

# Recent trends in global greenhouse gas emissions: regional trends and spatial distribution of key sources

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Keywords: greenhouse gas, global, emissions, inventory, trend

**ABSTRACT:** In 2004, JRC, MNP and MPIC have started a project to create fast (bi-)annual updates of the EDGAR global emission inventory system, based on the more detailed previous version 3.2. We first describe the key features of the Emission Database for Global Atmospheric Research, EDGAR 3, and then the compilation of recent global trends main influencing variables and the new 'Fast Track' approach to estimate recent emissions at a country-specific level. We present an overview of the approaches used for this 'Fast Track', the different source sectors and the accuracies achieved. Results will be available for 1995-2000 for various sources and greenhouse gases at regional and national scales, with a focus on the anthropogenic sources of methane.

## 1 INTRODUCTION

The EDGAR 3 suite of global anthropogenic emissions inventories of various trace gases, developed by RIVM and TNO in collaboration with the *Global Emission Inventory Activity (GEIA)* of the *International Geosphere-Biosphere Programme (IGBP)* provide emissions of direct greenhouse gases for the period 1970-1995 and for ozone precursors and SO<sub>2</sub> for the 1990-1995 period (Olivier *et al.*, 2001; Olivier and Berdowski, 2001). These datasets – supplemented with recent trend data – have been used for trend analysis of global emissions and atmospheric concentrations of trace gases and for analysis of regional distributions of present global emissions. The results of this work were used in integrated assessments for RIVM's annual national environmental balances and accompanying background reports (Environmental Data Compendium) (RIVM, 2005; MNP, 2005), for EEA's *Environmental Signals* report (EEA, 2000) and for the EU project 'POET' (project EVK2-CT-1999-00011). The EDGAR datasets are also part of the core datasets for global integrated environmental assessments made in the *Global Environmental Outlooks (GEO)* of UNEP.

The rapid expansion of high-resolution spatially detailed satellite data, which is produced almost real time, from which total column concentrations of various atmospheric trace gases can be determined, further enhanced the wishes of atmospheric modelers for more recent global emission inventories. Also other policy-oriented users of the EDGAR data have expressed their wish to know recent global trends, as only the Annex I countries to the Kyoto Protocol provide their update of national emissions. This has led the new project team composed of Netherlands Environmental Assessment Agency (MNP [formerly RIVM]), the Joint Research Centre (JRC) of the European Union in Ispra and the Planck Institute for Chemistry (MPIC) in Mainz to start a new 'Fast Track' update of EDGAR 3, prior to and in parallel with the more detailed update to EDGAR 4.

In this paper we first describe the key features of the *Emission Database for Global Atmospheric Research*, EDGAR 3, and then the compilation of recent global trends main influencing variables and the new ‘Fast Track’ approach to estimate recent emissions at a country-specific level.

## 2 EDGAR 3

EDGAR version 3 has been compiled using international statistics for 1970-1995 for individual countries and country-specific (e.g. CH<sub>4</sub> from landfills), regional (e.g. CH<sub>4</sub> from livestock) and sometimes global (e.g. CO<sub>2</sub>, N<sub>2</sub>O from fossil fuel combustion) emission factors from literature. For greenhouse gases mostly IPCC default factors were used. For some sources international statistics were not available to serve as activity data. Examples are biofuel use (except for Latin America, for which data from OLADE were used) and large-scale biomass burning (forest and savanna burning), waste disposal and wastewater (Olivier, 2002; Olivier, 2005). In cases of significant changes of these sources over time the emission factors were not set to a constant value but different values were used, e.g. for 1970, 1990 and 1995. In addition, the emissions calculated at for each country are spatially distributed to a 1x1 degree grid to provide the datasets needed by atmospheric models as input to their model. Regional EDGAR emissions are presented for 13 major world regions, e.g. in Olivier and Berdowski (2001).

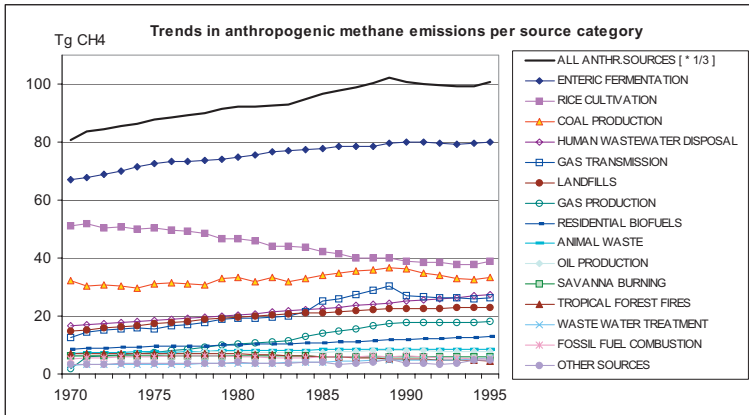


Figure 1.a. Trend in global emissions of methane by source category 1970-1995.

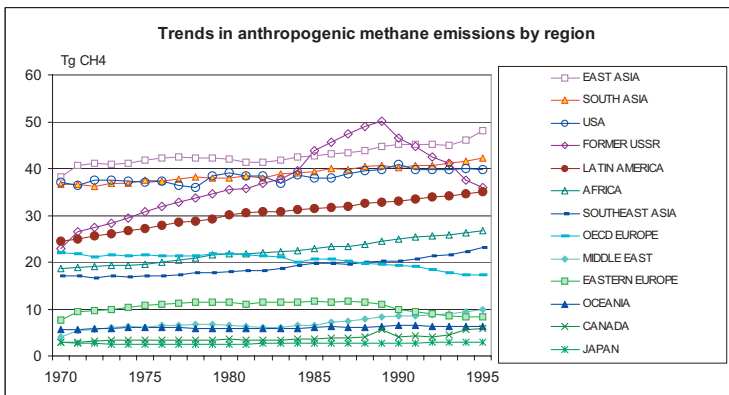


Figure 1.b. Trend in anthropogenic emissions of methane by region 1970-1995.

The emissions of the precursors could not easily be calculated for the 1970-1990 period, since in many regions these emission factors have changed over time due to environmental policies to control the emissions. However, for users of long-term global historical emissions datasets the EDGAR-HYDE datasets were developed for the period 1890-1990, which was based on the EDGAR 2 datasets for 1990 (Van Aardenne *et al.*, 2001). Figure 1.a and 1.b show the global 1970-1995 trend in methane per source and per region, respectively, whereas Figure 2 shows as an example the global trend in sources of emissions of HFCs, PFCs and SF<sub>6</sub> (so-called F-gases), which has been compiled from the underlying data at country level.

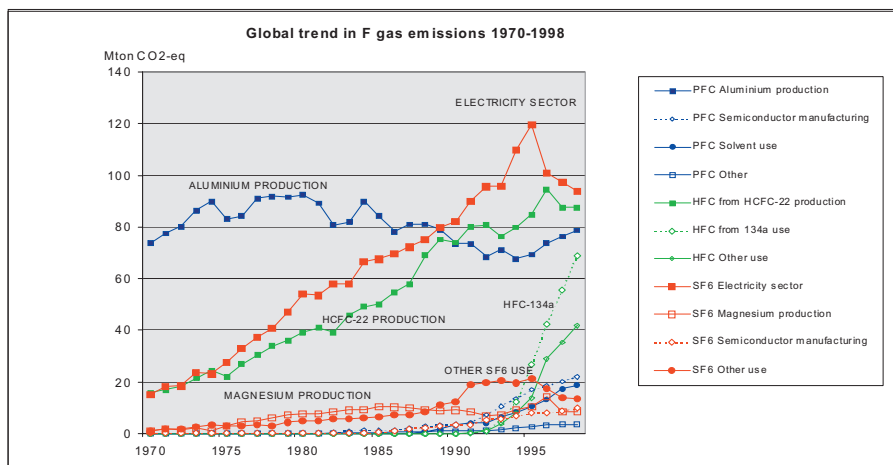


Figure 2. Global trends in sources of F-gas emissions (source: EDGAR 3.2).

### 3 RECENT GLOBAL TRENDS

Until recently, after completion of EDGAR 3, annually estimates for global total emissions of greenhouse gases were made for years after 1995 by extrapolation of global total activity data per major source category, e.g. using international statistics for fuel use (by sector from the International Energy Agency (IEA) or per main fuel type from BP), cement production data from USGS, key livestock data from the FAO) and F-gas sales data from RAND. For CO<sub>2</sub> 5 source categories, for CH<sub>4</sub> 16 sources, for N<sub>2</sub>O 18 sources and for F-gases 7 sources were used. These 1995 onwards global activity trends were used to estimate the emissions in more recent years, but were corrected if the ‘implied emission factor’ – i.e. the division of annual emissions by the activity data selected for the extrapolation – of the global 1990-1995 emissions showed a significant trend (Table 1). In addition, some sources were corrected for substantial changes known from national submissions to the UNFCCC (so-called CRF files accompanying National Inventory Reports submitted to the UNFCCC and posted at the Climate Secretariat’s website ([www.unfccc.int](http://www.unfccc.int))), notably the strong decrease in N<sub>2</sub>O from adipic acid production and the use of SF<sub>6</sub> in the electricity sector and for other uses. The resulting trends, e.g. as shown in Figure 3, are published annually on the RIVM/MNP website (MNP, 2004).

Later, a first attempt was made to differentiate these global trends by separately estimating for Annex II and EIT countries (i.e. OECD’90 and former USSR and Eastern European countries) based on data reported to the UNFCCC by these countries for 1995-2000; extrapolated from 1995 to 2002 and rounded to 5%-points (Table 2). For the remaining non-Annex I region the trend was calculated from the global total trend estimated as described above and corrected for the Annex I trends. These regional trend data are used by the IEA to calculate the trend key sources as published in IEA (2004).

Table 1. Sources for which trends in the 1990-1995 implied emission factors are extrapolated.

Gas	Source	Trend
CH <sub>4</sub>	Coal production	trend
	Gas production	trend
	Rice areas	trend
	Animals	trend
N <sub>2</sub> O	Fossil fuel use	trend
	Nitric Acid production	trend
	Adipic Acid production	trend 1)
	Animal waste as fertiliser	trend
	Animal waste (stables)	trend
	Crop production	trend
	Animal waste (soil)	trend
	Atmospheric Deposition/Leaching&Run-Off.	trend
F-gases	PFC Aluminium	trend
	SF <sub>6</sub> Electricity	trend 2)
	SF <sub>6</sub> Other	trend 2)

1) cf. Annex I trend (and activity data constant).

2) cf. Annex 1 trend and Rest of the World constant; 2002: extrapolation (-4%).

Table 2. Estimated regional 1995-2002 trends (for Annex II and EIT based on UNFCCC reported data).

Region	CH <sub>4</sub>	N <sub>2</sub> O	F-gas
Annex II	-10%	-5%	-15%
Economies-In-Transition	-20%	35%	0%
Non-Annex I	10%	-10%	150%

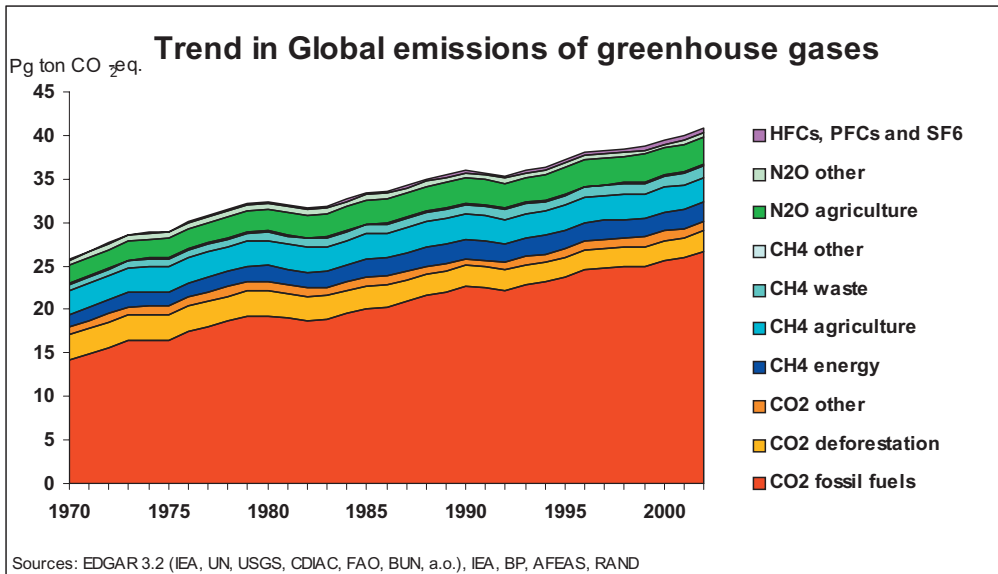


Figure 3. Global trends 1970-2002 in sources of greenhouse gas emissions (source: RIVM/MNP).

## 4 RECENT COUNTRY-SPECIFIC TRENDS

The Annex I countries to the UNFCCC, i.e. OECD'90 countries and Economies-In-Transition (EIT) countries, annually have to submit their update of national greenhouse gas emissions. However, in practice this refers to OECD'90 countries only, since many of the EIT countries are not yet able to meet their annual reporting requirements. For ozone precursors and SO<sub>2</sub> both the UNFCCC submissions and the UN-ECE/EMEP datasets are available as data source for estimating recent national trends for the globe, as requested by modelers and policy makers. Since making detailed updates is a laborious effort, which will only be done every five years or so, the new EDGAR consortium therefore decided to initiate a new so-called 'Fast Track' action to estimate the most recent global emissions at country level, based on readily available data. Basically this approach uses international statistics for each EDGAR source category and constant implied emission factors', unless reported national emissions are available that show a significant trends in the emission factors that should best not be neglected. The latter are greenhouse gas emission trends reported by the Annex I countries to the Kyoto Protocol, however in practice mostly limiting to the OECD countries (1990 composition). For ozone precursors and SO<sub>2</sub> the same dataset may be used or the emission trends reported to the UN-ECE, which are processed and sometimes adapted by the EMEP programme. In general, the reporting level of the UNFCCC/ECE source categories does not always match with the EDGAR categories. In those cases a similar reported category is used as indicator for an EDGAR source category.

For OECD countries that did not report their emissions for these sources the 1995-2000 trend index of the reported average OECD trend was used, e.g. for CH<sub>4</sub> from gas production 0.82, gas transport 0.96, oil production 0.97, landfills, 0.91 and wastewater treatment 1.02. For some sources extrapolation with international statistics is not a good proxy for the development of national emissions. For example, for landfills we used extrapolations of the 1990-1995 emissions trend. Also, for LUCF no annual statistics are available, therefore emissions were kept constant. As an exception, in 2005 the fossil fuel emissions have been calculated based on latest IEA fuel combustion dataset and for large-scale biomass burning a multi-year average of datasets published by Van der Werf is used.

In general this estimation procedure is expected to produce reasonably accurate results, with a accuracy similar to the uncertainty reported (estimated) for the 1995 emissions dataset. However, a reservation has to be made for sources where unexpected fast changes may occur, e.g. due to the introduction of new control policies or when the national source category refers to only one or a few point sources, in which case changes in the operations by the manufacturer can result in apparent discontinuities in the emissions (e.g. expansion of production capacity or the closing down of a production plant or changing to another manufacturing process).

## ACKNOWLEDGEMENTS

Constructing these global emission inventories would not have been possible without the funding and co-operation of many individuals and organisations. Besides the funding by the Dutch *National Research Programme on Global Air Pollution and Climate Change*, project no. 954222, and the POET project of the Fifth Framework Programme of the European Union, EVK2-1999-00011, we thank the Dutch *Ministry of Housing, Spatial Planning and the Environment* (VROM) and the European Commission for funding. This work is also part of the *Global Emissions Inventory Activity* (GEIA) of the *International Geosphere-Biosphere Programme* (IGBP). We greatly appreciate the co-operation with various GEIA Study Groups and other persons and organisations as well as the interest in the datasets received from policy makers and the international atmospheric modelling community at large

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