, bandages, cloths, etc. Some countries choose to include these items in the MSW. Clinical waste is usually incinerated. However, some clinical waste may be disposed in SWDS. No regional or country-specific default data are given for clinical waste generation and management. In most countries, the amount of greenhouse gas emissions due to clinical waste appears to be insignificant. Default DOC and fossil carbon content in clinical waste are given in Section 2.3.4, Table 2.6.

Hazardous waste: Waste oil, waste solvents, ash, cinder and other wastes with hazardous nature, such as flammability, explosiveness, causticity, and toxicity, are included in hazardous waste. Hazardous wastes are generally collected, treated and disposed separately from non-hazardous MSW and industrial waste streams. Some hazardous wastes are incinerated and can contribute to the fossil CO_2 emissions from incineration (see Chapter 5) (Eurostat, 2005)[6]. Neutralisation and cement solidification are also treatment processes for hazardous waste. These processes applied together to organic sludge or other liquid-like waste with hazardous nature can reduce (or delay) greenhouse gas emissions at SWDS by isolation. In many countries it is prohibited to dispose hazardous waste at SWDS without pre-treatment. Emissions from solid waste disposal of hazardous waste are likely to be small. No regional or country-specific default data are given for hazardous waste generation and management. Default DOC and fossil carbon content in hazardous waste are given in Section 2.3.4, Table 2.6.

Agricultural waste: Manure management and burning of agricultural residues are considered in the AFOLU Volume. Agricultural waste which will be treated and/or disposed with other solid waste may however be included in MSW or industrial waste. For example, such waste may include manure, agricultural residues, dead body of live stock, plastic film for greenhouse and mulch.

[6] Eurostat (2005) collects data based on national statistics from European countries on hazardous waste generation and treatment.

2.3 WASTE COMPOSITION

2.3.1 Municipal Solid Waste (MSW)

Waste composition is one of the main factors influencing emissions from solid waste treatment, as different waste types contain different amount of degradable organic carbon (DOC) and fossil carbon. Waste compositions, as well as the classifications used to collect data on waste composition in MSW vary widely in different regions and countries.

In this Volume, default data on waste composition in MSW are provided for the following waste types:

(1) food waste

(2) garden (yard) and park waste

(3) paper and cardboard

(4) wood

(5) textiles

(6) nappies (disposable diapers)

(7) rubber and leather

(8) plastics

(9) metal

(10) glass (and pottery and china)

(11) other (e.g., ash, dirt, dust, soil, electronic waste)

Waste types from (1) to (6) contain most of the DOC in MSW. Ash, dust, rubber and leather contain also certain amounts of non-fossil carbon, but this is hardly degradable. Some textiles, plastics (including plastics in disposable nappies), rubber and electronic waste contain the bulk part of fossil carbon in MSW. Paper (with coatings) and leather (synthetic) can also include small amounts of fossil carbon.

Regional and country-specific default data on waste composition in MSW are given in Table 2.3. These data are based on weight of wet waste. Table 2.3 does not give default data for garden and park waste and nappies. In the Tier 1 default method these waste fractions can be assumed to be zero, i.e., they can be assumed to be encompassed by the other waste types.

TABLE 2.3
MSW COMPOSITION DATA BY PERCENT - REGIONAL DEFAULTS

Region	Food waste	Paper/cardboard	Wood	Textiles	Rubber/leather	Plastic	Metal	Glass	Other
Asia									
Eastern Asia	26.2	18.8	3.5	3.5	1.0	14.3	2.7	3.1	7.4
South-Central Asia	40.3	11.3	7.9	2.5	0.8	6.4	3.8	3.5	21.9
South-Eastern Asia	43.5	12.9	9.9	2.7	0.9	7.2	3.3	4.0	16.3
Western Asia & Middle East	41.1	18.0	9.8	2.9	0.6	6.3	1.3	2.2	5.4
Africa									
Eastern Africa	53.9	7.7	7.0	1.7	1.1	5.5	1.8	2.3	11.6
Middle Africa	43.4	16.8	6.5	2.5		4.5	3.5	2.0	1.5
Northern Africa	51.1	16.5	2	2.5		4.5	3.5	2	1.5
Southern Africa	23	25	15						
Western Africa	40.4	9.8	4.4	1.0		3.0	1.0		
Europe									
Eastern Europe	30.1	21.8	7.5	4.7	1.4	6.2	3.6	10.0	14.6
Northern Europe	23.8	30.6	10.0	2.0		13.0	7.0	8.0	
Southern Europe	36.9	17.0	10.6						
Western Europe	24.2	27.5	11.0						
Oceania									
Australia and New Zealand	36.0	30.0	24.0						
Rest of Oceania	67.5	6.0	2.5						
America									
North America	33.9	23.2	6.2	3.9	1.4	8.5	4.6	6.5	9.8
Central America	43.8	13.7	13.5	2.6	1.8	6.7	2.6	3.7	12.3
South America	44.9	17.1	4.7	2.6	0.7	10.8	2.9	3.3	13.0
Caribbean	46.9	17.0	2.4	5.1	1.9	9.9	5.0	5.7	3.5

TABLE 2.3 (CONTINUED)
MSW COMPOSITION DATA BY PERCENT - REGIONAL DEFAULTS

Note 1: Data are based on weight of wet waste of MSW without industrial waste at generation around year 2000.

Note 2: The region-specific values are calculated from national, partly incomplete composition data. The percentages given may therefore not add up to 100%. Some regions may not have data for some waste types - blanks in the table represent missing data.

Sources:

Doorn and Barlaz (1995)

Hoornweg (1999)

Vishwanathan and Trakler (2003a and b)

Shimura *et al*. (2001)

www.defra.gov.uk/environment/statistics/wastats/mwb0203/wbch04.htm

www.climatechange.govt.nz/resources/reports/nir-apr04

CONADE/SEDUE (1992); INE/SMARN (2000)

U.S. EPA (2002)

BID/OPS/OMS (1997)

Monreal (1998)

JICA (1991)

OPS/OMS (1997)

Ministerio de Desarrollo Social y Medio Ambiente/Secretaría de Desarrollo Sustentable y Política Ambiental (1999)

López, C. (2006). Personal Communication.

Ministry of Science and Technology, Brazil (2002)

U.S. EPA (1997)

MAG/SSERNMA/DOA-PNUD/UNITAR (1999)

López *et al*. (2002)

Default values for DOC and fossil carbon content in different waste types is given in Table 2.4. Table 2.4 gives default values also for garden and park waste, and disposable nappies. These waste types were not included in Table 2.3 due to lack of data. All fractions in the Table 2.4 are given as percentages.

TABLE 2.4
DEFAULT DRY MATTER CONTENT, DOC CONTENT, TOTAL CARBON CONTENT AND FOSSIL CARBON FRACTION OF DIFFERENT MSW COMPONENTS

MSW component	Dry matter content in % of wet weight [1]	DOC content in % of wet waste		DOC content in % of dry waste		Total carbon content in % of dry weight		Fossil carbon fraction in % of total carbon	
	Default	Default	Range	Default	Range [2]	Default	Range	Default	Range
Paper/cardboard	90	40	36 - 45	44	40 - 50	46	42 - 50	1	0 - 5
Textiles [3]	80	24	20 - 40	30	25 - 50	50	25 - 50	20	0 - 50
Food waste	40	15	8 - 20	38	20 - 50	38	20 - 50	-	-
Wood	85 [4]	43	39 - 46	50	46 - 54	50	46 - 54	-	-
Garden and Park waste	40	20	18 - 22	49	45 - 55	49	45 - 55	0	0
Nappies	40	24	18 - 32	60	44 - 80	70	54 - 90	10	10
Rubber and Leather	84	(39) [5]	(39) [5]	(47) [5]	(47) [5]	67	67	20	20
Plastics	100	-	-	-	-	75	67 - 85	100	95 - 100
Metal [6]	100	-	-	-	-	NA	NA	NA	NA
Glass [6]	100	-	-	-	-	NA	NA	NA	NA
Other, inert waste	90	-	-	-	-	3	0 - 5	100	50 - 100

[1] The moisture content given here applies to the specific waste types before they enter the collection and treatment. In samples taken from collected waste or from e.g., SWDS the moisture content of each waste type will vary by moisture of co-existing waste and weather during handling.

[2] The range refers to the minimum and maximum data reported by Dehoust *et al*., 2002; Gangdonggu, 1997; Guendehou, 2004; JESC, 2001; Jager and Blok, 1993; Würdinger *et al*., 1997; and Zeschmar-Lahl, 2002.

[3] 40 percent of textile are assumed to be synthetic (default). Expert judgement by the authors.

[4] This value is for wood products at the end of life. Typical dry matter content of wood at the time of harvest (that is for garden and park waste) is 40 percent. Expert judgement by the authors.

[5] Natural rubbers would likely not degrade under anaerobic condition at SWDS (Tsuchii et al., 1985; Rose and Steinbüchel, 2005).

[6] Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common.

DOC values for different waste types, which are derived from analyses based on sampling during waste collection at SWDS or at incineration facilities, may include impurities, e.g., traces of food in glass and plastic waste. Carbon contents of paper, textiles, nappies, rubber and plastic may also be different between countries and at different time periods. These analyses may therefore result in DOC estimates different from those given in Table 2.4. It is *good practice* to use DOC values consistently with the way the waste composition data are derived.

The best composition data can be obtained by routine monitoring at the gate of SWDS or incineration and other treatment facilities. If these data are not available, composition data obtained at generation and/or transportation, treatment and recycling facilities can be used for disposed DOC estimations using waste stream analysis (see Box 2.1).

Waste can be sampled at pits in waste treatment facilities, at loading yards in transportation stations and SWDS. Composition data of disposed waste can be obtained from field sampling at SWDS. The amount of waste (typically more than 1 m^3 for a representative sample) should be separated manually into each item and weighed by item in order to obtain wet weight composition. A certain amount of each item should be reduced and sampled by quartering and used for chemical analysis including moisture and DOC. Samples should be taken on different days of the week.

MSW composition will vary by city in a same country. It will also vary by the day of the week, season and year in the same city. National representative (or average) composition data should be obtained from sampling at several typical cities on same days of the week in each season. Sampling at SWDS on rainy days will change moisture content (i.e., wet weight composition) significantly, and needs attention in interpretation of that in annual data.

Analyses to determine the national waste composition should be based on appropriate sampling methods (see Volume 1, Chapter 2, Approaches to Data Collection) and be repeated periodically to cover changes in waste generation and management. The sampling methods, frequency of sampling and implications on time series should be documented.

The default DOC values given in Table 2.4 are used in estimating CH_4 emissions from and carbon stored in SWDS (see Chapter 3). The default total carbon contents and fossil carbon fractions for estimating fossil CO_2 emissions from incineration and open burning are also given in Table 2.4.

2.3.2 Sludge

The DOC content in sludge will vary depending on the wastewater treatment method producing the sludge, and also be different for domestic and industrial sludge.

For domestic sludge, the default DOC value (as percentage of wet waste assuming a default dry matter content of 10 percent) is 5 percent (range 4 - 5 percent, which means that the DOC content would be 40-50 percent of dry matter).

A rough default value of 9 percent DOC (assuming the dry matter content to be 35 percent) can be used for industrial sludge, when country and/or industry-specific is not available. The default DOC value applies for total industrial sludge in a country. Sewage, food industry, textile industry and chemical industry will generate organic sludge. DOC is also found in sludge from water work and dredging. The DOC in sludge can vary much by industry type. Examples of carbon contents in some organic sludge (percentage of dry matter) in Japan are: 27 percent for pulp and paper industry, 30 percent for food industry and 52 percent for chemical industry (Yamada *et al*., 2003).

2.3.3 Industrial waste

The average composition of industrial waste is very different from the average composition of MSW, and varies by type of industry, although many of the waste types can be included in both of industrial waste and MSW. DOC and fossil carbon in industrial waste is mainly found in the same waste types as in MSW. DOC is found in paper and cardboard, textiles, food and wood. Synthetic leather, rubber, and plastics are major sources of fossil carbon. Waste oils and solvents are also important sources of fossil carbon in industrial liquid waste. Paper and cardboard and plastics will be generated at various industries mainly from office work and by packaging waste. Wood will be found in wastes from pulp and paper, wood manufacturing industries and construction and demolition activities. Food, beverage and tobacco industry will be the major source of food waste. Details of product and/or activity of each industry are different country by country. In order to estimate the DOC and fossil carbon in industrial waste, surveys on waste generation and composition at representative industries and estimation of unit generation of certain composition per economic driver, such as production, floor area and employee number, can be used. Non-hazardous waste (like office waste and waste from catering) from industrial activities is sometimes included in MSW. Double counting of the emissions should be avoided.

Table 2.5 provides default values of DOC and fossil carbon contents in industrial waste by industry type per amount waste produced. The default values are only for process waste generated at the facilities (e.g., office waste is assumed to be included in MSW). Countries are encouraged to collect and use national data where available as the default data are very uncertain. The guidance given above and in Chapter 2 of Volume 1 can be used to develop data collection systems for industrial waste. The DOC and fossil carbon contents can be determined using the same sampling methods as for MSW.

TABLE 2.5
DEFAULT DOC AND FOSSIL CARBON CONTENT IN INDUSTRIAL WASTE (PERCENTAGE IN WET WASTE PRODUCED)[1]

Industry type	DOC	Fossil carbon	Total carbon	Water content [2]
Food, beverages and tobacco (other than sludge)	15	-	15	60
Textile	24	16	40	20
Wood and wood products	43	-	43	15
Pulp and paper (other than sludge)	40	1	41	10
Petroleum products, Solvents, Plastics	-	80	80	0
Rubber	(39) [3]	17	56	16
Construction and demolition	4	20	24	0
Other [4]	1	3	4	10

Source: Expert Judgement; Pipatti *et al*. 1996; Yamada *et al*. 2003.

[1] The default values apply only for process waste from the industries, office and other similar waste are assumed to be included in MSW.

[2] Note that water contents of industrial wastes vary enormously, even within a single industry.

[3] Natural rubbers would likely not degrade under anaerobic condition at SWDS (Tsuchii, *et al*., 1985; Rose and Steinbüchel, 2005).

[4] These values can be used also as defaults for total waste from manufacturing industries, when data on waste production by industry type are not available. Waste from mining and quarrying should be excluded from the calculations as the amounts can be large and the DOC and fossil carbon contents are likely to be negligible.

2.3.4 Other waste

Default values for DOC and fossil carbon for hazardous waste and clinical waste are given in Table 2.6. The values should be applied only for total amounts of hazardous and clinical waste generated in the country. Major part of hazardous waste would be generated as sludge or liquid-like nature, as well as ash, cinder and slug which are dry nature.

TABLE 2.6
DEFAULT DOC AND FOSSIL CARBON CONTENTS IN OTHER WASTE (PERCENTAGE IN WET WASTE PRODUCED)

Waste type	DOC	Fossil carbon	Total carbon	Water Content
Hazardous waste	NA	5 - 50 [1]	NA	10 - 90 [1]
Clinical waste	15	25	40	35

NA = not available

Sources: Expert Judgement; IPCC 2000

[1] The higher fossil carbon value is for waste with lower water content. When no data on the water content are available, the mean value of the range should be used.

Annex 2A.1 Waste Generation and Management Data - by country and regional averages

Table 2A.1 in this Annex shows MSW generation and management data for some countries whose data are available. Regional defaults for waste generation and treatment that are provided in Table 2.1 in Chapter 2 are derived based on the information from this table. The data are applicable as default data for the year 2000.

For comparison, data on waste generation and disposal to SWDS from *the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (*1996 IPCC Guidelines*) are also given in the table.

TABLE 2A.1
MSW GENERATION AND MANAGEMENT DATA - BY COUNTRY AND REGIONAL AVERAGES

Region /Country	MSW [1, 2] Generation Rate IPCC -1996 values [4] (tonnes/cap/yr)	MSW [1, 2, 3] Generation Rate Year 2000 (tonnes/cap/yr)	Fraction of MSW disposed to SWDS IPCC-1996 values [4]	Fraction of MSW disposed to SWDS	Fraction of MSW incinerated	Fraction of MSW composted	Fraction of other MSW management, unspecified [5]	Source
Asia								
Eastern Asia	**0.41**	**0.37**	**0.38**	**0.55**	**0.26**	**0.01**	**0.18**	
China		0.27		0.97	0.02	0.01		1
Japan	0.41	0.47	0.38	0.25	0.72	0.02	0.01	2, 31
Rep. of Korea		0.38		0.42	0.04		0.54	3
Southern and Central Asia	**0.12**	**0.21**	**0.60**	**0.74**	**-**	**0.05**	**0.21**	
Bangladesh		0.18		0.95			0.05	4
India	0.12	0.17	0.60	0.70		0.20	0.10	4
Nepal		0.18		0.40			0.60	4
Sri Lanka		0.32		0.90			0.10	4
South-eastern Asia		**0.27**		**0.59**	**0.09**	**0.05**	**0.27**	
Indonesia		0.28		0.80	0.05	0.10	0.05	4
Lao PDR		0.25		0.40			0.60	4
Malaysia		0.30		0.70	0.05	0.10	0.15	4
Myanmar		0.16		0.60			0.40	4
Philippines		0.19		0.62		0.10	0.28	4, 5
Singapore		0.40		0.20	0.58		0.22	6
Thailand		0.40		0.80	0.05	0.10	0.05	4
Vietnam		0.20		0.60			0.40	4
Africa								
Africa [6]		**0.29**		**0.69**			**0.31**	
Egypt				0.70			0.30	4
Sudan		0.29		0.82			0.18	7
South Africa			1.00	0.90			0.10	4
Nigeria				0.40			0.60	4
Europe								
Eastern Europe		**0.38**		**0.9**	**0.04**	**0.01**	**0.02**	
Bulgaria		0.52		1.00	0.00	0.00	0.00	8
Croatia				1.00	0.00	0.00	0.00	8
Czech Republic		0.33		0.75	0.14	0.04	0.06	8
Estonia		0.44		0.98	0.00	0.00	0.02	8
Hungary		0.45		0.92	0.08	0.00	0.00	8
Latvia		0.27		0.92	0.04	0.02	0.02	8
Lithuania		0.31		1.00	0.00	0.00	0.00	8
Poland		0.32		0.98	0.00	0.02	0.00	8

TABLE 2A.1 (CONTINUED) MSW GENERATION AND MANAGEMENT DATA - BY COUNTRY AND REGIONAL AVERAGES								
Region /Country	**MSW [1, 2] Generation Rate** IPCC -1996 values [4] (tonnes/cap/yr)	**MSW [1, 2, 3] Generation Rate** Year 2000 (tonnes/cap/yr)	**Fraction of MSW disposed to SWDS** IPCC-1996 values [4]	**Fraction of MSW disposed to SWDS**	**Fraction of MSW incinerated**	**Fraction of MSW composted**	**Fraction of other MSW management, unspecified [5]**	**Source**
Romania		0.36		1.00	0.00	0.00	0.00	8
Russian Federation	0.32	0.34	0.94	0.71	0.19	0.00	0.10	9
Slovakia		0.32		1.00	0.00	0.00	0.00	8
Slovenia		0.51		0.90	0.00	0.08	0.02	8
Northern Europe		**0.64**		**0.47**	**0.24**	**0.08**	**0.20**	
Denmark	0.46	0.67	0.2	0.10	0.53	0.16	0.22	8
Finland	0.62	0.50	0.77	0.61	0.1	0.07	0.22	8
Iceland		1.00		0.86	0.06	0.01	0.06	8
Norway	0.51	0.62	0.75	0.55	0.15	0.09	0.22	8
Sweden	0.37	0.43	0.44	0.23	0.39	0.10	0.29	8
Southern Europe		**0.52**		**0.85**	**0.05**	**0.05**	**0.05**	
Cyprus		0.68		1.00	0.00	0.00	0.00	8
Greece	0.31	0.41	0.93	0.91	0.00	0.01	0.08	8
Italy	0.34	0.50	0.88	0.70	0.07	0.14	0.09	8
Malta		0.48		1.00	0.00	0.00	0.00	8
Portugal	0.33	0.47	0.86	0.69	0.19	0.05	0.07	8
Spain	0.36	0.60	0.85	0.68	0.07	0.16	0.09	8
Turkey		0.50		0.99	0.00	0.01	0.00	8
Western Europe	**0.45**	**0.56**	**0.57**	**0.47**	**0.22**	**0.15**	**0.15**	
Austria	0.34	0.58	0.4	0.30	0.10	0.37	0.23	8
Belgium	0.40	0.47	0.43	0.17	0.32	0.23	0.28	8
France	0.47	0.53	0.46	0.43	0.33	0.12	0.13	8
Germany	0.36	0.61	0.66	0.30	0.24	0.17	0.29	8
Ireland	0.31	0.60	1.0	0.89	0.00	0.01	0.11	8
Luxemburg	0.49	0.66	0.35	0.27	0.55	0.18	0.00	8
Netherlands	0.58	0.62	0.67	0.11	0.36	0.28	0.25	8
Switzerland	0.40	0.40	0.23	1.00	0.00	0.00	0.00	8
UK	0.69	0.57	0.90	0.82	0.07	0.03	0.08	8
Central, South America and Caribbean states								
Caribbean		**0.49**		**0.83**	**0.02**		**0.15**	
Bahamas		0.95		0.7			0.3	10
Cuba		0.21		0.90			0.1	11
Dominican Republic		0.25		0.90	0.06		0.04	12
St. Lucia		0.55		0.83			0.17	13
Central America		**0.21**		**0.50**			**0.50**	
Costa Rica		0.17						14, 15
Guatemala		0.22		0.40			0.60	16, 17, 18
Honduras		0.15		0.40			0.60	4
Nicaragua		0.28		0.70			0.30	4
South America								
South America		**0.26**		**0.54**	**0.01**	**0.003**	**0.46**	
Argentina		0.28		0.59			0.41	4
Bolivia		0.16		0.70			0.30	19

TABLE 2A.1 (CONTINUED)
MSW GENERATION AND MANAGEMENT DATA - BY COUNTRY AND REGIONAL AVERAGES

Region /Country	MSW [1,2] Generation Rate IPCC -1996 values [4] (tonnes/cap/yr)	MSW [1,2,3] Generation Rate Year 2000 (tonnes/cap/yr)	Fraction of MSW disposed to SWDS IPCC-1996 values [4]	Fraction of MSW disposed to SWDS	Fraction of MSW incinerated	Fraction of MSW composted	Fraction of other MSW management, unspecified [5]	Source
Brazil		0.18		0.80	0.05	0.03	0.12	20, 21
Chile				0.40			0.60	4
Colombia		0.26		0.31			0.69	22
Ecuador		0.22		0.40			0.60	23
Paraguay (Asuncion)		0.44		0.40			0.60	24
Peru		0.20		0.53			0.47	4, 25
Uruguay		0.26		0.72			0.28	26, 27
Venezuela		0.33		0.50			0.50	28
North America								
North America	**0.70**	**0.65**	**0.69**	**0.58**	**0.06**	**0.06**	**0.29**	
Canada	0.66	0.49	0.75	0.71	0.04	0.19	0.06	29, 30, 31
Mexico		0.31		0.49			0.51	32, 33
USA	0.73	1.14	0.62	0.55	0.14		0.31	34
Oceania								
Oceania	**0.47**	**0.69**	**1.00**	**0.85**			**0.15**	
Australia	0.46	0.69	1.00	1.00				4, 31
New Zealand	0.49		1.00	0.70			0.30	4

[1] Data are based on weight of wet waste.
[2] To obtain the total waste generation in the country, the per-capita values should be multiplied with the population whose waste is collected. In many countries, especially developing countries, this encompasses only urban population.
[3] The data are default data for the year 2000, although for some countries the year for which the data are applicable was not given in the reference, or data for the year 2000 were not available. The year for which the data are collected is given below with source of the data, where available.
[4] Values shown in this column are the ones included in the *1996 IPCC Guidelines.*
[5] Other, unspecified, includes data on recycling for some countries.
[6] A regional average is given for the whole of Africa as data are not available for more detailed regions within Africa.

Source	Year	
1		Urban Construction Statistics Yearbook of China – Year 2000 (2001). Ministry of Chinese Construction. Chinese Construction Industry Publication Company.
2		OECD Environment Directorate, OECD Environmental Data 2002, Waste.
		Ministry of Environment, Japan (1992-2003): Waste of Japan, http://www.env.go.jp/recycle/waste/ippan.html.
3		1) '97 National Status of Solid Waste Generation and Treatment , the Ministry of Environment, Korea, 1998.
		2) '96 National Status of Solid Waste Generation and Treatment , the Ministry of Environment, Korea, 1997.
		3) Korea Environmental Yearbook, the Ministry of Environment, Korea, 1990.
4		Doorn and Barlaz, 1995, Estimate of global methane emissions from landfills and open dumps, EPA-600/R-95-019, Office of Research & Development, Washington DC, USA.
5		Shimura et al. (2001).
6	2001	National Environmental Agency, Singapore (www.nea.gov.sg.) and www.acrr.org/resourcecities/waste_resources/europe_waste.htm.
7		Ministry of Environment and Physical Development, Higher Council for Environment and Natural Resources, Sudan (2003), Sudan's First National Communications under the United Nations Framework Convention on Climate Change.
8	2000	Eurostat (2005). Waste Generated and Treated in Europe. Data 1995-2003. European Commission - Eurostat, Luxemburg. 131p.
9		Problems of waste management in Russia: Not-for-Profit Partnership “Waste Management – Strategic Ecological Initiative” http://www.sagepub.com/journalsProdEditBoards.nav?prodId=Journal201691.

TABLE 2A.1 (CONTINUED)
MSW GENERATION AND MANAGEMENT DATA- BY COUNTRY AND REGIONAL AVERAGES

Source	Year	
10		The Bahamas Environment, Science and Technology Commission (2001). Commonwealth of the Bahamas. First National Communication on Climate Change. Nassu, New Providence, April 2001, 121pp.
11	1990	OPS/OMS (1997). Análisis Sectorial de Residuos Sólidos en Cuba. Serie Análisis 1. Sectoriales No. 13, Organización Panamericana de la Salud, 206 pp., 2. López, C., et al. (2002). República de Cuba. Inventario Nacional de Emisiones y Absorciones de Gases de Invernadero (colectivo de autores). Reporte para el Año 1996/Actualización para los Años 1990 y 1994. CD-ROM Vol. 01. Instituto de Meteorología-AMA-CITMA. La Habana, 320 pp. ISBN: 959-02-0352-3.
12		Secretaría de Estado de Medio Ambiente y Recursos Naturales (2004). República Dominicana. Primera Comunicación Nacional a la Convención Marco de Naciones Unidas sobre Cambio Climático. UNEP/GEF, Santo Domingo, Marzo de 2004, 163 pp.
13	1990	Ministry of Planning, Development, Environment and Housing (2001). Saint Lucias's Initial National Communication on Climate Change, UNEP/GEF, 306 pp.
14		Lammers, P. E. M., J. F. Feenstra, A. A. Olstroorn (1998). Country/Region-Specific Emission Factors in National Greenhouse Gas Inventories. UNEP/Institute for Environmental Studies Vrije Universiteit, 112 pp.
15		Ministerio de Recursos Naturales, Energía y Minas (1995). Inventario Nacional de Fuentes y Sumideros de Gases con Efecto Invernadero en Costa Rica. MRNEM, Instituto Meteorológico Nacional, San José, Septiembre 1995.
16		Ministerio de Ambiente y Recursos Naturales (2001). República de Guatemala. Primera Comunicación Nacional sobre Cambio Climático..
17		JICA (Agencia Japonesa de Cooperación Internacional) (1991). Estudio sobre el Manejo de los Desechos Sólidos en el Area Metropolitana de la Ciudad de Guatemala. Volumen 1.
18		Guatemala de la Asunción, diciembre 2001, 127 p.,OPS/OMS (1995). Análisis Sectorial de Residuos Sólidos en Guatemala, Diciembre 1995, 183 pp.
19	1990	Fondo Nacional de Desarrollo (FNDR). Cantidad de RSM dispuestos en RSA-años 1996 y 1997, La Paz, Bolivia., 2. Ministerio de Desarrollo Sostenible y Medio Ambiente/Secretaría Nacional de Recursos Naturales y Medio Ambiente (1997). Inventariación de Emisiones de Gases de Efecto Invernadero. Bolivia – 1990. MDSMA/SNRNMA/SMA/PNCC/U.S. CSP, La Paz, 1997.
20		Ministry of Science and Technology, Brazil (2002). First Brazilian Inventory of Anthropogenic Greenhouse Gas Emissions. Background Reports. Methane Emissions from Waste Treatment and Disposal. CETESB. 1990 and 1994, Brazília, DF, 85 pp.
21		CETESB (1992). Companhia de Tecnologia de Saneamiento Ambiental. Programa de gerenciamiento de residuos sólidos domiciliares e de services de saúde. PROLIXO, CETESB; Sao Paulo, 29 pp., IBGE: Instituto Brasileiro de Geografía e Estadística. http://www.ibge.gov.br/home/estadistica/populacao/atlassaneamiento/pdf/mappag59.pdf in November 2004.
22	1990	Ministerio de Medio Ambiente/IDEAM (1999). República de Colombia. Inventario Nacional de Fuentes y Sumideros de Gases de Efecto Invernadero. 1990. Módulo Residuos, Santa Fe de Bogotá, DC, Marzo de 1999, 14 pp.
23		BID/OPS/OMS (1997). Diagnóstico de la Situación del Manejo de los Residuos Sólidos Municipales en América Latina y el Caribe., Doorn and Barlaz, 1995, Estimate of global methane emissions from landfills and open dumps, EPA-600/R-95-019, Office of Research & Development, Washington DC, USA.
24	1990	MAG/SSERNMA/DOA – PNUD/UNITAR (1999). Paraguay: Inventario Nacional de Gases de Efecto Invernadero por Fuentes y Sumideros. Año 1990. Proyecto PAR GLO/95/G31. Asunción, Noviembre 1999, 90 pp.
25	1990 1994 1998	Estudios CEPIS-OPS y/o Estudio Sectorial de Residuos Sólidos del Perú. Ditesa/OPS., Lammers, P. E. M., J. F. Feenstra, A. A. Olstroorn (1998). Country/Region-Specific Emission Factors in National Greenhouse Gas Inventories. UNEP/Institute for Environmental Studies Vrije Universiteit, 112 pp.
26		Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente/Dirección Nacional de Medio Ambiente/Unidad de Cambio Climático (1998). Uruguay. Inventario Nacional de Emisiones Netas de Gases de Efecto Invernadero 1994/Estudio Comparativo de Emisiones Netas de Gases de Efecto Invernadero para 1990 y 1994. Montevideo, Noviembre de 1998, 363pp.
27		OPS/OMS (1996). Análisis Sectorial de Residuos Só,Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente/Dirección Nacional de Medio Ambiente/Unidad de Cambio Climático (2004). Uruguay. Segunda Comunicación a la CMNUCC. 330p. lidos en Uruguay. Plan Regional de Inversiones en Medio Ambiente y Salud, Marzo 1996.
28	2000	Ministerio del Ambiente y de los Recursos Naturales Renovables. Ministerio de Energía y Minas (1996). Venezuela. Inventario de Emisiones de Gases de Efecto Invernadero. Año 1990. GEF/UNEP/U.S CSP.
29	1992	Organization for Economic Cooperation and Development (OECD) http://www.oecd.org/dataoecd/11/15/24111692.PDF

TABLE 2A.1 (CONTINUED)
MSW GENERATION AND MANAGEMENT DATA- BY COUNTRY AND REGIONAL AVERAGES

Source	Year	
30		The Fraser Institute, Environmental Indicators, 4th Edition (2000). http://oldfraser.lexi.net/publications/critical_issues/2000/env_indic/section_05.html.
31		UNFCCC Secretariat, Working paper No.3 (g) (2000). Expert report, prepared for the UNFCCC secretariat, 20 February 2000.
32	1992	http://www.oecd.org/dataoecd/11/15/24111692.PDF.
33		INE/SMARN (2000). Inventario Nacional de Emisiones de Gases de Invernadero 1994-1998, Ciudad de Mexico, Octubre 2000, 461 p.
34		Waste generation from: BioCycle (January 2004). "14th Annual BioCycle Nationwide Survey: The State of Garbage in America", Waste disposition from: BioCycle (December 2001). "13th Annual BioCycle Nationwide Survey: The State of Garbage in America"; Personal Communication: Elizabeth Scheele, U.S. EPA.

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Dehoust, G., *et al*. (2002). Dehoust, G., Gebhardt, P., Gärtner, S., Der Beitrag der thermischen Abfallbehandlung zu Klimaschutz, Luftreinhaltung und Ressourcenschonung [The contribution of thermal waste treatment to climate change mitigation, air quality and resource management]. For: Interessengemeinschaft der Betreiber Thermischer Abfallbehandlungsanlagen in Deutschland (ITAD). Öko-Institut, Darmstadt 2002 [In German].

Doorn, M. and Barlaz, M. (1995). *Estimate of global methane emissions from landfills and open dumps*, EPA-600/R-95-019, Office of Research & Development, Washington DC, USA.

Environmental Statistics Yearbook of China (2003). URL:http://www.cnemc.cn/stat/indexs.asp?id=15 (in Chinese)

Estonian Environment Information Centre. (2003). URL: http://www.keskkonnainfo.ee/english/waste

Eurostat (2005). Waste Generated and Treated in Europe. Data 1995-2003, European Commission -Eurostat, Luxemburg. 131 p.

Gangdonggu Go"mi (1997). Study on the situation of wastes discharge in Gangdonggu. (Institute of Metropolitan), Seoul (University of Seoul) 1997.2

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