Climate Change Research: Evaluation and Policy Implications
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Emissions inventories and options for control

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1. Introduction and background

In 1990, little was known about the emissions of greenhouse gases in the Netherlands, notably those of the non-CO_2 greenhouse gases. Uncertainties included the causes, the emissions factors and the regional distribution of emissions. The main objectives of the project at that time were formulated as follows:

a) provide information for prioritizing greenhouse gas emissions research in the Netherlands
b) provide input data for global models (later shifted to the EDGAR-project)
c) support national and international policy development

The emphasis of the project was on non-CO_2 greenhouse gases, notably methane (CH_4) and nitrous oxide (N_2O). While state-of-the-art information from international research would be used and analyzed, the focus of the project was on the Dutch emissions and their causes. Information was drawn from literature research, discussions with national and international experts, and experimental information from NRP and other projects. We refer to the products of the project listed in the reference list for more detailed lists of relevant literature.

2. National inventory

In 1990, a first inventory of current and future emissions of greenhouse gases in the Netherlands was performed. In this inventory, data from the international literature and expert opinions were used to arrive at estimates of national emissions (van den Born et al., 1991). Because of the relatively small area of the Netherlands, emissions from industry, energy consumption and transport generally dominate over land-related natural and agricultural emissions.

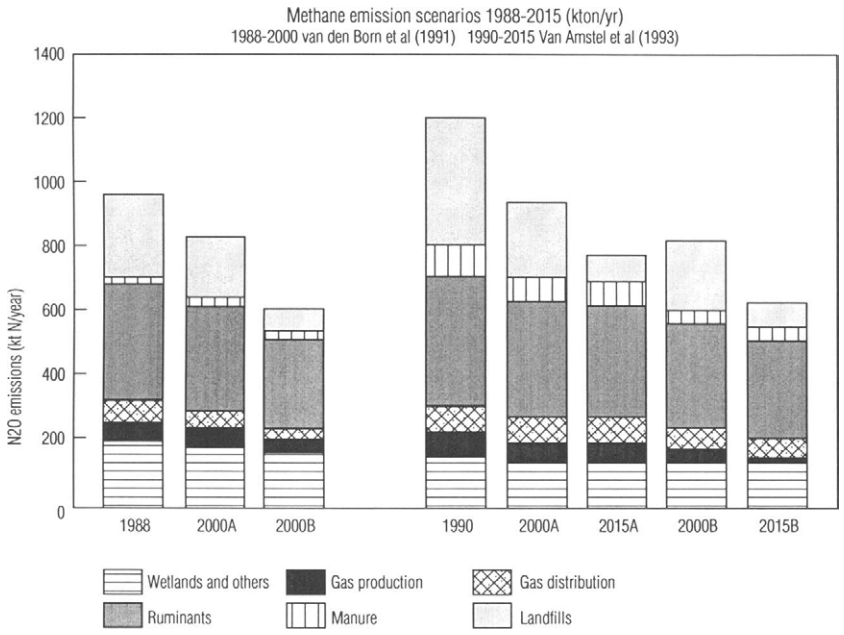
Carbon dioxide

As a result of policies, emissions of carbon dioxide were estimated to be reduced slightly by 2000, consistent with the 3-5 % government target. Options for further reduction of carbon dioxide emissions would be found primarily in energy conservation, reduction of demand and efficiency improvements, followed by a shift to non-fossil fuels. Because of the small size of the Netherlands, sequestration by afforestation programmes can only play a minor, albeit psychologically important role. Additional, technologically feasible measures in the energy sector were suggested to achieve at least another 20 % reduction, but the cost-effectiveness of these measures was concluded to be subject to controversy, as it indeed still is.

Methane

As most important sources of methane in the Netherlands, cattle, landfills, gas distribution and the production of oil and natural gas were identified. Because of policies in the areas of waste disposal, livestock management and distribution of natural gas, emissions of methane were estimated to decrease by approximately 10 % by 2000 as compared to 1990.

Figure 1: Methane emissions 1988-2000 accoording to van den Born et al. (1991) and 1990-2015 according to van Amstel et al. (1993): A = current policies and B = additional policies



Nitrous oxide

As major Dutch sources of nitrous oxide the following were identified: grassland (both on organic and mineral soils), agricultural lands, transportation, and - surprisingly - coastal and inland waters and waste water treatment plants. The source strengths were found to be extremely uncertain and therefore more research would be necessary to better quantify the emissions level and to evaluate response options. Through the year 2000, emissions reductions of nitrous oxide because of planned reduction of fertilizer application were estimated to be balanced by emissions increases because of the introduction of three-way catalysts in transport.

Halocarbons

The Netherlands' programme to phase out CFCs and reduce the associated emissions was found to effectively reduce their contribution to the enhanced greenhouse effect. On the long term it was concluded to be important that HCFCs and HFCs with a remaining (though smaller) global warming potential should be regarded as useful products only in a (short) transition period.

Ozone precursors

Carbon monoxide contributes to the enhanced greenhouse effect as precursor of ozone and carbon dioxide, and competes with methane for hydroxyl radicals (OH) in the troposhere, therewith enhancing methane's lifetime. Main sources are the transportation sector and industry, notably the basic metals producers. Present policies in the transportation sector are likely to reduce emissions by 40 % in 2000. Emissions of nitrogen oxides and non-methane hydrocarbons (or volatile organics compounds, VOCs) in the Netherlands contribute significantly to climate change because of their role as precursors of ozone and the fact that the national emissions are relatively high due to intensive traffic and industrialization. It was found that the present policies to abate acidification and photochemical air pollution are also important from the point of view of climate change.

3. Support of the joint IPCC/OECD Programme on Guidelines for National Emissions Inventories

The expertise acquired with the first national inventory was used to support the joint IPCC/OECD Programme on Guidelines for National Emissions Inventories. Amongst others, an international workshop was organized in support of the IPCC process (van Amstel, 1993a and 1994). More than 100 particants from about 30 countries discussed methods for emissions inventories and options for control for 10 source categories: methane from oil and gas, methane from coal mining, methane from ruminants, methane from animal waste, methane from landfills and sewage treatment, methane from combustion and industry, methane from rice production and wetlands, methane from biomass burning, nitrous oxide from agricultural soils and nitrous oxide from combustion and industry (Van Amstel and Swart, 1994). Also, RIVM participated actively in the International Liaison Group supporting the Programme. Jointly with the Institute for Environmental Studies of the Amsterdam Free University, RIVM staff helped the implementation of regional workshops, and performed an in-depth study for OECD to compare submissions of national inventories (van Amstel, 1993b). The ideas developed in this project have to a large extent influenced the structure and contents of the international Symposium "Non-CO_2 Greenhouse Gases: Why and How to Control?" and its Conference Statement (van Ham et al., 1994).

4. Methane emissions reductions: a side-effect of waste disposal and agricultural policies

A background study on methane updated the 1991 estimate of national emissions, applying new information on methane sources (van Amstel et al., 1993).

The specific objectives of the methane study were:

- o to test the IPCC methodology on 1990 data, to further refine the emissions estimates,
- o to assess the effects of curent policies in more detail, and
- o to assess the needs of additional policies in reaching the government 10 % reduction target.

The most important of the methane sources in the Netherlands were confirmed to be landfills, cattle, manure and the exploration, transport and distribution of oil and gas (figure 1). In van Amstel et al. (1993), the emissions of methane were determined both by applying the draft version of the IPCC/OECD Guidelines for National Emissions Inventories and by using more detailed information on the situation in the Netherlands. Even for a developed country as the Netherlands the application of the draft Guidelines for estimating the emissions from the production of oil and gas appeared to be difficult, primarily because of the absence of sufficient information about the number of wells in operation and the composition of the oil/gas mixture. A national method, which makes use of emissions factors expressed as volume percentages, is recommended.

The government emissions control target, set at a 10 % reduction of the 1990 emissions by 2000, was estimated to be reached only if the planned measures to reduce landfilled waste, acid deposition and the manure surplus would be fully effective. While the relative reduction would remain as estimated by 1991, the absolute emissions levels were upgraded considerably. Notably, potential emissions from manure were found to be considerably higher than estimated in the 1991 report. Additional policies for up to 30 % methane emissions reductions were found to be feasible, amongst others in the recovery of landfill gas and in the utilization of vented gas on North Sea platforms.

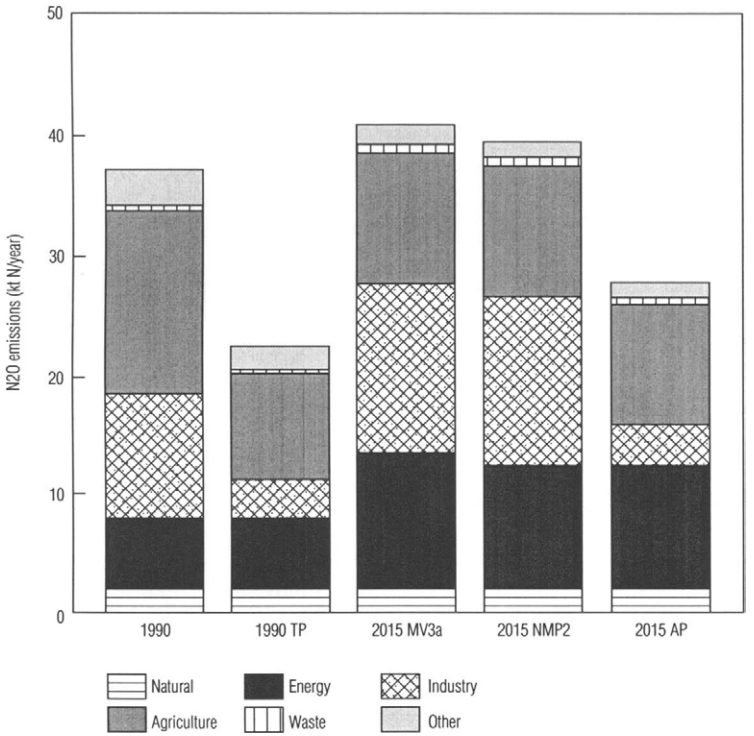
5. Nitrous oxide: losses at different places of the nitrogen cycle makes control difficult

The study on nitrous oxide (Kroeze, 1994) had similar objectives of that on methane (see section above). A comparison was made between the IPCC Guidelines and the application of a more detailed methodology, taking recent experimental data from the Netherlands into account. The detailed method, an update of the methodology of the 1991 report, led to considerably higher emissions estimates (13 - 70 Gg N/yr, central estimate 37 Gg N) than in the 1991 report (6 - 38 Gg N/yr, central estimate 17 Gg N/yr). The reasons were: 1) higher local emission factors were used for key sources and 2) in the IPCC Guidelines some sources appeared not to be taken into account (figure 2).

Currently, no specific nitrous oxide reduction policies have been developed to achieve the government goal of stabilizing emissions, primarily because stabilization was expected to be autonomous. Kroeze (1994) however shows that emissions reductions from soils, as caused by decreasing nitrogen deposition and fertilizer application, will probably be outweighed by expected emissions increases from especially the transport sector: emissions by 2000, 2010 and 2015 emissions

are estimated to be 1 %, 6 % and 10 % higher than in 1990. The technical potentials of additional control options to reduce N_2O emissions (figure 2) have been estimated for emissions from stationary combustion (15%), industry (70%), agriculture (35%) and waste (50%). Before 2000, technological options to reduce Dutch emissions include: a catalytic reduction step in nitric acid production; improved fertilzer-N use efficiency by, e.g. the use of slow-release fertilizers; improved combustion of municipal solid waste and sewage treatment, and improved combustion in power plants. Conceivable technologies that will not be implementable before 2000 include a number of promising options, such as low NOx engines in vehicles, electric vehicles, NOx reduction with low N_2O formation in stationary combustion and development of modified combustors.

Figure 2: Total Dutch emissions of N_2O in 1990, the theoretical potential (TP) to reduce 1990 emissions (if nothing else would change) and the 2015 projections based on current policy (MV3a), National Environmental Policy Plan 2 (NMP-2) and additional policy (AP)



6. Conclusions and recommendations for further work

The project "Emissions inventories and options for control" has facilitated the development of the national capabilities to comply with the requirement of the Framework Convention on Climate Change that countries should regularly report about their emissions of greenhouse gases and national policies. The methodologies

developed and applied in the project, will be used for future national National Environmental Outlooks and national communications to comply with the requirements of the Convention. The project has laid out the special circumstances that govern the emissions of greenhouse gas emissions in the Netherlands: because of the high intensity of population and economic activities - including intensive agriculture, industry, transport - the vast majority of emissions are of anthropogenic origin. The implementation of policies in areas other than climate policies - notably the prevention, disposal and treatment of solid waste and manure and the abatement of acidifying nitrogen emissions - has a counteracting effect on the tendency of growing non-CO_2 emissions that would result from the growth of economic activities.

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