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TAKING THE ENVIRONMENT INTO ACCOUNT: THE NAMEA APPROACH

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The National Accounting Matrix including Environmental Accounts (NAMEA) shows environmental burdens that are consistent with the economic figures in the national accounts. In the NAMEA, the existing national accounts matrix has been extended with accounts in physical units. On the basis of the expected contribution of each polluting substance to a particular environmental problem, emissions are converted to theme equivalents. This results in six summary environmental indicators that are directly comparable to the conventional economic aggregates. In addition, this meso-level information system can be used as the core data framework for integrated analyses and forecasts of economic and environmental changes.

1. INTRODUCTION

In general, the value of commodities in the System of National Accounts (SNA) is based on actual payments and receipts for these commodities in the market place. In this way receipts always equal outlays, an important accounting practice that guarantees the system's consistency. This valuation method reflects the revealed preferences on markets and the preferences for public goods as the outcome of (democratic) decision-making processes. The present representation of pollution in the national accounts is based on this same starting point. If polluting companies are not actually charged for the resulting damage on the environment, there are no costs subtracted from Gross Domestic Product (GDP). This makes sense because these social burdens are not actually paid for by anyone and thus also not subtracted from factor payments to employees and capital suppliers of polluting companies. Analogously, free use of environmental functions, like swimming in a clean sea, does not lead to an increase in GDP. Similarly, unpaid household labour and leisure are not taken into account.

It can be concluded that the core SNA contributes to the understanding of the development of welfare, but does not provide a complete picture. Although welfare aspects such as Net National Income, employment and social security payments are part of the system, these aspects are not all reflected in a single indicator, for instance a national income adjusted for unemployment. A much more fruitful way to deal with the unpriced welfare issues is to expand the national

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accounts with non-monetary data on aspects of welfare, whereby for each aspect a separate indicator is constructed.[1] Changes in indicators can then subsequently be compared in overview tables. Examples can be found in Tables 4 and 5 of this paper. The NAMEA contains detailed information on the environment and converts this into a number of summary environmental indicators. In this way, indicators on the economy and the environment are reflected in a single accounting system. This is elaborated in the next section. Section 3 discusses on the environmental themes in the NAMEA framework. Section 4 gives an application of the NAMEA in which economic and environmental indicators are compared for various industries and consumption purposes. Finally, Section 5 winds up with other possible uses and discusses some aspects of the NAMEA's relationship to the interim Handbook on Integrated Environmental and Economic Accounting (SEEA) of the United Nations (1993).

2. An Aggregate NAMEA

In the NAMEA, the National Accounting Matrix is extended with three accounts on the environment. A substances account (account 11 in Table 1), an account for global environmental themes (account 12) and an account for national environmental themes (account 13). These accounts do not express transactions in money terms but include information on the environment as it is observed in reality: that is in physical units.[2] In this part of the NAMEA, not only pollution generated by producers and consumers is presented, but also the accumulation of hazardous agents in the Dutch environment. This accumulation is equal to the domestic output of pollutants plus the balance of transboundary pollutant flows to and from other countries. In this statistical matrix, the value of these pollutant flows, expressed in guilders is equal to their transaction value in the economy, namely zero. In the environmental accounts, these trivial values are not reflected, but replaced by the corresponding physical units.

The other accounts in the NAMEA contain a brief overview of the regular transactions in the National Accounting Matrix (cf. Keuning and de Gijt, 1992).[3] Sometimes, actual transactions which are relevant to an environmental concern, are isolated and explicitly shown (see for instance account 1a in Table 1). In the NAMEA, receipts are reflected in the rows and outlays in the columns. Most of the accounts contain a balancing item in the column, defined as the difference between total receipts in the row, and the sum of total outlays in the column. These balancing items are doubly framed in the columns of the accounts in Table 1. In this way, column and row totals are equal for each account, a rule that guarantees the consistency of the accounting system. In order to emphasize that currency units and physical units cannot be added up, the physical units are positioned higher in the rows, and more to the left in the columns of accounts 2,

[1]See Keuning (1995) for an elaborate discussion on this issue.
[2]See Keuning (1993) for arguments against an imputation of hypothetical prices to physical flows within an accounting framework.
[3]These are standard ESA accounts.

3, 6 and 9. Table 1 is an aggregate presentation of the Netherlands NAMEA for 1991. The rest of this section gives a short description of this table.[4]

The first row and column contain the goods and services account. The intermediate and final use are presented in the row, and total domestic and foreign supply are presented in the column. Environmental cleansing services are reflected separately. In the NAMEA, two types of cleansing services are distinguished: internal and external environmental cleansing. External cleansing services are sold to other kind-of-activity units (intermediate consumption), to the government and to households (private consumption). These services are considered as production in the national accounts. An example is collection and incineration of waste by cleansing companies. Internal environmental cleansing services are produced by the same establishment that uses this service within its own production process. These internal services are in the national accounts identified neither as production nor intermediate consumption. In order to express the financial burdens of different industries on behalf of the environment, these expenditures are explicitly shown in the NAMEA.[5] Therefore, production as well as intermediate consumption are higher in the NAMEA than in the standard national accounts, but Net Domestic Product (NDP) and concomitantly all other balances do not change. A more detailed presentation of environmental cleansing services can be found in Table 6 of this paper. The column of the goods and services account also contains taxes on products (VAT, excises etc.) and trade and transport margins. Both of them make up the difference between the payments of users and the receipts of producers.

The second account is a specific consumption account, which reallocates consumption expenditures (matrix 1, 2) to consumption purposes (vector 2, 5). The latter are connected to specific pollution patterns (2, 11). Consumer goods that are purchased in order to protect the environment are presented separately. This concerns, for example, the extra costs of cars fitted with catalytic converters. These expenditures reflect the outlays of households for the protection of the environment (cell 2a, 5). Pollution generated by the government is in the NAMEA connected to government production and not to government consumption.

The third account shows in the row the production of goods and services, and in the column the intermediate use and value added. Other taxes on production are recorded on the a separate tax account (cell 8, 3) and consumption of fixed capital is directly put on the capital account (cell 6, 3), so that the balancing item in cell (4, 3) equals Net Domestic Product (NDP) at factor cost. In row 3 the production of goods and services is expanded with the concomitant emissions of unpriced pollutants (row-vector 3, 11). Table 2 gives detailed information on the agents emitted in all branches of industry. Vector (11, 3) contains information on a number of inputs in production processes for which no money is paid, and these are thus measured in physical units. Examples of these inputs are the extraction of natural resources and the amount of waste processed in incineration plants.

[4]The NAMEA's concept and application originated from Keuning (e.g. 1993); cf. also De Boo *et al.* (1993). De Haan *et al.* (1993) provides a more elaborate insight in the sources and methods for the actual compilation of the NAMEAs for the Netherlands.
[5]For a conceptual discussion on internal environmental costs, see De Boo (1995).

TABLE 1

A NATIONAL ACCOUNTING MATRIX INCLUDING ENVIRONMENTAL ACCOUNTS (NAMEA) FOR THE NETHERLANDS, 1
(Account 1–10 in million Guilders)

ACCOUNT (classification)		Goods and services (Product-groups)		Consumption of households (Purposes)		Production (Branches of industry)	Income generation (Primary input categories)	Income distribution and use (Sectors)	Capital	Taxes (Tax categories)		Rest of the world Current
				Environment	Other purposes					Environmental taxes	Other taxes	
		1a	1b	2a	2b	3	4	5	6	8a	8b	9
Goods and services (Product groups)		Trade and transport margins		Household consumption		Intermediate consumption		Government consumption	Gross capital formation			Export (fob)
Environmental cleansing services	1a			24	-	6305		1410				
Other goods and services	1b	-	-	710	321727	501763		76837	114818			293086
Consumption of households (Purposes)								Consumption of households				
Environment	2a							734				
Other purposes	2b							321727				
Production (Branches of industry)	3	Output, basic prices 7627	994861									
Income generation (Primary input categories)	4					Net Domestic Product, factor cost 429118				VAT not handed over to the government	1880	Wages from the rest of the world 820
Income distribution and use (Sectors)	5						Net National Generated Income, factor cost 430650	Property income and current transfers 573920		Taxes 3982	137518	Property income and current transfers from the rest of the world 60190
Capital	6					Consumption of fixed capital 61560		Net saving 72960				
Financial balance	7								Net lending to the rest of the world 17340			
Taxes (Tax categories)		Taxes less subsidies on products				Other taxes less subsidies on production		Taxes on income and wealth	VAT on land and taxes on investment			Taxes from the rest of the world
Environmental taxes	8a		907			855		2220				
Other taxes	8b	112	45787			2887		88730	992			1050
Rest of the world Current	9	Import (cif)	267386				Wages to the rest of the world 1170	Property income and current transfers to the rest of the world 67720		Taxes to the rest of the world	160	
Rest of the world Capital	10								Capital transfers to the rest of the world 2350			Current external balance -18710
Substances (CFCs and halons in 1000 kg, gas and oil in pj and other substances in million kg)						Absorption of substances in production						Trans-border pollution to the rest of the world
CO_2	11a											
N_2O	11b											
CH_4	11c											
CFCs and Halons	11d											
NOx	11e											488
SO_2	11f											159
NH_3	11g											113
P	11h											24
N	11i											581
Waste	11j					2645						
Gas	11k					2595						
Oil	11l					138						
Global environmental themes									Environmental indicators			
Greenhouse effect (GWP)	12a								188890			
Ozone layer depletion (ODP)	12b								3816			
National environmental themes												
Acidification (AEQ)	13a								156			
Eutrophication (EEQ)	13b								287			
Waste (KG)	13c								23761			
Loss of Natural resources (PJ)	13d								-759			
TOTAL		Supply, market prices 7739	1308941	Consumption of households 734	321727	Costs, basic prices 1002488	Allocation of generated income 431820	Current outlays 1206258	Capital outlays 135500	Tax receipts 3982	139558	Current receipts from the rest of the world 336436

Note: Due to rounding, totals do not always add up.

	Rest of the world Capital	Substances (CFCs and halons in 1000 kg, gas and oil in pj and other substances in million kg)												Global environmental themes		National environmental themes				TOTAL
		CO2	N2O	CH4	CFCs & halons	NOx	SO2	NH3	P	N	Waste	Gas	Oil	Greenhouse effect	Ozone layer deple-tion	Acidi-fication	Eutro-phication	Waste	Loss of Natural Resour-ces	
	10	11a	11b	11c	11d	11e	11f	11g	11h	11i	11j	11k	11l	12a	12b	13a	13b	13c	13d	
																				Commodity use, market prices
1a																				7739
1b																				1308941
		Emission of pollutants from household consumption																		Consumption of households
		36372	2	4	656	156	5	-	15	115	6663									
2a																				734
2b																				321727
3		Emission of pollutants from production																		Production, basic prices
		128040	59	724	4375	397	191	220	155	1257	19742									1002488
4																				Generated income 431820
5																				Current receipts 1206258
6	Capital transfers from the rest ofthe world 980	Other changes in natural resources										1836	138							Capital receipts 135500
7	Net lending from the rest of the world -17340																			0
																				Tax payments
8a																				3982
8b																				139558
9		Trans-border pollution from the rest of the world				93	99	27	20	415										Current pay-ments to the rest of the world 336436
10																				Capital pay-ments to the rest of the world -16360
														Allocation to global environmental theme		Allocation to national environmental themes (accumulation of substances)				Destination of substances
11a														164412						164412
11b														61						61
11c														728						728
11d															5031					5031
11e																158				646
11f																136				295
11g																134				247
11h																	166			190
11i																	1206			1787
11j																		23760		26405
11k																			-759	1836
11l																				138
																				Theme-equiva-lents global
12a																				188890
12b																				3816
																				Theme-equiva-lents national
13a																				156
13b																				287
13c																				23760
13d																				-759
	Capital receipts from the rest of the world	Origin of substances												Theme-equivalents, global		Theme-equivalents, national				
	-16360	164412	61	728	5031	646	295	247	190	1787	26405	1836	138	188890	3816	156	287	23760	-759	

TABLE 2

DETAILED PRESENTATION OF THE ORIGIN AND DESTINATION OF MATERIAL FLOWS IN THE 1991 NAMEA FOR THE NETHERLANDS

	CO_2 11a	N_2O 11b	CH_4 11c	CFCs and halons 11d	NOx 11e	SO_2 11f	NH_3 11g	P 11h	N 11i	Waste 11j	Natural Gas 11k	Crude Oil 11l
	mln kg			1000 kg	mln kg						pj	
Origin												
Household consumption expenditure (2)	36,372	2	4	656	156	5	—	15	115	6,663		
Own transport	14,672	2	—	—	135	4	—	—	39	120		
Other	21,700	—	4	656	21	1	—	15	76	6,543		
Production (3)	128,040	59	724	4,375	397	191	220	155	1,257	19,742		
Agriculture, hunting, forestry, fishing	10,260	33	534	—	36	2	215	131	1,117	1,190		
Mining and quarrying												
Crude petroleum and natural gas production	1,566	—	78	—	5	2	—	—	2	1,368		
Other mining and quarrying	357	—	—	—	—	1	—	—	—	—		
Manufacturing												
Food, beverage and tobacco industry	4,173	—	1	8	12	2	—	1	4	2,225		
Textile, wearing apparel and leather industry	357	—	—	160	1	—	—	—	—	61		
Wood, furniture and building materials industry	83	—	—	478	1	—	—	—	—	216		
Paper, paper products, printing and publishing industry	1,626	—	—	5	4	—	—	—	1	381		
Petroleum industry	11,843	—	—	—	22	76	—	—	9	56		
Chemical industry	20,307	17	3	1,626	41	22	4	14	25	3,099		
Rubber and artificial materials processing industry	1,487	—	—	720	3	—	—	—	1	41		
Manufacture of building materials, earthenware and glass products	2,335	—	—	50	14	5	1	—	5	378		
Manufacture of basic metals	6,097	—	—	15	12	14	—	—	4	308		
Manufacture of metal products and machinery	1,190	—	—	742	3	—	—	—	1	160		
Industrial manufacturing n.e.c.	992	—	—	472	2	—	—	9	16	123		

Public utilities												
Electricity	38,781	—	—	—	68	35	—	—	21	149		
Other public utilities	75	—	96	—	1	—	—	—	—	485		
Construction	2,501	—	8	—	26	3	—	—	8	3,574		
Transport and storage	9,254	2	—	6	78	22	—	—	23	2,270		
Environmental cleansing and sanitary services	3,641	6	4	—	5	3	—	—	2	690		
Other services	11,115	1	—	93	63	4	—	—	18	2,968		
Capital (6)											1,836	138
Rest of the World, current (9)					93	99	27	20	415			
Total = column total 11	164,412	61	728	5,031	646	295	247	190	1,787	26,405	1,836	138
Destination												
Production (3)										2,645	2,595	138
Crude petroleum and natural gas production											2,595	138
Environmental cleansing and sanitary services										2,645		
Rest of the World, current (9)					488	159	113	24	581			
Global environmental themes (12)	164,412	61	728	5,031								
National environmental themes (13)					158	136	134	166	1,206	23,760	−759	0
Total = row total 11	164,412	61	728	5,031	646	295	247	190	1,787	26,405	1,836	138

The emissions of waste incineration plants are again taken into account in row-vector (3, 11). When sufficient data on the destination of recycled waste become available, this can also be reflected in vector (11, 3).

The fourth row contains different components of NDP (wages and salaries, employers' social contributions and operating surplus) and wages and salaries from abroad. Cell (4, 3) reflects the value added tax invoiced by sellers, but not handed over to the government, for various reasons. In the column of account four, the income flows are allocated to institutional sectors in the economy (financial and non-financial corporations, households and the government) and to the rest of the world. In the fifth account, income is (re-)distributed and used for consumption and saving. In account 6, net saving is converted into various types of capital formation. Account 7 presents the financial balances (net lending) of the total economy and the rest of the world. By definition, these balances add up to zero. Therefore the presentation of an (empty) column is not necessary.

Account 8 of the NAMEA is a separate tax account in which a variety of taxes are presented, such as taxes (minus subsidies) on products in sub-matrix (8, 1), other taxes on production in vector (8, 3) and taxes on income in vector (8, 5). In the detailed NAMEA, environmental taxes such as energy levies, levies on the pollution of surface waters and levies on waste water drain-offs are presented separately. The collection of tax receipts is reflected in the column of the tax account (row-vector 5, 8 and cell 9, 8b).

Accounts 9 and 10 represent transactions with the rest of the world. The row of the current account (9) contains not only imports of goods and services, but also the pollution that enters the Netherlands through the rivers or the air. In the column, outlays such as exports are presented, as well as the export of pollutants to other countries. Unfortunately, trans-border flows of waste are still missing due to lack of data. Cell (10, 9) reflects the current external balance of the rest of the world with the Netherlands. The figures show that the Netherlands managed to create a surplus for commodities as well as for pollutants.

Account 11 registers in the column the origin of ten types of pollutants. This pollution is caused by producers (row-vector 3, 11), consumers (row-vector 2, 11) and the rest of the world (vector 9, 11). Moreover this column registers additions to proven reserves and other changes in natural resources (vector 6, 11). The row of this account presents the extraction of natural resources (crude oil and natural gas) as well as the absorption of pollutants into the economic process. This concerns for instance, waste incineration (vector 11, 3). The rest of the pollutants is exported to other countries (vector 11, 9), or is reallocated to five environmental themes (sub-matrices 11, 12 and 11, 13) The use of natural resources is allocated to a sixth theme: loss of natural resources. Account 11 is expressed in kilograms or in petajoules (pj). Of course, the row and column totals of account 11 are equal.

3. Environmental Themes

The so-called "environmental themes" as presented in account 12 and 13 are adopted from the Netherlands' National Environmental Policy Plan (VROM, 1993). Environmental themes are used as an inventory framework of current environmental issues in the Netherlands. The column totals of account 12 and 13 reflect a weighted aggregation procedure. The weights reflect for each theme the potential relative stress on the environment of each substance. These aggregation methods are developed by the Dutch Ministry of the Environment (VROM) and are for the major part based on international research on the effects of different substances on environmental quality.[6]

Here, we present a brief overview of the environmental themes in the NAMEA. Changes in the concentrations of greenhouse gases in the atmosphere may result in climate changes. The following greenhouse gases have been incorporated in the greenhouse effect indicator: carbon dioxide (CO_2), methane (NH_4) and nitrous oxide (N_2O). CFCs and halons have also been mentioned as greenhouse gases but their contribution to the greenhous effect is inconclusive (IPCC, 1992). The relative contribution of each gas to the greenhouse effect can be expressed in CO_2 equivalents or so-called Global Warming Potentials (GWP). GWPs reflect the CO_2 concentration that would have had about the same effect on the radiating properties of the atmosphere as a particular concentration of another greenhouse gas. Table 3 reflects the compilation of the greenhouse effect indicator in the NAMEA.

TABLE 3

CONVERSION OF DUTCH GREENHOUSE GAS EMISSIONS INTO GWP, 1991

	Emission in mln kg	Global Warming Potential (GWP)/kg	Emission in GWP	%
CO_2	164,412	1	164,412	87
N_2O	61	270	16,470	9
CH_4	728	11	8,008	4
Total (account 12a)			188,890	100

A decreasing concentration of ozone in the stratosphere leads to a higher exposure to UV-B radiation, which may have negative effects on human health and ecosystems. Chlorofluorocarbons (CFCs) and halons are considered as catalysts in the reaction chains that lead to the depletion of stratospheric ozone.[7] The use of CFCs and halons is regulated by the Montreal Protocol which aims at a complete ban of CFCs in the year 1996. The ODP value is an indication of the degree to which a specific gas influences ozone concentrations in relation to CFC-11 (see VROM, 1992b).

Extensive deposition of acid substances leads to changes in the composition of soil and surface waters in the Netherlands. This process has already caused major damage to ecosystems, buildings and crops. The most important substances leading to acidification are nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3). The potential contribution to acidification of each of these substances can be expressed in Potential Acid Equivalents (PAE). This measure reflects the amount of a substance that is necessary to form an acid with a certain

[6]See Adriaanse (1993) for a more detailed discussion.
[7]Carbontetrachloride and 1,1,1 trichloroethane also included in the compilation of the ozone depletion indicator. Data on HCFCs and methylbromide were too scarce to allow for their incorporation.

amount of H^+ ions. One acid equivalent equals 1/2 mol (32 grams) SO_2, or 1 mol (46 grams) NO_2, or 1 mol (17 grams) NH_3 (Schneider and Bresser, 1988).

The excessive accumulation of nitrogen (N), phosphorus (P) and potassium (K) can lead to eutrophication. In turn, eutrophication may result in the loss of species, and a decreasing quality or even poisoning of drinking water. The NAMEA has only been focusing on nitrogen and phosphorus because of data availability. A preliminary common unit is used to aggregate both substances to one theme (see VROM, 1992a). Based on the average appearance of nitrogen and phosphorus in natural circumstances, a 1 to 10 ratio between nitrogen and phosphorus is assumed to arrive at Eutrophication Equivalents (EEQ).

The accumulation and removal of waste is a major environmental problem in most countries. Dutch environmental policy has been focusing on a reduction of the amount of waste generated (VROM, 1989). The theme-indicator therefore reflects the total amount of waste in millions of kilograms. Other aspects of particular waste flows such as the hazard of toxic chemical waste are not reflected in the waste indicator.

Finally, the net change in the combined proven oil and gas reserves during the reference year is reflected in the last indicator. This change is determined by the balance of extraction [−(11k, 3) and −(11l, 3)] and all other changes in proven reserves [cells (6, 11k) and (6, 11l)].

The environmental themes lead to a limited number of physical environmental indicators. Account 12 in the NAMEA contains two environmental themes which are related to global environmental problems: the greenhouse effect and the depletion of the ozone layer. The corresponding indicators reflect the Netherlands' contribution to these global problems. Different accounting rules are applied to acidification, eutrophication and waste accumulation because these themes cause environmental damage within the national boundaries. For these problems information on the national accumulation of pollutants is relevant. This means: total domestic pollution plus import minus export of pollutants.

Most of the environmental themes allocate pollutants to certain environmental problems and are therefore an empirical reflection of highly complex cause-effect relationships in the environment. Many environmetal losses are the result of a combination of different types of environmental stresses. The actual environmental effects caused by a single environmental theme are in general difficult to measure. An objective determination of the relative seriousness of a particular environmental theme is even more troublesome. Social preferences are crucial in this respect. In the first pilot NAMEA (De Haan *et al.*, 1993), the theme indicators were based on the quotients of current environment pressures and their concomitant policy target, as stated in the Netherlands environmental policy plan (VROM, 1989 and 1992a). This plan reflected the official government policy and was formally approved by the Parliament. Policy endorsed norms are in our view the most acceptable weights if one wants to compile a single environmental pressure index. However, the user community, as reflected in the Dutch national accounts advisory board, was reluctant to mix statistics with politically determined targets.

At the most aggregate level, NAMEA presents the interrelation between macro-indicators for the economy (NDP, Net Saving, external balance) and the environment (environmental theme indicators). Underlying Table 1 a much more detailed information system is available, distinguishing for each account a number of categories. Table 2 presents more detailed information on substance flows in account 11 of the corresponding macro-table. The pollution from production is classified by industry branch. Pollution emitted by consumption is shown for two consumption purposes: (a) own transport and (b) other purposes.

4. Comparing Industries' and Households' Contributions to Environmental and Economic Indicators

The indicators presented in Tables 4 and 5 are calculated by converting the emission data in the NAMEA into environmental stress equivalents and by aggregating these equivalents per theme. Table 4 shows that the emissions in the Netherlands as reflected in the NAMEA have on average decreased or increased significantly less than the Gross Domestic Product (GDP). The emission of pollutants which damage the ozone layer decreased by an average 12.4 percent per year. Other environmental indicators also show a decrease: euthrophication by 3.5 percent and acidification by 2.2 percent per year. The volume of waste, on the other hand, grew by 1.8 percent per year, while the emission of greenhouse gases increased by 2.0 percent. These percentage increases are, however, significantly lower than the volume increase of GDP between 1989 and 1991, i.e. 3.2 percent per year.

The average consumption growth equalled 3.8 percent between 1989 and 1991. In spite of this, consumers produced 2.1 percent less waste per year and emitted 4.9 percent less acid substances. The ozone layer depleting emissions were reduced by 12.3 percent yearly. However, the higher consumption did lead to more emissions of greenhouse gases (+2.9 percent) and eutrophicating substances (+2.5 percent) per year. These increases surpass the annual growth of the producers' emissions by industries (+1.8 percent and −4.0 percent respectively).

Remarkably, the relatively lower pollution due to consumption is nearly all accounted for by the lower emissions of cars and other forms of personal transport. In this consumption category emissions are down all along the line, while the consumption volume rose by nearly 3 percent per year. This is partly related to the increasing proportion of cars in the Dutch car fleet being fitted with catalytic converters since 1989. In spite of this decrease, in 1991 personal transport still caused 86 percent of the acidification due to consumption. Moreover it accounted for 41 percent of the greenhouse effect and 15 percent of eutrophication. In comparison, expenditure on personal transport made up only 9 percent of total consumer expenditure in 1991 (see Table 5).

In nearly all branches of industry which contribute significantly to the thinning of the ozone layer, eutrophication and acidification, the emission of pollutants which cause these problems dropped. The only exception was the emission of acidifying substances by the oil industry (+2.3 percent). The volume growth of value added was relatively high here too (+4.8 percent). The category "other manufacturing" realized the greatest reduction in damage to the ozone layer (−18.4 percent); this was mainly due to improvements in the manufacture of rubber and plastic products and in the metal products industry.

The decrease in the emission of eutrophicating substances was mainly caused by less emission by agriculture (−3.9 percent, with a production growth of 6.5

TABLE 4

AVERAGE ANNUAL VOLUME CHANGES 1990—91 FOR SOME ECONOMIC AND ENVIRONMENTAL INDICATORS

	Economic Indicators			Environmental Indicators				
(%)	GDP (factor cost)	Labour Volume	Consumption expenditure	Greenhouse Effect	Ozone Layer Depletion	Acidification	Eutrophication	Waste
Household consumption expenditure			3.8	2.9	−12.3	−4.9	2.5	−2.1
Own transport			2.8	−1.1	—	−6.3	−7.9	—
Other			3.8	6.0	−12.3	4.8	4.7	−1.7
Production	3.3	1.8		1.8	−12.4	−1.8	−4.0	3.2
Agriculture, hunting, forestry and fishing	6.5	−0.4		6.8	—	−1.5	−3.9	1.2
Mining and quarrying	4.8	0.0		—	—	—	—	5.2
Manufacturing	1.9	0.8		0.7	−12.5	−1.0	−3.0	4.4
Food, beverage and tobacco industry	3.7	0.3		2.0	—	—	—	9.0
Petroleum industry	4.8	0.0		0.3	—	2.3	—	—
Chemical industry	0.0	0.0		0.9	−3.1	−5.6	−13.6	3.2
Manufacture of basic metals	−1.9	−1.7		−3.8	—	−2.2	—	—
Other manufacturing of which	2.1	1.1		3.6	−18.4	−1.3	—	1.5
Public utilities	3.2	−2.2		0.4	—	−7.0	—	—
Electricity	2.2	−1.9		0.1	—	−7.7	—	—
Construction	0.0	0.0		—	—	—	—	−3.9
Transport and storage	6.7	2.9		2.8	—	−0.5	—	5.0
Environmental cleansing and sanitary services	1.9	3.8		2.7	—	—	—	—
Other services	3.3	2.5		1.1	—	−0.7	—	9.4
Total	3.2	1.8	3.8	2.0	−12.4	−2.2	−3.5	1.8

Note: — means contribution too small for a reliable estimate of change.

percent). Acidification also dropped in this branch of industry (−1.0 percent). This form of pollution was also down in electricity generation (−7.7 percent) and in the chemical industry (−5.6 percent). Electricity plants stabilized their emission of greenhouse gases while increasing value added by 2.2 percent. In some branches of industry the increase in waste generation and in the emission of greenhouse gases was higher than production growth. The amount of waste showed a strong growth in "other services" (9.4 percent), which includes commercial services, financial services, government etc., and in the food industry (9.0 percent). Between 1989 and 1991, the emission of greenhouse gases rose in nearly all the industries except the basic metals industry. The greatest increase was for agriculture and fishing (6.8 percent) and other manufacturing (3.6 percent).

Table 5 shows that in 1991 the share of "other services" in GDP is much higher than the contribution of this activity to the above-mentioned five environmental problems. Leaving aside the damage to the ozone layer this also holds for other manufacturing. Agriculture and fishing, the chemical industry and electricity plants show the reverse for most of the environmental problems.

It should be noted that in the NAMEA pollution is registered with the activity where the actual emission has taken place. For example, greenhouse gases emitted during electricity production for rail transport are not registered with the transport industry. Such indirect effects may, however, be calculated in a matrix multiplier analysis based on the NAMEA.

Table 6 contains an overview of pollution prevention expenditures of the government, households and branches of industry. As mentioned above, these expenditures can be subdivided into two types of services: internal and external cleansing services. The share of environmental cleansing services in government and household consumption expenditures slightly rose between 1989 and 1991. A major part of the external cleansing services provided to households is actually consumed and paid for by the government.[8] From 1989 to 1991, the average annual increase in expenditures on cleansing services by industries equalled 18 percent, which is much higher than the annual GDP growth rate. The percentages in Table 6 give the total environmental protection expenditures as a share of total household or government consumption, or as a share of total input costs per industry. The average share for all industries equalled only 0.5 percent in 1989 and rose slightly to 0.6 percent in 1991.

The shares vary among production activities, and these differences are generally not in conformity with the relative contributions to environmental themes. For instance, electricity generation spends 2.5 percent of total input costs on environmental protection in 1991, while this percentage is only slightly above average in agriculture and fishing. Related to this, the emission of greenhouse gases from electricity generation nearly stabilized, while the annual value added growth equalled 2.2 percent. Acid emissions from electricity generation were reduced by almost 8 percent. This combination of relatively high expenditures on environmental cleansing and a reduction in the contributions to environmental themes was also found in the basic metals industry. Here, the average decrease in emissions for all themes surpassed the reduction in value added and employment.

[8]Typically, waste collection is not directly paid for by households, but through taxation.

TABLE 5

CONTRIBUTIONS TO PRODUCTION AND CONSUMPTION ACTIVITIES TO GDP, EMPLOYMENT AND SOME ENVIRONMENTAL THEMES ACCORDING TO THE 1991 NAMEA FOR THE NETHERLANDS

	Economic Indicators			Environment Indicators				
(%)	GDP (factor cost)	Labour Volume	Consumption Expenditure	Greenhouse Effect	Ozone Layer Depletion	Acidification	Eutrophication	Waste
Household consumption expenditure				20	10	11	9	25
Production				80	90	89	91	75
Household consumption expenditure			100	100	100	100	100	100
Own transport			9	41	0	86	15	2
Other			91	59	100	14	85	98
Production	100	100		100	100	100	100	100
Agriculture, hunting, forestry and fishing	4	5		16	0	49	86	6
Mining and quarrying	4	0		2	0	1	0	7
Manufacturing	19	18		36	98	24	11	36
Food, beverage and tobacco industry	3	3		3	0	1	0	11
Petroleum industry	1	0		8	0	10	0	0
Chemical industry	3	2		16	44	7	6	16
Manufacture of basic metals	1	1		4	0	3	0	2
Other manufacturing	12	13		5	54	3	4	7
Public utilities, of which	2	1		26	0	9	1	3
Electricity	1	0		26	0	9	1	1
Construction	6	8		2	0	2	0	18
Transport and storage	6	5		6	0	9	1	11
Environmental cleansing and sanitary services	0	0		3	0	1	0	3
Other services	9	63		7	2	5	1	15

TABLE 6

Use of Internal and External Environmental Cleansing Services by the Government, Households and Branches of Industries in the Netherlands, 1989 and 1991

	1989				1991			
	Internal	External	Total Use as % of Input	Total Use as % of Consumption	Internal	External	Total Use as % of Input	Total Use as % of Consumption
	Mln Guilders							
Consumption expenditure	509	1,021		0.43	710	1,434		0.54
Government	—	999		1.39	—	1,410		1.80
Households	509	22		0.02	710	24		0.02
Total production	1,273	3,251	0.50		1,613	4,692	0.63	
Agriculture, hunting, forestry and fishing	26	198	0.51		30	262	0.66	
Mining and quarrying	14	112	0.77		14	138	0.67	
Crude petroleum and natural gas production	12	112	0.83		12	138	0.70	
Other mining and quarrying	2	—	0.13		2	—	0.14	
Manufacturing	563	1,240	0.61		695	1,622	0.74	
Food, beverage and tobacco industry	103	172	0.36		132	196	0.42	
Textile, wearing apparel and leather industry	114	13	1.44		135	16	1.60	
Wood, furniture and building materials industry	9	3	0.18		10	5	0.21	
Paper, paper products, printing and publishing industry	52	30	0.31		63	39	0.35	
Petroleum industry	20	233	1.24		28	249	1.27	
Chemical industry	71	456	1.10		101	717	1.80	
Rubber and artificial materials processing industry	6	2	0.09		11	4	0.15	
Manufacture of building material, earthenware and glass products	15	33	0.57		16	44	0.67	
Manufacture of basic metals	16	194	1.86		21	200	2.32	
Manufacture of metal products and machinery	62	97	0.43		74	141	0.51	
Industrial manufacturing n.e.c.	95	7	0.23		104	11	0.24	
Public utilities	10	274	1.41		10	298	2.56	
Construction	24	20	0.06		28	201	0.29	
Transport and storage	61	416	1.09		80	589	1.35	
Environmental cleansing and sanitary services	18	—	0.86		24	—	0.87	
Other services	557	991	0.38		732	1,582	0.49	
Total	1,782	4,272			2,323	6,126		

Note: Internal environmental cleansing services are included in total input (and output) in the NAMEA.

Concomitantly, environmental protection expenditures were high in relation to value added. Reverse patterns were found for transport and oil refineries. Here, above-average environmental expenditures were not combined with decreases in pollution. Nevertheless, growth rates of the contributions to environmental themes by oil refineries were lower than the value added volume increase. In conclusion, a straight-forward relationship between environmental protection expenditures and pollution reduction could not be determined at the industry level. Anyhow, the NAMEA may be a suitable framework for further research on this policy issue.

5. Other Applications and Future Extensions

The NAMEA system can be used for many purposes. For example, the indirect economic and ecological effects of consumption or exports can be shown. With the help of a Leontief-inverse, it is possible to estimate the pollution generated in all activities that contributed to the realization of one unit of final product. Detailed classifications of production activities and the concomitant pollutants are very important in this respect. Besides, the NAMEA can serve as a framework for applied general equilibrium models. These models can be used for calculating e.g. the effects of an energy tax on the environmental and economic indicators in the system. Another model application of the NAMEA is the estimation of a National income in a sustainable situation.[9]

It goes without saying that the NAMEA system itself does not contain separate entries for eco-value-added, eco-margins etc. which are found in the SEEA handbook of the UN (1993). A correctly adjusted NDP can only be the result of an explicit modelling exercise. Such an exercise should yield a different, but again fully consistent NAMEA. In order to facilitate a calculation of the full effects of pricing the environment, the NAMEA contains a complete accounting system. Some of the NAMEA accounts, such as an income distribution and use account are not yet included in the SEEA. The NAMEA contains a weighted aggregation of residuals by environmental problem. The SEEA also distinguishes residuals, but without a further aggregation by environmental problem. The NAMEA's link to pressure indicators by type of environmental problem is useful for two reasons: (1) environmental policies are usually formulated at that level and (2) much more data are available for pressures than for changes in states. It may be noted that NAMEA can be used *both* for the derivation of OECD-type aggregate indicators *and* for "green" income simulations. The most important difference between both systems is perhaps that the NAMEA starts from an expansion of the National accounts with the so-called substances accounts, while the SEEA focuses to a large extent on an expansion of the asset accounts in the SNA with accounts for non-produced natural assets.

At present, the conceptual and statistical development of the NAMEA continues. For instance, the number of environmental themes will be expanded when new information becomes available. This relates to e.g. other themes from the Netherlands' Environmental Policy Plan (the dispersion of toxic substances,

[9]In De Boer *et al.* (1994) such a simple optimization model based on the NAMEA is presented.

stench and noise nuisance and excessive use of ground water). Another expansion of the system is the decomposition of supply and use data in the NAMEA into physical units and average prices. A direct connection can then be made between the use of natural resources and the emissions of pollutants. This may lead to detailed research on material flows in production processes (see Konijn *et al.*, 1995). Table 2 reflects the most detailed emission data that are presently available. The research on material flows, for instance on energy balances, may lead to more detailed emission estimates in the near future.

Finally, research continues to integrate national accounts, environmental accounts and socio-demographic accounts in a single information system that also yields the core economic, social and environmental indicators for monitoring human development (Keuning, 1995; Keuning and Timmerman, 1995).

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