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NAMWA: A new integrated river basin information system

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Content

Abstract

Since 2001, Statistics Netherlands (CBS) and the National Institute for Integrated Water Management and Wastewater Treatment (RIZA) are working together on the development of a new integrated river basin information system. This new information system is based on the National Accounting Matrix including Environmental Accounts (NAMEA), developed by Statistics Netherlands by the end of the eighties. However, until recently, water was not included in NAMEA's environmental accounts.

Driven by the increasing demand for information about the economic value of water, especially since the introduction of the European Water Framework Directive (WFD), the national environmental accounts were extended to include water flows (e.g. water extraction, wastewater discharge) and emissions of substances to water (e.g. nutrients, metals, other chemicals) linked to economic activities. This resulted in the National Accounting Matrix including Water Accounts (NAMWA).

In order to increase the usefulness of this new integrated information system for water policy and management, the data and information were disaggregated to the level of river basins where actual decision-making in the context of the WFD takes place. This resulted in the river basin NAMWA (NAMWARB). Presently, NAMWARB links the economic activities in the seven WFD river basins in the Netherlands (Meuse, Scheldt, Ems and the Rhine split up in 4 sub-basins) to their corresponding water use over the period 1996-2000.

By linking water and substance flows to economic flows and doing this systematically for a number of years, insight is gained into the (nature of the) relationship between our physical water systems and the economy. The integration of physical and economic information also allows the construction of integrated indicators. For instance, water use by various economic sectors can be related to the economic interests involved. It is this integration of water and economy at river basin level, which makes NAMWARB an important information tool to support policy and decision-making in the field of integrated water management as advocated by the WFD. By linking information about the physical pressures exerted on the water system by economic agents and the associated economic interests, NAMWARB enables policy makers and water managers at national and river basin scale in a consistent way to assess the necessary measures to reduce these pressures and meet the environmental objectives in the WFD in an integrated way. NAMWARB offers opportunities to analyse the trade-offs between environmental goals and the economic interests involved at the relevant level of analysis, i.e. river basins.

1 Introduction

Since a number of years, the demand for information about the economic value of water and the wider economic consequences of water policy and management has increased rapidly. In Europe, the introduction of the European Water Framework Directive (2000/60/EC) has given this demand an important impetus. The Water Framework Directive (WFD) is one of the first European directives in the domain of water, which explicitly acknowledges the important role of economics in water policy and management. One could say that the implementation of the WFD is one the most important challenges facing water policy and management in the next decade.

According to the European Task Force on Water Satellite Accounts (2002, p.4), the implications of the WFD include:

- an increase in the demand for water-related data of various kinds (water supply and use, economic data, water quality etc.) that are integrated and consistent;
- an increase in the availability of data that are comparable across countries, not least to facilitate the consolidation of river basin district plans comprising several countries;
- better studies of the costs and prices of water services, including as specified in the WFD the environmental and resource costs;
- more focus on the geographical boundaries of the data, i.e. water bodies and river basin districts.

In order to meet this growing demand, the possibilities of linking existing water information systems to the economic accounting system have been investigated in the Netherlands by Statistics Netherlands and the National Institute for Integrated Water Management and Wastewater Treatment (RIZA) (de Haan, 1997; Brouwer et al., 2002). This research has resulted in the creation of a new integrated water economics information system called the National Accounting Matrix including Water Accounts (NAMWA).

NAMWA provides information about the interlinkages between the physical water system and the economy at national and river basin scale. This involves not only linking water related environmental data to economic data, but also presenting these data at the relevant geographical scale through upscaling or downscaling. It is this issue of matching available data across the various scales, which has proven to be one of the major challenges in the compilation of a new integrated river basin information system. As acknowledged in the Handbook on Integrated Environmental and Economic Water Accounting, drafted by the UN, '… *it is important that the spatial reference is the same for hydrological and economic data*.' However, '*river basins for which hydrological data is usually available, do not generally coincide with administrative regions for which economic information is collected*' (to be published in 2005, p.17). In fact, no consistent water economic information system exists yet, which allows for the consistent disaggregation and aggregation between the national and river basin level. Most efforts in the area of integrated water accounting are based on national statistics (see the examples given in the UN handbook on Integrated Environmental and Economic Water Accounting).

The structure of NAMWA is based on the National Accounting Matrix including Environmental Accounts (NAMEA), which was developed by Statistics

Netherlands in the beginning of the 1990s (de Haan et al., 1993). Basically, NAMWA consists of three different accounts: an economic account, an emission account and a water balance account, which have been linked in a consistent and coherent manner, following the internationally established structure of the System of National Accounts (SNA). The main objective of this paper is to present the structure of this new information system in more detail and illustrate its usefulness as a database for the economic analysis in the WFD.

The paper is structured as follows. Section 2 describes the overall structure of NAMWA, focusing especially on the way how water related environmental data are linked in a consistent way to economic data. Section 3 discusses the way how different types of data collected and presented at different geographical scales are translated to the level of river basins. In section 4 the applicability and usefulness of the integrated indicators derived from NAMWA is illustrated for the WFD. Finally, section 5 concludes.

2 The structure of NAMWA

NAMWA is an extension of the National Accounting Matrix (NAM), which is published annually in the Netherlands by Statistics Netherlands. The NAM provides information about the flows of goods and services in the national economy in a particular year and the money flows that are related to these flows. As such, NAM provides an official account of the economic transactions in the Netherlands, in accordance with an internationally adopted methodology, i.e. the ESR (Eurostat, 1996), which is based on the worldwide System of National Accounts (SNA) (United Nations, 1993). The use of such an internationally accepted method allows for international comparability[1].

In the beginning of the 1990s, Statistics Netherlands extended this National Accounting Matrix with a 'satellite account', which includes the environmental pressures related to the production of goods and services. This resulted in the National Accounting Matrix including Environmental Accounts (NAMEA) (Keuning, 1993; de Haan and Keuning, 1996). Although not officially, the international methodology for integrated environmental and economic accounting, NAMEA has been adopted by and implemented in several countries worldwide.

NAMWA is a further specification of NAMEA for water, using the same basic structure as the NAMEA. Within this structure, each column represents the supply of a good or service, whereas the rows describe the demand for those goods and services. The monetary flows are in exactly the opposite direction: columns represent receipts and rows represent expenditures. The total of the columns equal the total of the rows. Together rows and corresponding columns make up an account for a specific good or service, reflecting where they come from and where they go.

Basically, the structure of NAMWA consists of three parts (Table 1):

- An economic account (the first 10 accounts, all in millions of euros).
- A water extraction and discharge account (account numbers 11 and 13 in millions of cubic metres).
- An emission account (account numbers 12 and 14 in kilograms).

The first accounts for the emission of substances and water extraction and discharge, account numbers 11 and 12, represent the flows. The second account (account number 13) for water extraction and discharge describes changes in stocks, while the second account (account number 14) for emissions describes the contribution of various substances to 'environmental themes' such as eutrophication or the dispersion of heavy metals in water. Also this is significantly different than the flow accounts. To stress these differences, the accounts are not presented consecutively, but alternating in NAMWA (see Table 1). The various accounts will be discussed in more detail below.

[1] In 1993 the United Nations published their first handbook on integrated environmental and economic accounting (SEEA), followed by an operational manual in 2000 and a revised handbook in 2003.

Account nr	1-10	11	12	13	14
1-10	NAM (economic); mln Euros				
11	Water balance; mln m^3				
12	Emission balance; kg				
13	Water balance; mln m^3				
14	Emission balance; kg				

Table 1: The basic structure of NAMWA

2.1 Economic accounts

The first ten accounts in NAMWA represent the traditional National Accounting Matrix (in millions of Euros). In view of the fact that NAMWA focuses on water related issues, the 'not to water related issues' are summarised and included in the section "other". In this way, the totals in NAMWA correspond with those in NAMEA and NAM.

Account number 1 represents the supply and demand of goods and services (in purchase prices) in the Netherlands for a particular year.[2] Supply exists of production (in base prices), taxes and imports. Demand is broken down into consumption by households, government, intermediary use, investments and exports. The types of goods and services distinguished in NAMWA are:

- Tap water (row 1a).
- Other goods and services (row 1b).
- External environmental services, excluding sewerage rights; e.g. collection of waste by environmental companies (row 1c1).
- Sewerage rights; taxes received by municipalities for use of sewerage (row 1c2).
- Internal environmental services related to water treatment; water related self-services (row 1d).
- Internal environmental services related to prevention of soil pollution (row 1e)
- Other internal environmental services; not water or soil related self-services (row 1f).

Account number 2 presents the budgets of households and how this is spent.

Account number 3 is the production account. This account presents in each row the production value (in basic prices). In the (sub)columns, the total production value is broken down into intermediary use, net value added, depreciation, and non-product related taxes. This account is specified for nine sectors with a further breakdown of the sector Government into 4

[2] The national accounts are usually published annually and always refer to a specific year in the past.

subcategories, based on the importance of water in these specific sectors. The nine sectors are:

- Agriculture and fisheries (row 3a).
- Oil and gas mining (row 3b1).
- Other mining activities, including gravel mining (row 3b2).
- Industrial manufacturing (row 3c).
- Water extraction and distribution by drinking water companies (row 3d).
- Electricity generation and distribution and gas distribution (row 3e).
- Environmental services, including wastewater treatment (row 3f).
- Construction and miscellaneous, including water boards (row 3g).
- Government (3h):
    - Central government (row 3h1).
    - Municipalities (row 3h2).
    - Other government (row 3h3).
    - Defence (row 3h4).

Special attention should be paid to the 'Government'. In NAMWA, an important difference exists between the Government as an economic activity, described in account 3, and the Government as a sector, described in account 5. In account 3, Government is split into general government (central government, municipalities and other), defence and subsidised education. A further subdivision for these sub-sectors is not possible in NAMWA. As a result, no data for water use or various non-product related taxes can be presented in NAMWA for the economic activity by the important sub-sector 'water boards' (including water quantity and water quality management). On the other hand, water quality management by water boards, most importantly wastewater treatment, is included in row 3g.

Account number 4 describes the primary income generation. Net value added, non-paid value added tax, and income generated abroad constitute net national income and income paid to other countries.

Account number 5 presents the income distribution and describes the secondary distribution of national income across different sectors. Here, we focus mainly on the sector Government. The sector Government includes the economic activity Government, as described in account number 3, and parts of the Government that have been included in other economic activities, i.e. activities which have been carried out by other companies, such as health care or environmental services, including wastewater treatment by regional water boards. The various sectors specified in account number 5 include:

- Non-financial institutes.
- Financial institutes.
- Government.
    - Water related revenues by the central government.
    - Water related revenues by provinces (some provinces receive dividend on shares of drinking water companies).
    - Water related revenues by the regional water boards (water pollution levy and levy for water quantity management).
    - Water related revenues by municipalities (sewerage and other environmental taxes).
    - Other government.

Account number 6 describes the capital flows. Capital expenditures (rows) include investments in goods and services, national credits, and capital transfers to other countries. These expenditures equal the revenues (columns) consisting of depreciation, savings, and capital transfers from abroad.[3]

Account number 7 describes the financial balance. This account presents the total of credits and debts with other countries. These are - by definition - each other's reciprocals.

Account number 8 describes taxes. Compared to NAMEA, NAMWA distinguishes the following typically to water related taxes:

- Water related taxes (row 8a).
    - Water board levies (row 8a1).
    - Water pollution levies (row 8a2).
    - Sewerage levies (row 8a3).
    - Levies on wastewater discharged into large state-owned rivers (row 8a4).
- Levies on groundwater extraction (row 8b).
- Other environmental taxes (row 8c), including green taxes.
- Other taxes (row 8d).

These taxes are received as product related taxes, non-product related taxes, income taxes, property taxes or tax income from abroad (rows). In the columns, the associated expenditures are presented, i.e. non-paid value added taxes, taxes minus subsidies, and taxes paid to other countries.

Account number 9 describes the payments to and from abroad for non-capital goods and capital formation. These include, in the rows, revenues from abroad from exports, wages, income distribution, and taxes. The columns represent expenditures paid for imports, wages and taxes paid abroad and the balance of current transactions with other countries.

Finally, account number 10 presents the capital balance with other countries. Capital transfers, the financial balance, and the balance for current transactions finance the capital expenditures in other countries.

2.2 Emission accounts

Whereas the economic accounts are all in millions of euros, the emission accounts are expressed in physical units (kg). NAMWA describes the emissions of 78 substances to the aquatic environment originating from economic activities. The list with substances includes the most important substances identified in the WFD. The emission data for these substances are supplied by the Dutch National Emission Registration. The list with substances is shown in Table 2. A list of the emission sources is presented in the Annex.

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[3] Statistics Netherlands accounts for depreciation (use of capital) in the same way as most other statistical institutes, i.e. by assuming an average economic lifetime of the capital stock. The most often used method to estimate the capital stock is the Perpetual Inventory Method (PIM). This method applies a survival function to estimate the gross value of the capital stock. The entire stock is then valued against purchase prices in the reporting year. The use of the capital stock is estimated using a linear method, assuming a proportional depreciation of the capital stock over its entire lifetime. The capital account is not specified for sectors or economic activities.

Substance	Substance
SB	Chrysene
AS	Benzo(a)anthracene
CD	Benzo(a)pyrene
CR	Benzo(b)fluoranthene
CU	Benzo(k)fluoranthene
HG	Benzo(ghi)perylene
PB	Indeno(1,2,3-C,D)pyrene
NI	Organotin compounds
SE	Naphtalene
SN	CZV
V	Cloridbenzene
AG	Trichloridethane,1,1,1-
ZN	Dichloridethane ,1,2-
Total P	Dichloridmethane
Total N	Dioxin and Phurane (I-TEQ)
Nitrates, Nitrites	Organic halogen compounds (total)
Kjeldahl-N	Hexachloridcyclohexane
CL	PCB AND PCT
CN	Tetrachloridethane (PER)
F	Tetrachloridmethane (TETRA)
SO4	Trichloridethane (TRI)
VOC,	Trichloridmethane (Chloroform)
Carbohydrates	Chloridphenol
Non-halogenised carbohydrates (total)	Aliphatic halogenised carbohydrates
Aluiphatic non-halogenised carbohydrates (total)	Aromatic halogenised carbohydrates
Aromatic non-halogenised carbohydrates (total)	Diuron
Non-methane VOC (total)	Drins (Aldrin, Dieldrin,….)
Ethylbenzene	Dichloridbenzene,1,4-
Acrylaldehyde (Acroleine)	Trichloridbenzene, NNB
Benzene	Hexachloridbenzene
Ethene	Pentachloridphenol
Phenols, Phenolates	PCB
Formaldehyde	Dichloridethane 1,2-
Phtalaten, Phtaalesters	EOCL(extractable organic chlorid)
PAC (10), PAC (6)	
Tolueen	
Xylene (total)	
Mineral oils	
Isopropylbenzene	
Dibutylphtalate	
Phenanthrene	
Anthracene	
Fluoranthene	

Table 2: List with substances included in NAMWA

The emission balance consists of two accounts, account number 12, and account number 14. The columns of account number 12 present the emissions by consumers, by producers, and emissions of which the source is unknown (labelled 'transport difference'), and the import of transboundary pollution from abroad.[4] Emissions to water through the air (atmospheric deposition) and through runoff from soils are attributed to the sources, which originally caused these emissions.

The rows of account number 12 describe the destination of the substances. Substances can be absorbed by producers (during the production process), environmental services (wastewater treatment), exported and/or contribute to environmental themes (cell 12,14).[5] This latter cell links account number 12, which describes water pollution, to account number 14, which describes the contribution of the various emitted substances to the various environmental themes, i.e. Eutrophication, Watewater, Heavy metals and Dispersion.

The 'contribution to environmental themes' described in account number 14 presents the actual pressure on the environment caused by a particular substance in the environment. For example, excess amounts of nitrogen (N) and phosphorous (P) contribute to eutrophication. Emissions of heavy metals contribute to the dispersion of heavy metals in the environment. In a similar way, the emission of wastewater contributes to excess amounts of organic substances in surface waters.

It is important to point out that NAMWA only describes environmental pressures, not the extent to which these pressures actually result in environmental problems or damage (i.e. impacts). The level of detail in NAMWA is furthermore such that NAMWA can also not be used to inform water managers about, for example, which lakes will be affected by eutrophication. NAMWA is a descriptive tool, presenting information about the pressures exerted on the water system in some period in the past, for instance in which river basins excess amounts of nutrients have entered surface waters. An impact analysis of whether environmental pressures result in environmental problems would require the use of appropriate models. The data presented in NAMWA can be used as input into these models. On the other hand, NAMWA does offer opportunities for time series analyses on environmental pressures. This allows us to evaluate, for instance, the effectiveness of environmental policies targeting environmental pressures exerted by specific economic sectors or activities.

[4] Both the column and row totals are increased by the discharges from wastewater treatment plants, in order to make the numbers comparable to those presented in NAMEA. The numbers presented in the columns can be interpreted as the amount of pollution discharged by wastewater treatment plants, whereas the rows illustrate where the emissions come from.

[5] The construction of cell (12,14) is different from the construction of the other cells in NAMWA. Column 14 presents the contribution of substances to an environmental theme in absolute terms, whereas columns 14a through 14c present their relative contribution. These relative values are not included in the totals, but are equal to the environmental indicators of row 14. The horizontal total of column 14 reflects the contribution to the balance of substances. The way the contributions of substances to the distinguished environmental themes are calculated is described in more detail in the Annex to this paper.

2.3 Water flow accounts

The water flow accounts, i.e. water extraction and discharge, in NAMWA are expressed in millions of cubic metres (m^3) and are, contrary to the emission accounts, not part of the NAMEA. The water flow accounts are currently only available for the years 1996 and 2001, as the necessary data are based on Statistics Netherlands' five yearly Water Survey.[6] The use of water by different economic activities is described in two accounts: water flows (account number 11) and changes in water stocks (account number 13).

Account number 11 describes the extraction of three types of water sources: groundwater, surface water and tap water. For groundwater a distinction is furthermore made between fresh and brackish groundwater and for surface water between fresh and salt water. The rows describe water consumption by households, different branches of industry and other sources including water losses as a result of condensation. Water consumption is further broken down into water consumption for cooling water purposes and other purposes. Total freshwater use equals the use of drinking water, fresh groundwater and fresh surface water minus freshwater used for cooling purposes, as cooling water is only extracted temporarily and recycled again into the surface water.

Account number 13, which describes the changes in stocks, is further specified into groundwater and fresh surface water. The rows present the extraction from these sources and the columns reflect additions to these sources (groundwater and surface water) through replenishment by rivers or rainfall.

[6] In this Water Survey approximately 7,500 companies are asked about their water consumption: how much fresh, brackish, and salt water they use and for which purpose (cooling water or other).

3 Allocation of data to river basins

3.1 Introduction

This section describes the way NAMWA is compiled at river basin level besides national level. NAMWA at river basin (NAMWARB) is described separately from the national one, because not all national data are also available on river basin level. The available regional economic accounts only include a subset of information and indicators compared with the national accounts. As a consequence, regional data are not presented in a matrix, like the NAM, but in tables per region.

NAMWARB presents information at the level of the four main river basins in the Netherlands Rhine, Meuse, Scheldt and Ems (Figure 1).[7] In view of the fact that the Rhine basin covers approximately 70 percent of the whole Dutch territory, making it difficult to carry out any meaningful analysis, this basin is split up furthermore into four different subregions: Rhine-North, Rhine-West, Rhine-East and Rhine-Centre (Figure 2). Like NAMWA, NAMWARB combines three different types of data and includes an economic account, an emission account and a water extraction and discharge account.

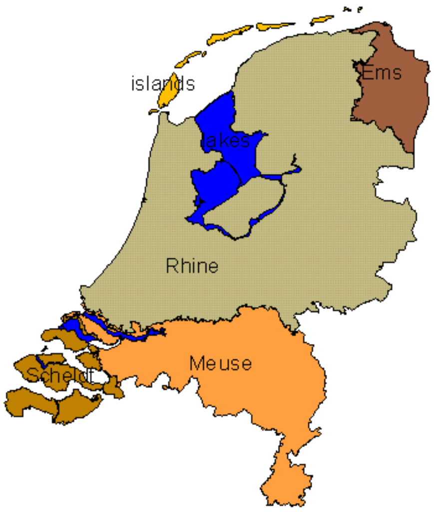

Figure 1: The Netherlands split up into four main river basins as distinguished in the WFD

3.2 Economic data

The regional economic accounts give a quantitative description of the economic processes in the various regions in the country in such a way that it is linked to the national accounts. However, the national accounts have a far wider scope of analysis, with an emphasis on production, income distribution, expenditures, and finance. The regional accounting system focuses on the production processes in each business unit in the various regions (Statistics

[7] The islands are added to the river basin of the Rhine.

Netherlands, 1999). In the Netherlands, regional accounts are composed at the level of 40 so-called COROP areas.

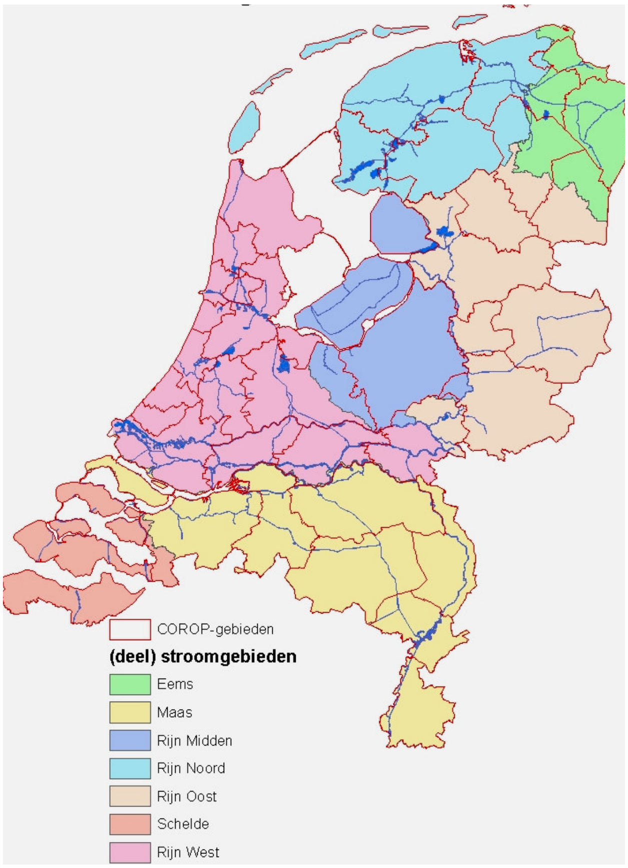

Figure 2: The Netherlands split up in 7 river basins and 54 COROPs.

COROP areas are the official regional economic units distinguished by Statistics Netherlands (Figure 2). These COROP areas are larger than the approximately 500 local authorities (municipalities) and smaller than the 12 provinces. The regional accounting system at COROP level provides the basis for the compilation of NAMWARB. The five indicators or variables included in the regional economic accounts are:

- *Production (at basic prices)*
  The production at basic prices is the value of all goods intended for sale and the receipts for established services valued at basic prices. The basic price is the amount of money received by the producer from the purchaser for a unit of a good or service produced minus any tax payable and plus any subsidy receivable on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer.

- *Use of intermediary products (at purchase prices)*
  The part of the goods and services that is produced or imported and is being used in the production process (includes resources, trade- and transport services).

- *Gross value added (at market prices)* [8]
  Gross value added equals the difference between production value and the value of the use of intermediary products in the production process. Market prices are prices including indirect taxes and subsidies.

- *Employers' wages*
  Includes periodically directly to the employers paid amounts and additions to these amounts, such as gratifications etc. Income taxes and subtractions because of social security legislation and pension funds are not subtracted from these amounts.

- *Labour force*
  Part-time jobs are recalculated to full time labour equivalents. Labour force of independents and co-working family members are not included (expressed in full time equivalents).

The economic data at the level of the 40 COROPs are disaggregated to the seven river basins in a number of steps (Figure 3). In a first step, data for COROPs which are situated entirely in one river basin are allocated directly to this river basin. This is the case for 23 of the 40 COROPs in total (see the Annex to this paper). For the remaining 17 COROPs, data are allocated in subsequent steps on the basis of the distribution of employees in the specific branches of industry in these 17 COROPs. The economic data are allocated to two or more river basins with the help of the estimated percentage of employees working in a specific river basin. These percentages are estimated by identifying:

(1) the specific branches of industry in the remaining 17 COROPs;

(2) the total number of employees working in these branches of industry;

(3) the municipalities in which the business units in these branches of industry are located;

(4) which municipalities in which these business units are located fall entirely in one specific river basin, and which municipalities overlap with other river basins.

Hence, after the specific branches of industry have been identified in these 17 COROPs, these branches of industry and the number of employees working in these branches of industry are linked to the municipalities in which the underlying business units are found. These municipalities are linked again to the specific river basins in which they fall. Business units and their number of employees in municipalities falling entirely inside a specific river basin are

[8] In the national accounts, only net value added is presented. Net value added equals gross added values minus depreciation. At a regional level, insufficient information is available about capital stocks in specific branches of industry to allow for the calculation of depreciation.

allocated directly to that specific river basin (Step 2 in Figure 3). For those municipalities located partly in one and partly in another river basin, the identified business units are linked in a next step to the postal codes within these municipalities. Also these postal codes are allocated to river basins.

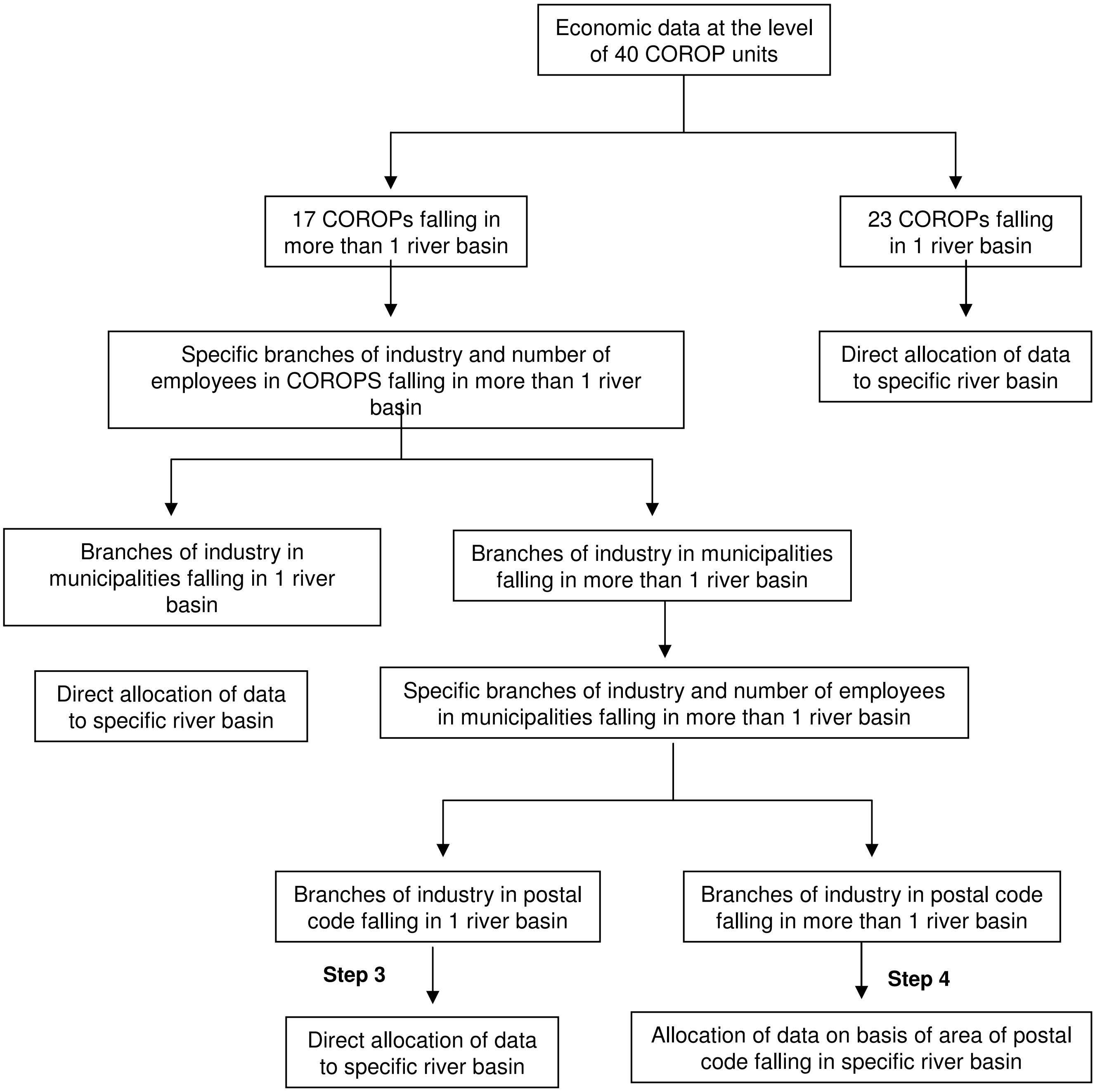

Figure 3: Allocation of economic data over river basins

Business units in postal code areas, which fall entirely within one specific river basin, are allocated directly to that basin (Step 3 in Figure 3). For those remaining postal codes found in two or more river basins, business units and their employees are allocated to a specific river basin on the basis of the area of the postal code falling in that river basin (Step 4 in Figure 3).

Most of the economic data could be allocated in this way directly at the level of COROPs. On average, 65 percent of the employees in each branch of industry are found in COROPs falling entirely in one specific river basin. Twenty seven percent of the economic data per branch of industry are allocated at the level of municipalities and 3 percent at postcode level. Five percent of all data is allocated by looking at the area within postcode areas, which falls inside a specific river basin. The percentage of employees per branch of industry, which can be allocated to a specific river basin at COROP, municipality or postcode level or through area size is presented in the Annex to this paper.

3.3 Emission data

Regional emission data are supplied by the Regional Emission Registration and include the same substances as the national emission data (see Table 2). Most data are available at the level of individual plants, including their x and y coordinates, making it relatively easy to attribute these emissions to one of the river basins. The regional emissions add up to the national totals.

In some cases a problem arises if the location of an economic activity does not correspond with the location of the emission source. For instance, a factory is located in one river basin, but its wastewater is transported to and discharged in another river basin. In these cases, the emissions are allocated to the river basin in which the economic activities take place, i.e. where the factory is located, although the actual pressure occurs in another river basin.

3.4 Water flow data

Regional water flow data are based on the National Water Survey conducted by Statistics Netherlands once every five years. The most recent surveys were in 1996 and 2001. This survey comprises business level data on water use by industry, mining and electricity companies. Additional information about water use in agriculture in those years is supplied by the Agricultural-Economic Institute (LEI). The regional water flows add up to the total of the national water flow.

The results from the National Water Survey are allocated to the different river basins in the same way as for the economic data. First, those business units are selected which are located in a municipality falling entirely in one specific river basin. Those business units falling in municipalities, which overlap across different river basins, are allocated in a second step based on their postal codes. If postal codes are found in more than one river basin, business units are allocated based on the area falling in a specific river basin. If no postal code is known, a municipality in which a business unit falls is allocated to the different river basins based on area size.

3.5 Confidentiality

Confidentiality is an important issue when disaggregating data to the level of river basins. Individual companies or business units cannot be identified, either directly or by combining data. Confidentiality only plays a role in economic and water flow data. With regard to economic data, one condition is that a sector should consist at least of three or more companies. Another condition is that the largest company cannot employ more than 75 percent of all employees in a specific region. Also for water flow data the condition applies that a sector should contain at least three or more companies. Furthermore, the largest company in a specific branch of industry in a specific region cannot use more than 70 percent of the total freshwater use in that region. For regional emission data, no special confidentiality conditions apply.

In the economic accounts, confidentiality problems are solved by adding data of a specific sector to those of another sector, leaving the space in the table for the sector whose data are added to another sector open. For water flow data, the confidential information is not added to another sector because of fear that this completely alters the results, but are shown in the total water use data.

4 NAMWA and the Water Framework Directive

4.1 Information requirements in the Water Framework Directive

The usefulness of NAMWA for the WFD will be illustrated in this section. The WFD requires that river basins across Europe are described in physical terms, but also in economic terms. According to Article 5, the economic characterisation of river basins should include an assessment of (Wateco, 2003):

- the economic significance of current water use;
- future water use up to 2015;
- current levels of cost recovery of water services.

4.1.1. Economic importance of current water use

The Wateco guidance document[9] provides some first guidelines on how to prepare an economic analysis of current water use and their economic importance. According to the Wateco guidance, this step will require a high level of coordination with other experts and stakeholders to build a common knowledge and representation of the river basin. First, water uses and services should be identified by socio-economic sector (agriculture, industry, households and recreation). Secondly, one should assess the relative socio-economic importance of the identified water uses. Potential indicators to assess the socio-economic importance of the identified water uses are value added, employment and volumes of water demand. The main outputs of this step in the economic analysis are key indicators of economic significance of water uses.

According to the Wateco guide, the economic role of water uses should be identified at the minimum at the River Basin District (RBD) level, which is also the level of reporting to the Commission. However, this may be of little use for follow-up analyses and consultation required for developing river basin management plans that are likely to require lower disaggregation for economic information and indicators (e.g. sub-regions of the basin or sub-economic sectors). Key is to collect information that is relevant to water management issues in the river basin and to key economic sectors likely to be affected by the Directive Implementation. Combining biophysical and economic information will require agreement on common spatial scale of analysis and reporting. Initiating the integration of economic and technical information for developing an adequate integrated information base will be key to the activities aimed at characterising river basin districts. If initiated at this stage, consultation would focus on seeking views on key issues and concerns in the river basin and on informing about the appraisal process.

4.1.2. Future trends in water use

According to Wateco, the projection of trends in key indicators and driving forces up to 2015, when the first integrated river basin management plans have to be ready, basically consists of an assessment of trends of key

[9] The Water Economics working group Wateco was one of the European working groups set up under the Common Implementation Strategy of the Water Framework Directive (WFD) with an aim to provide guidelines for the economic analysis in the WFD. This resulted in 2002 in the Wateco guidance document.

hydrological and socio-economic factors and drivers that are likely to affect pressures (e.g. demography, climate, sector policies, technological development) and/or the forecasting of changes in pressures based on changes in economic and physical drivers and proposed water-related measures. The expected information requirements include:

- Prospective analyses of likely development of key economic sectors or economic drivers influencing significant pressures.
- General information on population growth, economic growth, sector growth patterns, future policies and forecasts of the impact of climate change.
- Studies on existing and projected water balance.
- Inventory of existing measures (and costs) for complying with existing water legislation.
- Identification of technological developments in the water sector.

The assessment and forecasting of trends should result in a so-called '*baseline scenario*' for pressures.

4.1.3. Current level of cost recovery of water services

The Wateco guidance identifies four different types of information necessary to assess the current levels of cost recovery:

- Estimation of the costs of water services, including financial, environmental and resource costs. The financial costs broken down into operating, maintenance and capital costs.
- Estimation of the price/tariff currently paid by the users and evaluation of tax transfers.
- Assessment of the extent of financial and environmental cost recovery by water service and sector.
- Assessment of the contribution to cost recovery from key water uses.

If felt necessary, a review of incentive pricing properties of existing tariffs can be initiated on the basis of the information above. This is needed to evaluate the effort needed to meet the 2010 deadline. Principles for allocating costs of water services to categories of water users will need to be defined in a coherent manner. The main output of this element in the economic analysis is an assessment of the current extent of cost-recovery. Assessing incentive pricing properties of existing tariffs might be difficult in practice: it should be done so as to inform the future introduction of incentives in tariffs by 2009.

The usefulness of NAMWA for each of these points will be presented and discussed in the next sections.

4.2 Economic significance of current water use

Essentially, the economic significance of water use in the different river basins is measured in two different ways. *Economic significance* is measured through production values and value added generated in river basins per sector (expressed in euros), while *water use* is measured through water extraction (expressed in cubic metres) by economic activities on the one hand and the emission of polluting substances (expressed in kilograms) per sector on the other hand. Water use can furthermore be measured through wastewater discharge per sector in each river basin (expressed in inhabitant equivalents).

4.1.1 Economic indicators

The allocation of economic data to river basins, enables a detailed description of the economic structure of these river basins. Most economic value (50%) is currently (2000) generated in the river basin Rhine West (Figure 4), followed by the Meuse (21%) and Rhine East (10%).

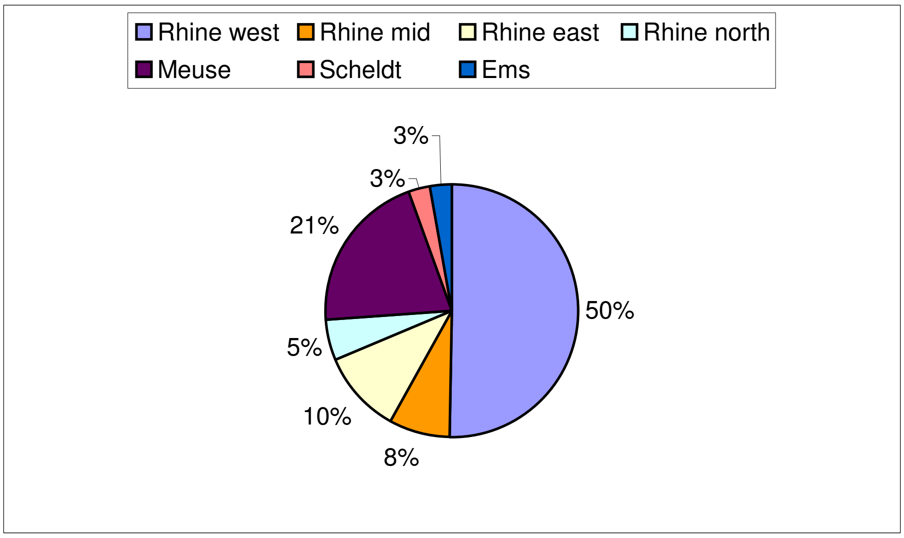

Figure 4: Distribution of economic value added generated in the various river basins in the Netherlands (in %)

The most important reason for this is that these are the three largest river basins in the Netherlands (see Figure 2). Rhine West is furthermore economically speaking a very important area in the Netherlands and furthermore the most densely populated area in the Netherlands. The contribution of three of the four other basins in total Gross Domestic Product (GDP) (i.e. sum of gross value added across the various river basins) is less than 5 percent. In 2000, total GDP was 402 billion euros.

Over the period 1996-2000 (currently, NAMWA is available for the years 1996-2000), Rhine west also showed the highest growth in economic production value (Figure 5), followed by Meuse, Rhine Mid and Scheldt[10].

Finally, the economic structure per river basin is presented in Figure 6 (based on the value added generated in 2000). Overall, the river basins show a fairly similar structure. The service sector dominates in each river basin, but most importantly in the river basins Rhine West and Rhine Mid. Almost 60 percent of total value added is generated in the service sector in these river basins, compared to approximately 50 percent in the rest of the Netherlands.

[10] On a regional level, including river basin, economic values are only available in current prices, not in constant prices. In Figure 5, economic production values are deflated using the same national deflator for all river basins.

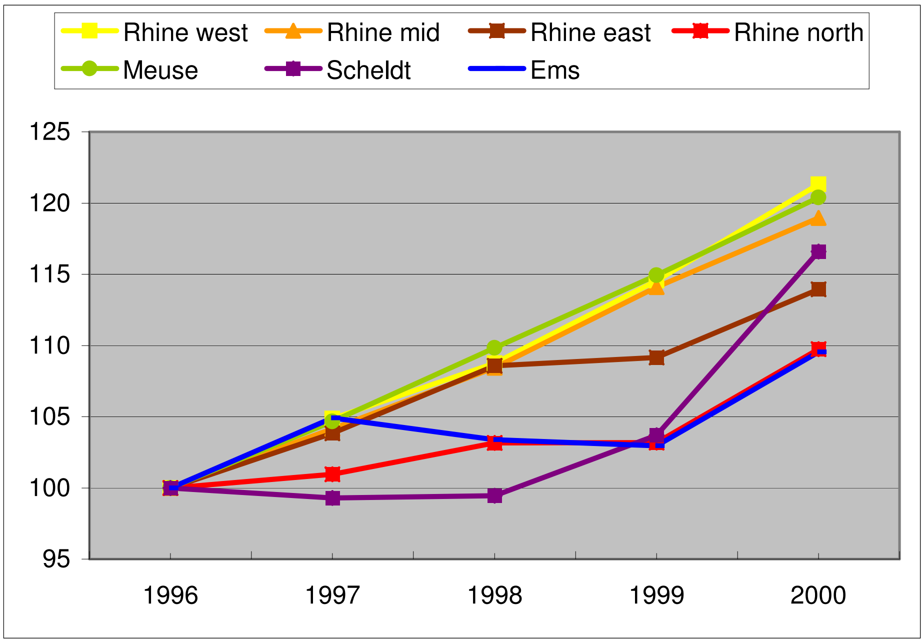

Figure 5: Economic growth (in production value in current prices) per river basin over the period 1996-2000 (1996=100)

The share of agriculture in total value added is relatively low compared to other sectors. Agriculture is especially important in Rhine North and Rhine East. Industry consists of many sub-sectors. Those which are generally believed to have an important relationship with water (mining, food, chemical, metal, energy) are shown explicitly in Figure 6. Mining (oil and gas) is particularly important in Rhine North and Ems, while the share of the chemical and food industry are relatively high in the Scheldt basin. No substantial differences can be found in the case of the energy sector. The metal industry is slightly more important in the Meuse basin compared to the rest of the Netherlands.

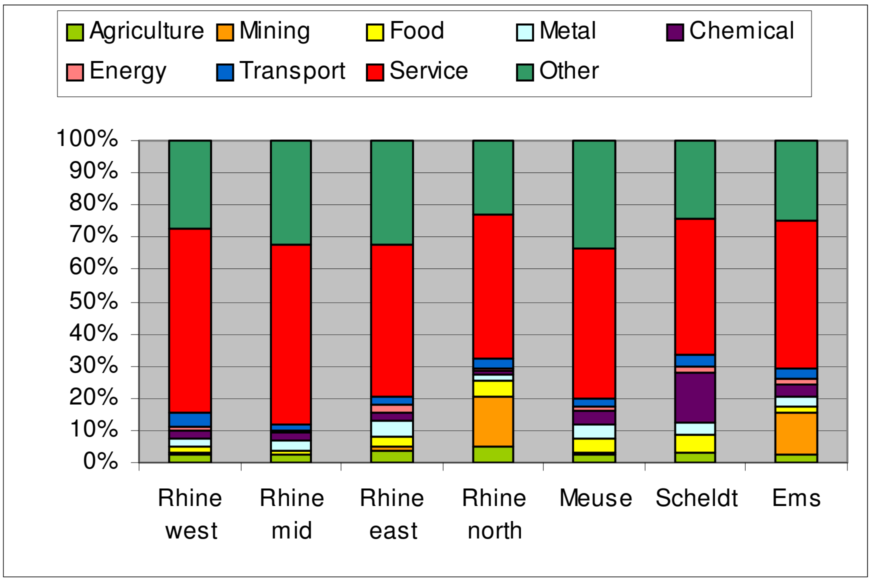

Figure 6: Economic structure in each river basin in the Netherlands (measured as the share of different sectors in total value added in 2000)

4.1.2 Water use indicators

Water use indicators are compiled based on water extraction and emissions to surface water. In addition, NAMWA also provides information about wastewater discharges in each river basin.

Water extraction

Total water use from tap water, groundwater and surface water (salt and fresh surface water) is highest in the largest river basin Rhine West (where also most people live in the Netherlands), followed by Meuse and Rhine East. Total water consumption in Rhine West was about 8 billion cubic metres in 2001 (45 percent of the total water use in the Netherlands in that year). Total water use in the Meuse was 3.8 billion cubic metres (21% of total water consumption) and in Rhine East 2 billion (11% of total water consumption).

The source of water varies significantly across river basins. Overall, most water use is extracted from fresh surface waters (40% of the total water consumption). Across all river basins, about a third of all water is extracted from the sea whilst 20 percent of all water consumption is based on groundwater. The remainder (about 10 percent) consists of tap water.

Salt water is (for obvious reasons) only extracted in those river basins, which are bordered by the sea (i.e. Rhine West, Rhine North, Ems and Scheldt). In Rhine West, 50 percent of all water use consists of salt water, in Rhine North 60 percent, in the Ems 75 percent and in the Scheldt 40 percent. Eighty-five to ninety five percent of all water use in these river basins, but also in the Meuse, is used as cooling water and discharged again into surface water after use. Relatively much tap water is used in Rhine mid (20 percent compared to 10 percent in the rest of the country). Rhine East depends for its water consumption relatively heavily on groundwater (85% of all water use comes from groundwater) and the Meuse basin on fresh surface water (also 85%). Relatively small amounts of groundwater are used in Rhine West and the Scheldt.

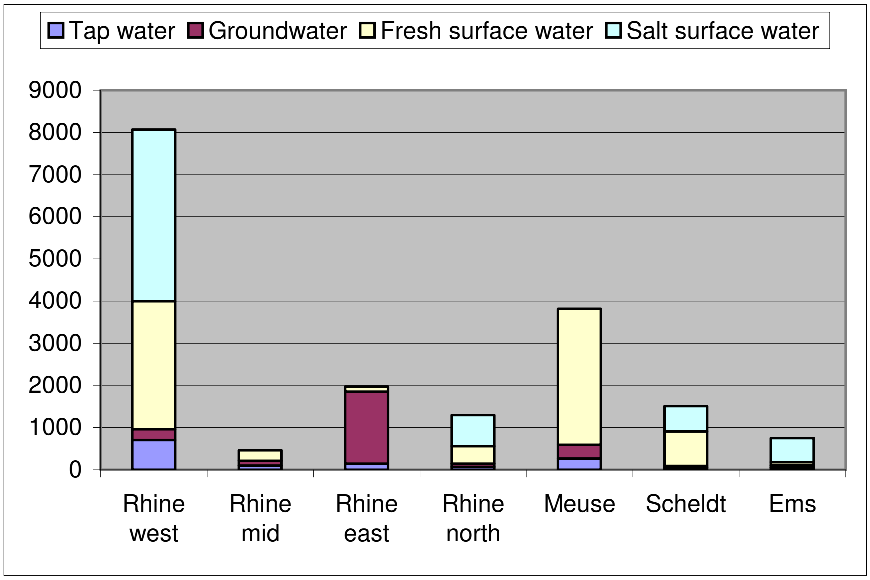

Figure 7: Total water use from different water sources per river basin in 2001 (in million m^3)

Relating total water use to the total number of inhabitants in each river basin, a slightly different picture emerges. Water use per capita in 2001 is highest in the Scheldt basin (3.3 thousand m^3/inhabitant), followed by the Ems basin (1.5 thousand m^3/inhabitant) and Rhine North (1.4 thousand m^3/inhabitant). Water use is lowest in Rhine Mid (0.3 thousand m^3/inhabitant). Average water use in the Netherlands in 2001 was 1.4 thousand m^3 per inhabitant.

When comparing water consumption across sectors in the two largest water consuming river basins in the Netherlands (Rhine West and Meuse), the energy sector appears to be one of the most important water users in these two river basins. In Rhine West (Figure 8), more than half (54%) of all water is used in this sector only and in the Meuse river basin (Figure 9) 80 percent of all water.

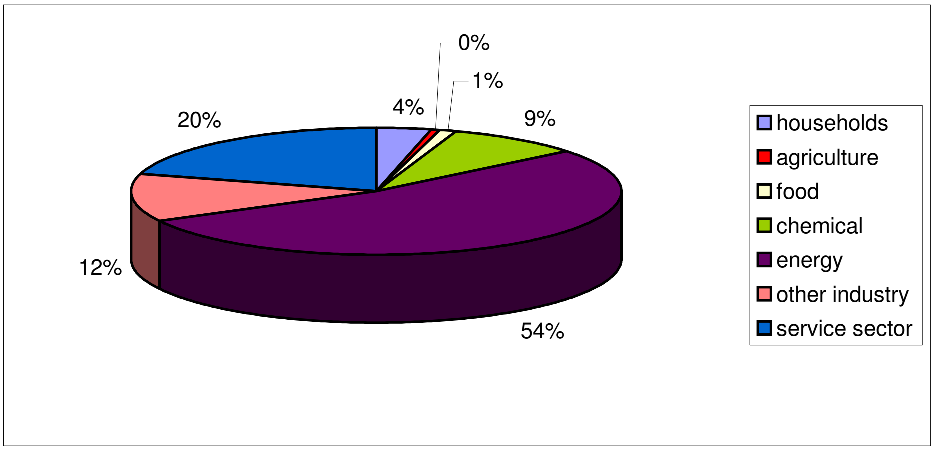

Figure 8: Share of different sectors in total water use in Rhine West in 2001

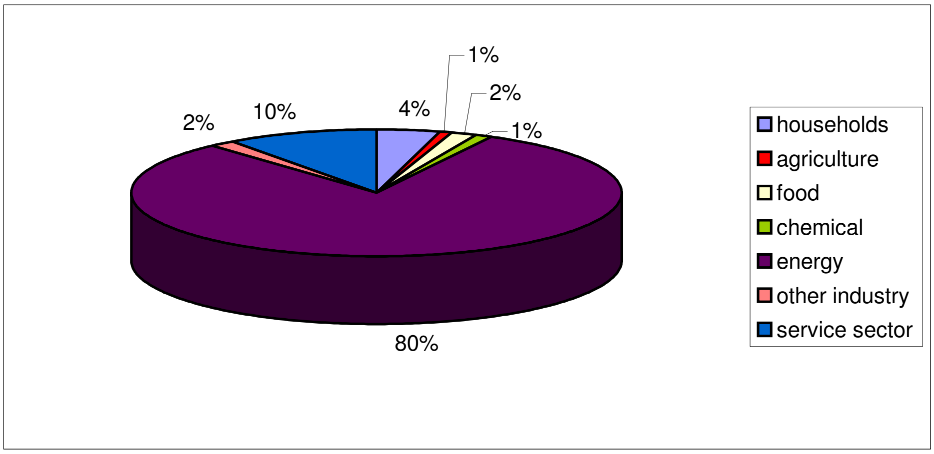

Figure 9: Share of different sectors in total water use in the Meuse river basin in 2001

However, all water extracted in this sector is used for cooling purposes only and discharged immediately into surface water after use. All water used in the energy sector in the Meuse river basin is extracted from fresh surface waters. In the river basin Rhine West, 65 percent of all cooling water used in the energy sector is extracted from the sea.

After the energy sector, the service sector follows as the second largest water user in the two river basins with a share of 20 and 10 percent in Rhine West and the Meuse basin respectively. Approximately 4 percent of all water use is related to household consumption in both river basins. In Rhine West, the chemical industry and other industrial activities appear to have a relatively much higher water consumption than the same sectors in the Meuse river basin.

Water use per sector is only presented here for the two largest water consuming river basins in the Netherlands, because no information about water use in the energy sectors in the other river basins can be published for confidentiality reasons. Presenting information about water use in the other sectors in the other five river basins without the energy sector will result in serious bias.

Wastewater production

Most wastewater is produced in Rhine West, followed by the Meuse and Rhine East. Total wastewater production in 2000 was 27 million inhabitant equivalents (i.e.). This is slightly lower than in 1996 (-0.5%). Rhine Mid and Rhine North are the only two river basins, which show an increase in total wastewater production over the period 1996-2000 (4 and 1.5% respectively). Wastewater production decreased most in the Ems river basin (-9%). Meuse and Scheldt show a decrease of 1 percent over this period (Figure 10).

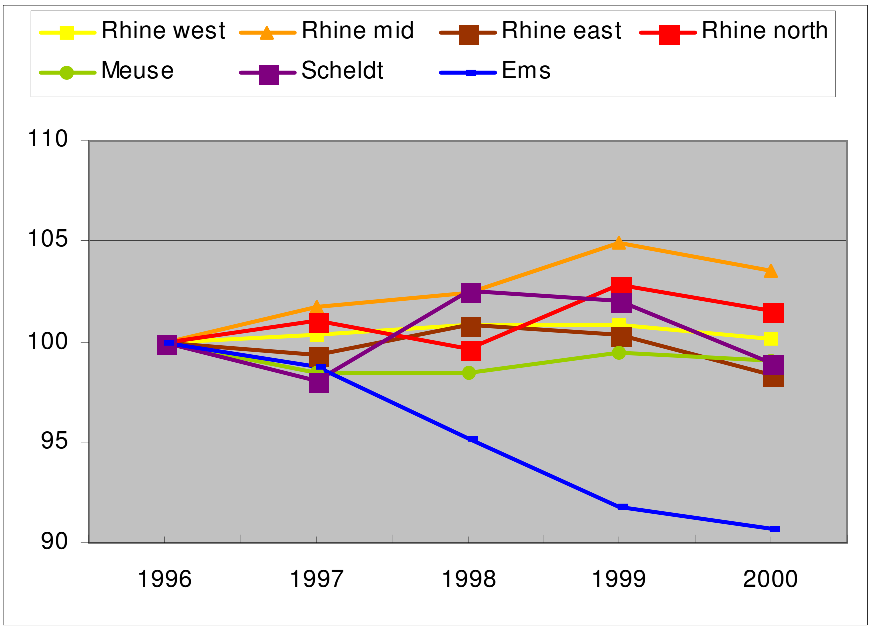

Figure 10: Development of wastewater production over the period 1996-2000 per river basin (1996=100)

When relating wastewater production to the total number of inhabitants in the river basins to get a rough indicator of the relative amount of wastewater produced in a river basin taking into account the number of people living there (on average 60% of all wastewater is produced by households), the highest wastewater production per capita ratio in 2000 is found in the Scheldt (2.4 i.e./inhabitant), followed by Rhine East (2.0 i.e./inhabitant) and Ems (1.9 i.e./inhabitant). Average wastewater production per capita in the Netherlands is 1.8 i.e. Obviously, this indicator has to be interpreted with the necessary care in view of the fact that not only households but also industry is responsible for the amount of wastewater produced in a specific basin.

Most wastewater (on average 85% on a national level) is treated in wastewater treatment plants (WWTP) before it is discharged. In Rhine east all wastewater is treated in WWTP. In the Ems river basin and Rhine Mid about 75 percent of all wastewater is treated before it is discharged. The remainder is either treated in individual biological wastewater treatment systems (by households or industry) or discharged into surface water without any treatment at all.

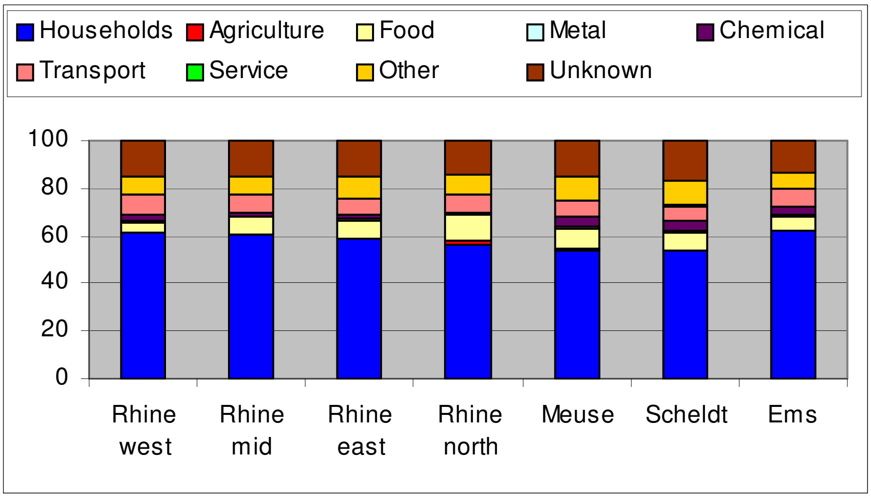

Figure 11: Relative contribution of different sectors to total wastewater production in 2000 (in %)

When looking at wastewater discharge per sector across river basins, no significant differences exist. Most wastewater is produced by households (about 60%) (Figure 11). The food and transport sector contribute each for about 7-8 percent. The contribution from agriculture, the metal industry and the service sector is relatively low (less than 1%). Of about 15 percent of all wastewater, the exact source is unknown.

<u>Emission of pollutants</u>

Although emission data are available for 78 substances (see Table 2), a complete emission balance is only available for the nutrients total P and total N and the metals As, Cd, Cr, Cu, Hg, Ni, Pb and Zn. For the other substances, information about influents is missing or information about import and export by rivers or runoff from agricultural land.

<u>Nutrients</u>

The total emission of nitrogen (N) to water in the Netherlands in 2000 was 285 thousand tonnes, and of phosphorus (P) 28 thousand tonnes. More than half of all N and P (55-60%) are emitted in the largest river basins Rhine West and Meuse (Figure 12 and 13), followed by Scheldt and Rhine East.

When relating nutrient emissions to the area size of the river basins, a slightly different picture emerges. The highest emission-land ratio for both N and P is found in the Scheldt basin (236 kg/ha for N and 19 kg/ha for P in 2000), followed by Rhine West (96 kg/ha for N and 14 kg/ha for P) and Meuse (117 kg/ha for N and 10 kg/ha for P). On average, nutrient emissions per hectare in the Netherlands in 2000 were 93 kg for N and 8 kg for P[11].

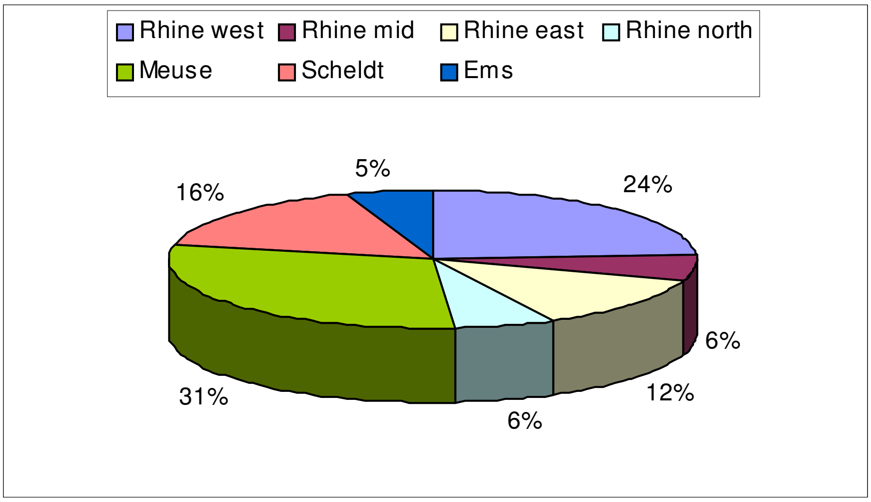

Figure 12: Relative contribution of different river basins to the total emission of nitrogen (N) in 2000

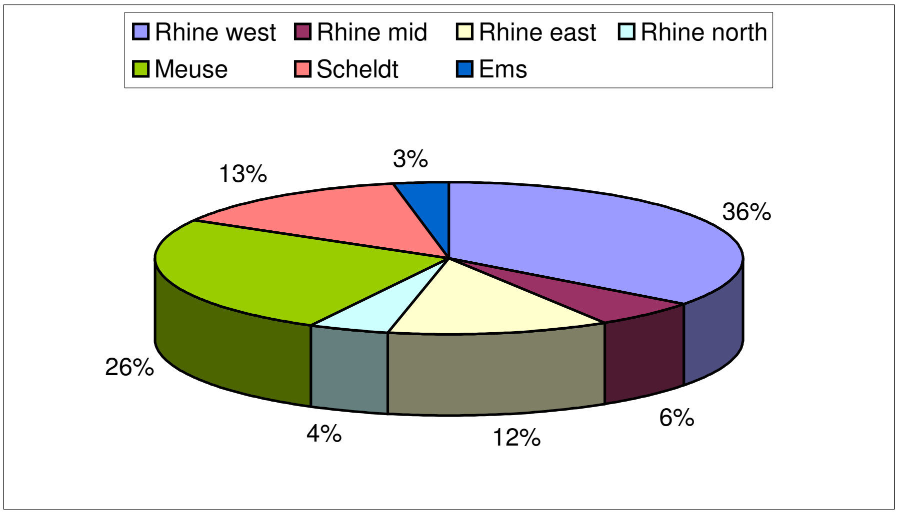

Figure 13: Relative contribution of different river basins to the total emission of phosphorus (P) in 2000

Over the period 1996-2000, the emission of N decreased in the Netherlands by 10 percent and the emission of P by 14 percent. When looking at the decrease in nutrient emissions across river basins, no significant differences can be detected. The percentage reduction was highest in Rhine North and lowest in Rhine Mid.

[11] These numbers apply to the total area of a basin. When related to agricultural land only, average nutrient emissions per hectare are significantly higher.

Most nutrients enter the Dutch water systems through the large international rivers Rhine, Meuse and Scheldt (see Figures 14-17). On average, 43 percent of all P and 57 percent of all N emissions have their origins abroad. In some river basins, the relative contribution of nutrient emissions from abroad can be as high as 80 percent for N and 70 percent for P (both cases refer to the Scheldt river basin). Numbers like these immediately make clear the necessity of an international river basin approach, as advocated in the recently adopted WFD, in tackling current and future water quality management problems.

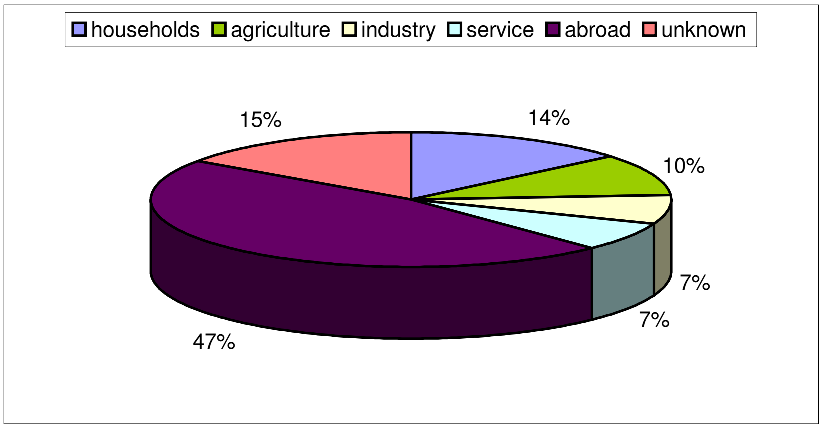

Figure 14: Share of different sources in total P emissions in 2000 in the Rhine basin

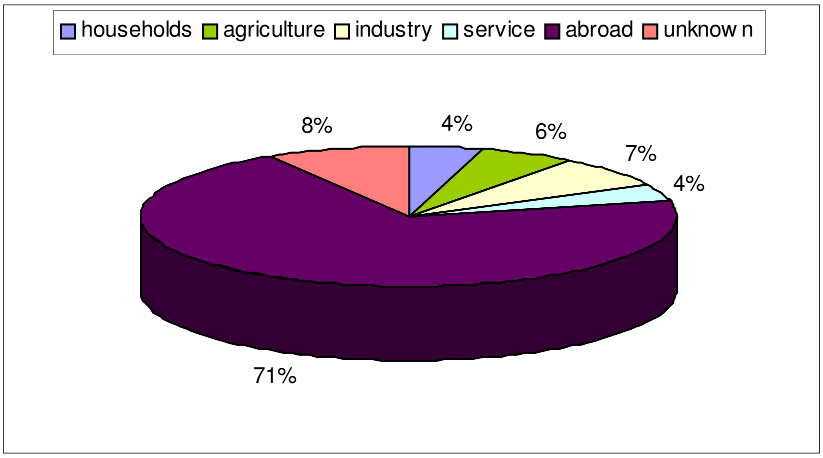

Figure 15: Share of different sources in total P emissions in 2000 in the Scheldt basin

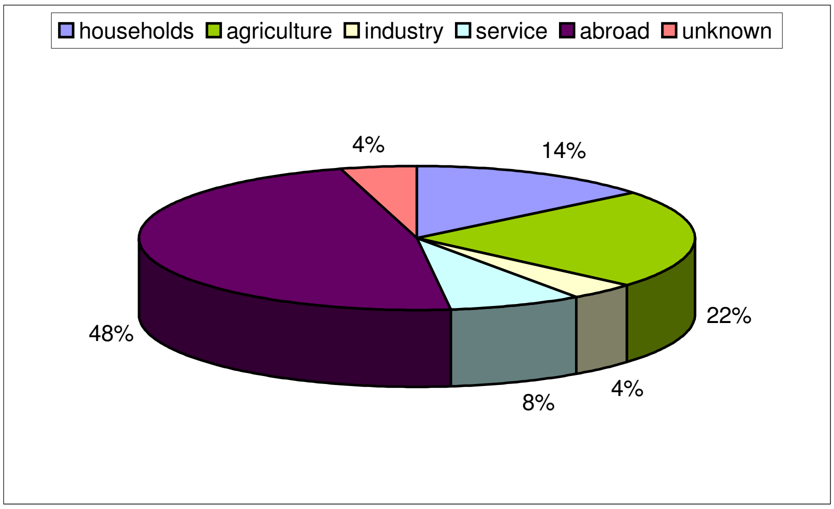

Figure 16: Share of different sources in total N emissions in 2000 in the Meuse basin

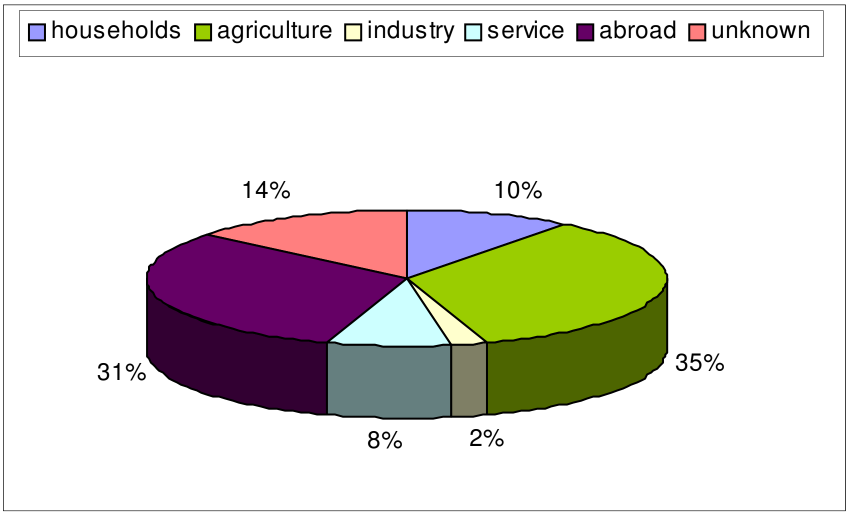

Figure 17: Share of different sources in total N emissions in 2000 in the Ems basin

Looking only at domestic emissions, agriculture is the largest source of N emissions (approximately 20 percent on average across all river basins), followed by private households (approximately 10 percent across all river basins). In the case of P, a relatively large share of the total amount of P emitted cannot be attributed to one specific emission source (on average 17 percent), but is the result of diffuse pollution. For N, the share of diffuse pollution is about 7 percent. In the case of P, about 15 percent originates from households and 12 percent from agriculture.

The emission quantities above do not necessarily correspond with the quantities, which eventually enter into the water system. Excluding emissions from abroad and unknown diffuse pollution, on average across all river basins about 85 percent of all P and 50 percent of all N emissions from households, industry and the service sector were treated in 2000 by wastewater treatment plants and did therefore not enter the water system. The Meuse has the highest P absorption rate (91%), followed by the Ems (89%) and Scheldt (74%). The absorption rate is defined here as the percentage of all emissions (including untreated discharges in surface water) treated in WWTP (influents), not to be confused with the WWTP treatment efficiency. No information about nutrient absorption rates in the Rhine and its different sub-basins is available. In the case of N, the Scheldt has the highest absorption rate (60%) and the Ems the lowest (37%), suggesting that a relatively high percentage of N in the Ems basin originates from diffuse sources.

Metals

Of all metals, Zinc (Zn) is emitted in the largest quantities in the Netherlands (Figure 18). Total Zinc emission was about 1.5 thousand tonnes in 2000. Copper (Cu), Lead (Pb) and Nickel (Ni) are also emitted in relatively large quantities (350, 265 and 130 thousand tonnes respectively in 2000). Chromium (Cr), Arsenic (As), Cadmium (Cd) and Mercury (Hg) are emitted in relatively smaller quantities (which does of course not mean to say that they are therefore less harmful to the water environment!). Total Cr emission in 2000 was 62 thousand tonnes, Arsenic 24 thousand tonnes, Cadmium 7 thousand tonnes and Mercury 1.2 thousand tonnes.

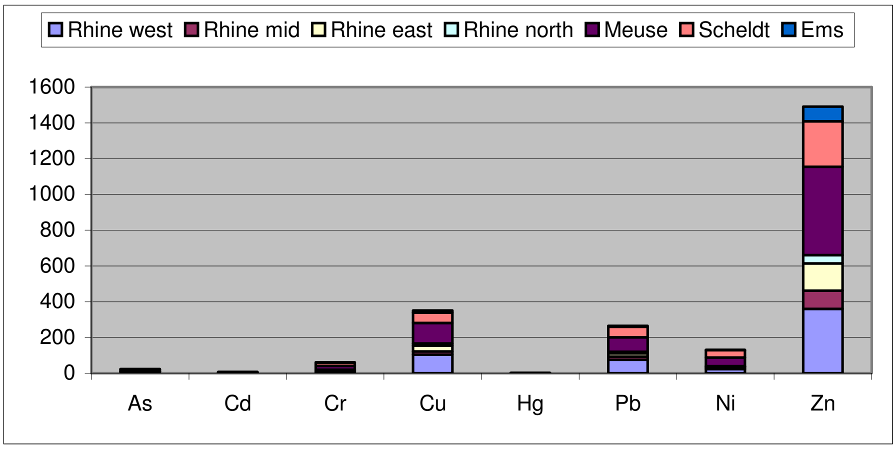

Figure 18: Emission of different metals in the various river basins in 2000 (in thousands of tonnes)

Most metals enter the water system in the Meuse river basin (Figure 19)[12]. On average, about 35 percent of all the metals entering the water system do so within the boundaries of the Meuse. Scheldt and Rhine West follow, each with a share of about 25 percent. Hence, on average, approximately 85 percent of all metals are emitted in the river basins Meuse, Scheldt and Rhine West. The contribution of the other river basins is relatively low, usually not exceeding more than 5 percent of the total emission of a specific metal.

[12] Remember that the Rhine is split up in four sub-basins. When represented as a whole, metal emissions would be highest for the Rhine except for Cadmium, Chromium and Nickel.

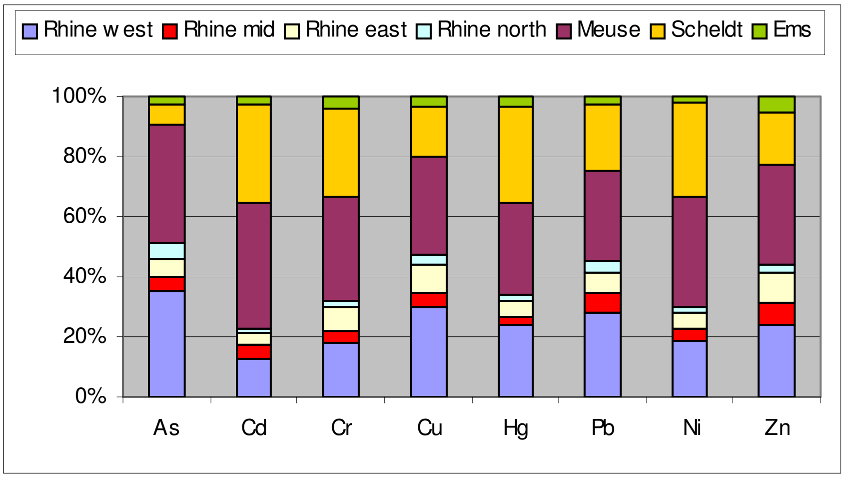

Figure 19: Share of different river basins in the total emission of specific metals in the Netherlands in 2000

As for nutrients, most metal emissions have their origins abroad (Figure 20)[13]. On average across all river basins in the Netherlands, 65 percent of total metal emissions come from abroad. The share of emissions from abroad in the total flow of emissions is largest in the Scheldt river basin (86% in 2000) and lowest in the Ems basin (32% in 2000). As for nutrients, these numbers underline the need for an international approach to water quality problems at international river basin scale as they show that waters know no administrative boundaries.

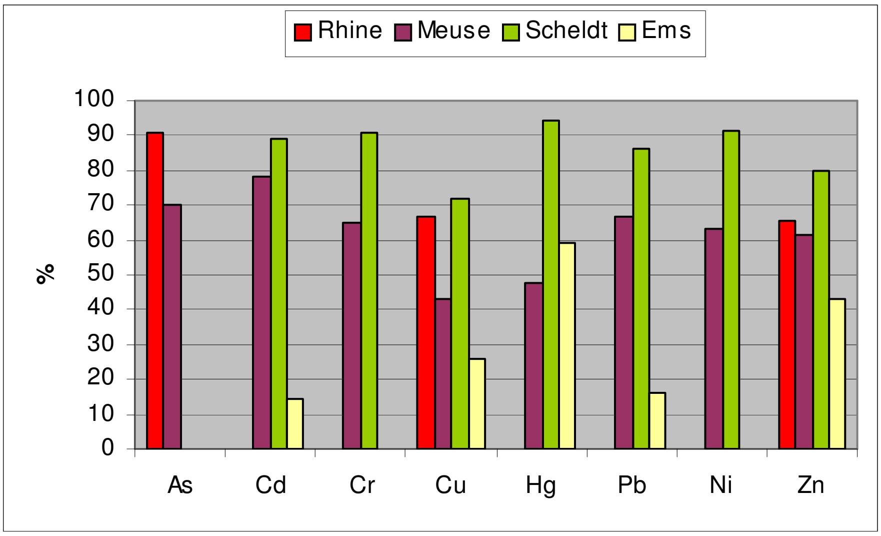

Figure 20: Percentage of total metal emissions from abroad in different river basins in 2000

Households and the service sector (including waste water treatment plants) are generally the most important domestic emission sources, followed by industry. However, different sources may be more or less important in different river basins depending on the specific metal. Examples are given in Figures 21-23 for three different metals in three different river basins.

[13] No import information is available for the four Rhine sub-basins separately, only for the whole Rhine river basin (i.e. metals entering the Netherlands via the Rhine at Lobith).

In the case of Copper, households appear to be the largest domestic emission source in the Meuse river basin. Industry is the largest domestic source of emission in the Ems river basin when looking at Zinc, while in the Scheldt the service sector (including wastewater treatment plants) is responsible for most Arsenic emissions.

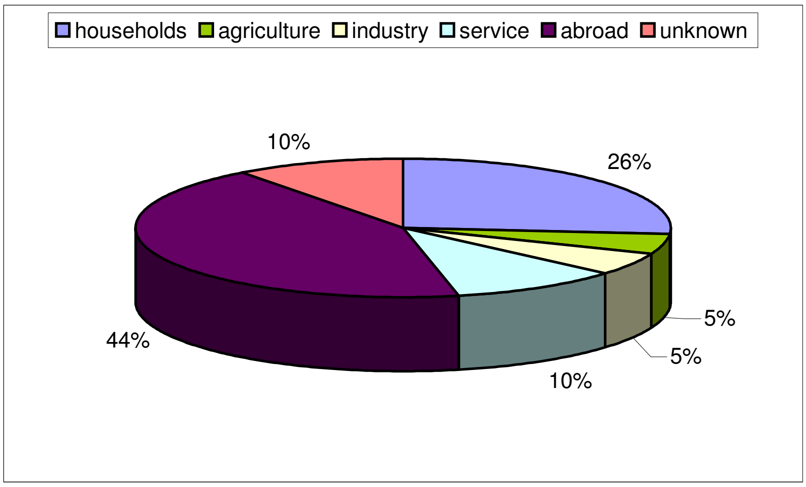

Figure 21: Share of different sources in total Copper (Cu) emissions in 2000 in the Meuse river basin

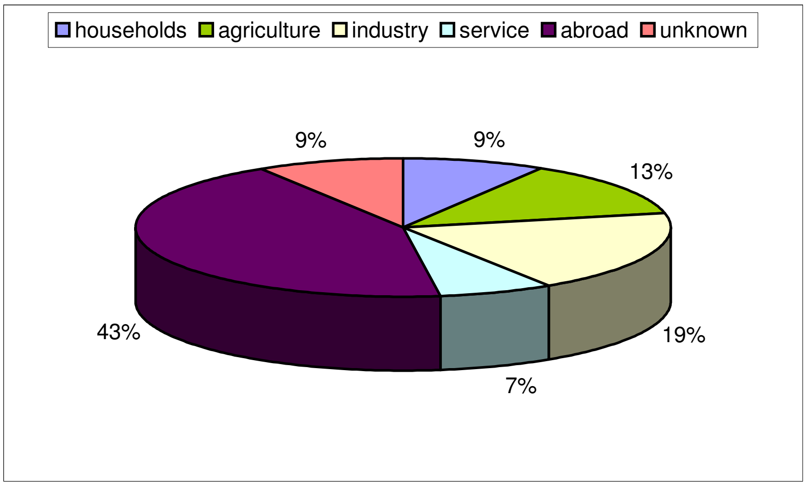

Figure 22: Share of different sources in total Zinc (Zn) emissions in 2000 in the Ems river basin

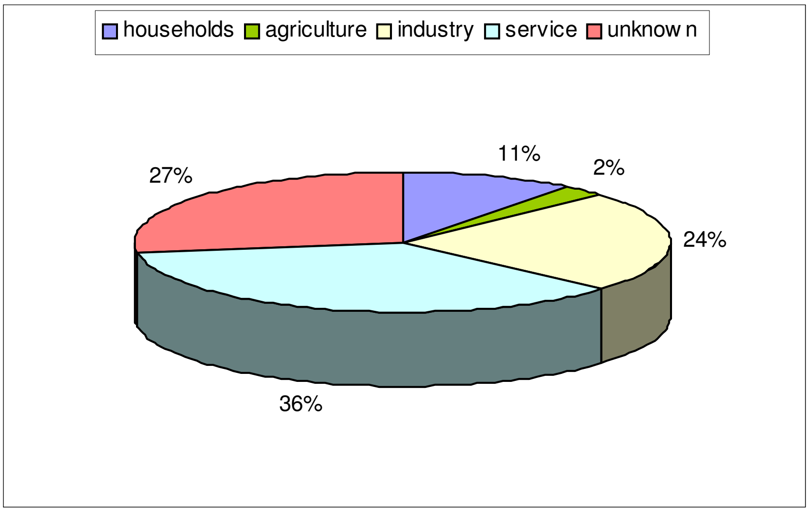

Figure 23: Share of different sources in total Arsenic (As) emissions in 2000 in the Scheldt river basin (excluding emissions from abroad)

Not all emissions enter into the water system. On average, about 40 percent of all domestic emissions, i.e. excluding emissions from abroad (which are essentially outside the control of water managers), are treated by wastewater treatment plants and do not enter the water system (Figure 24).

Average absorption rates across all river basins are highest for copper (Cu) and mercury (Hg) (51 and 52% respectively) and lowest for cadmium and lead (21 and 26% respectively). There exist large differences between river basins though. In the case of cadmium (Cd), for example, the domestic absorption rate was as low as 12 percent in the Scheldt and 50 percent in the Meuse river basin. Or, for chromium (Cr), the metal absorption rate in 2000 was only 20 percent in the Ems and 70 percent in the Meuse basin.

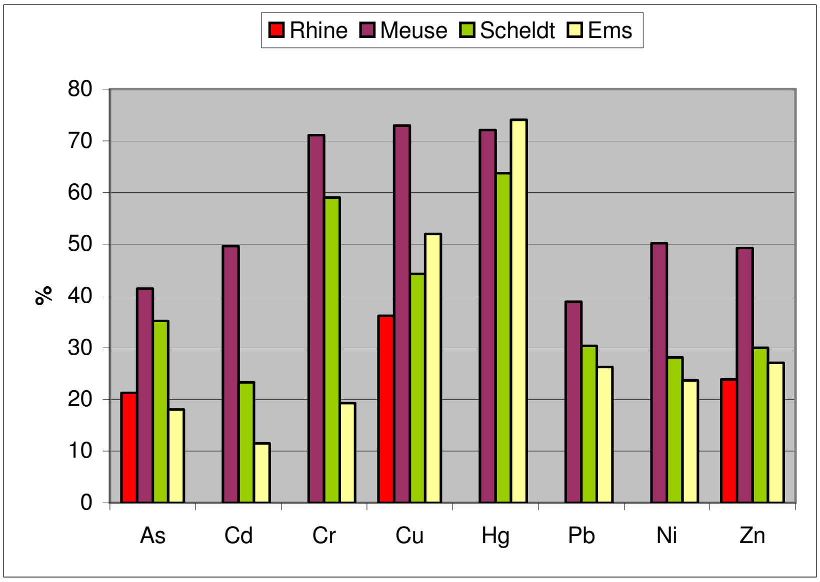

Figure 24: Absorption rates of different metals across river basins in 2000 (excluding emissions from abroad)

4.3 Prediction of trends in future water use

Based on time series analysis, possible trends can be identified. In NAMWA, trends in economic driving forces can be linked to pressures such as water consumption, wastewater production and the emission of polluting substances (nutrients, metals etc.). An example is given in Figure 25. At a national level, real economic growth (in terms of GDP in constant prices) over the period 1996-2001 was 18 percent (on average 3 percent per year). Total wastewater production remained more or less the same over that same period, whereas the emission of nutrients decreased significantly by approximately 15 percent and the emission of metals by about 10 percent. Figure 25 hence seems to suggest that economic activities use the water environment in a more efficient way[14].

Although diagrams like these have to be interpreted with the necessary care (they provide, for instance, no hard evidence of a direct link between production and water use such as wastewater production or emission of pollutants), these types of indicators are helpful in assessing the success (or failure) of environmental (sector) policy, as they provide important insight in the environmental efficiency of economic activities, i.e. the relationship between production output and the use of the environment or environmental inputs. They may also provide a basis for trend analysis. Based upon the observed development of economic activities within sectors and corresponding water use over the past 5 or 10 years, one can extrapolate this development into the future[15]. An important condition obviously is that one has to be able to identify a trend first. Based on the average growth rates in Figure 25 and assuming that the observed trend of a more efficient water use will continue into the future, economic driving forces (production volumes) and corresponding water pressures can be calculated (Figure 26). Needless to say that these numbers have to be used very carefully in any analysis and should, if possible, be supplemented with more ‘qualitative data’ regarding expected regional, national or international (sector) policies and/or technological change.

[14] In Figure 25 (and later also Figures 26-28), nutrients and metals refer to the environmental themes eutrophication and dispersion of metals. See the annex to this paper for more information about how these indicators are calculated.

[15] It has to be pointed out that a longer time period than the past 5 years is preferred when trying to detect trends in economic driving forces and associated pressures. This will be the case in the next few years when NAMWA will be extended to also include more recent years (2001-2003) and possibly a few more years in the past as well (1990-1995).

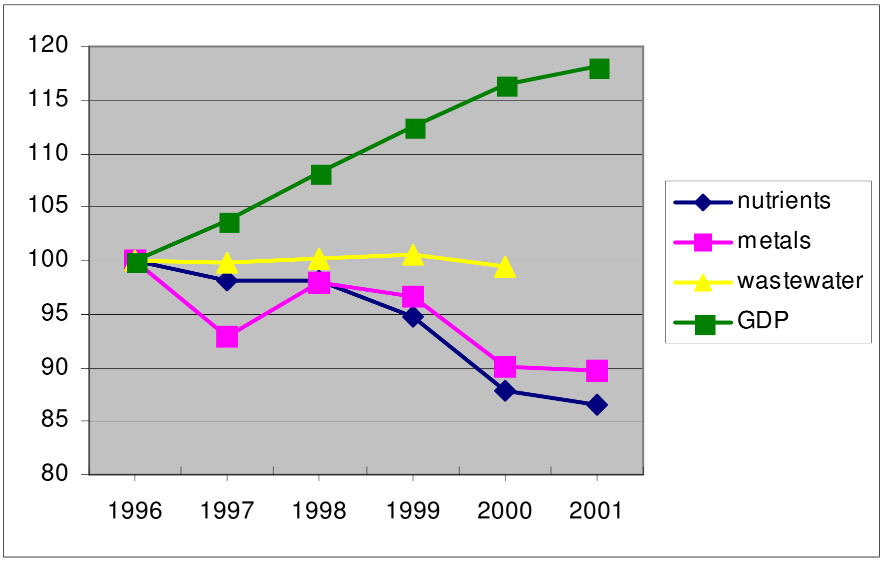

Figure 25: Economic growth, wastewater production, emission of nutrients and metals (excluding import) in the Netherlands over the period 1996-2001 (1996=100)

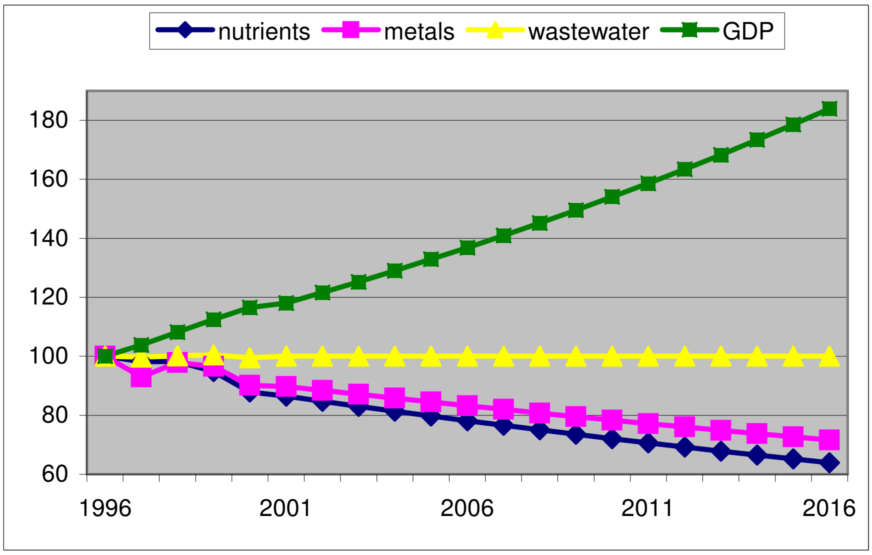

Figure 26: Predicted trend in economic growth, wastewater production, emission of nutrients and metals in the Netherlands after 2001 (1996=100)

NAMWA allows detailed trend analysis of specific substances per sector at river basin level. The trends identified at national level, are, for instance, also found in Rhine West (Figure 27), but in the Meuse river basin metals show a more fluctuating development, with an actual increase over the period 1998-2000 (Figure 28)[16].

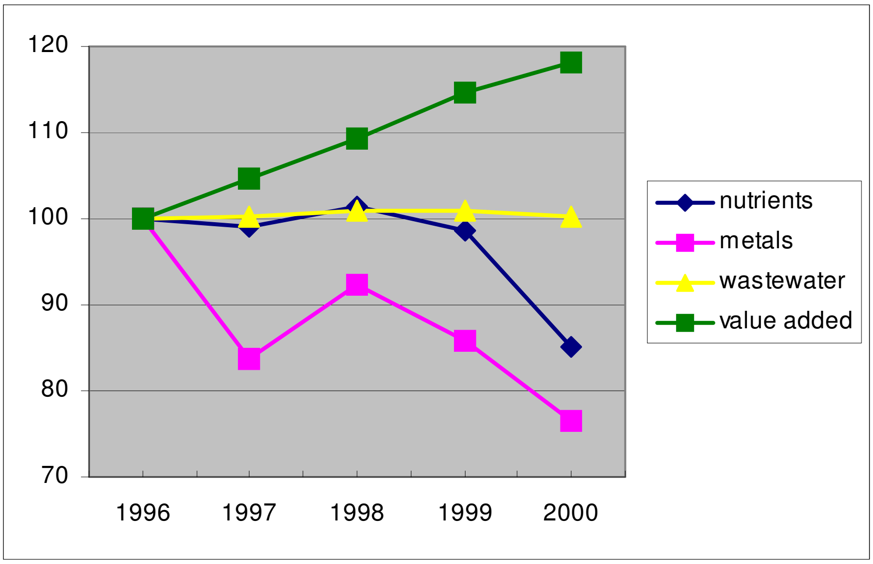

Figure 27: Economic growth, wastewater production, emission of nutrients and metals (excluding import) in Rhine West over the period 1996-2000 (1996=100)

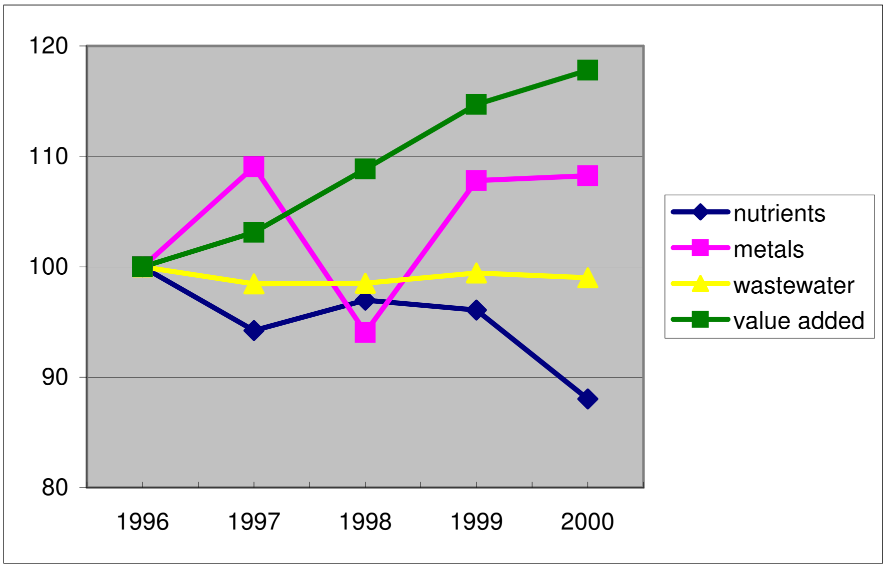

Figure 28: Economic growth, wastewater production, emission of nutrients and metals (excluding import) in the Meuse river basin over the period 1996-2000 (1996=100)

Inspecting, in more detail, the emission of the various metals in the Meuse river basin, which make up the aggregated indicator 'metals' in Figure 28, arsenic (As) and cadmium (Cd) emissions appear to show a high increase over this time period (Figure 29). Arsenic emissions within the river basin (i.e.

[16] At river basin level we only show here the development of the indicators over the period 1996-2000 as two of the four indicators (value added and wastewater) are not yet available for the year 2001.

excluding import from abroad) increase by more than a factor 2, while the increase in cadmium emissions is almost 75 percent. Especially arsenic has a relatively high weight in the calculation of the dispersion of metals (see the Annex). The fluctuation in other metals between 1996 and 2001 varies between –5% for mercury (Hg) and +23% for lead (Pb).

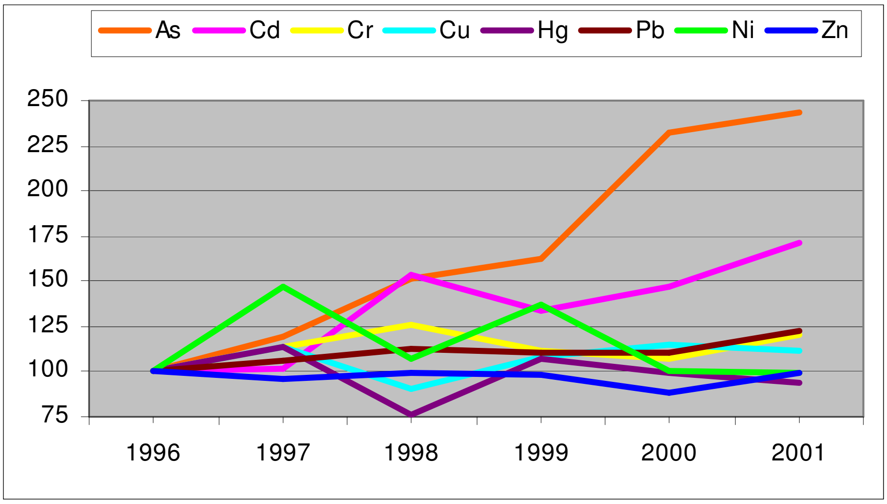

Figure 29: Changes in the emission of various metals within the Meuse river basin (excluding import) over the period 1996-2001 (1996=100)

The increase in arsenic emissions can be attributed to a large extent to the chemical industry in the river basin and WWTP (Figure 30). The emission of arsenic by the chemical industry doubled in the period 1996-2001. However, the relative contribution of the chemical industry to the total emission of arsenic within the river basin remains low (3%).

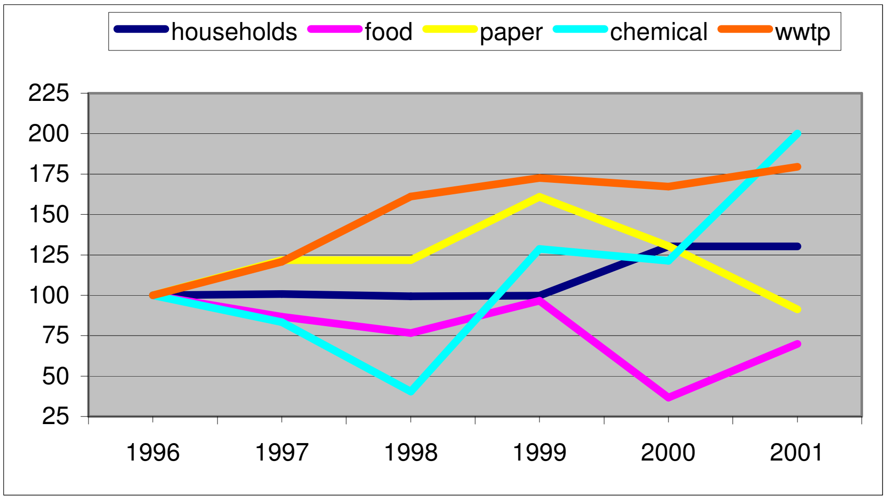

Figure 30: Changes in the emission of Arsenic (As) by various sources within the Meuse river basin over the period 1996-2001 (1996=100)

On the other hand, the 80 percent increase from WWTP has a much more severe impact in view of the fact that this sector is responsible for almost a quarter of all domestic arsenic emissions in the Meuse river basin.

The emissions from households increased by 30 percent over the period 1996-2001. Hence, a substantial part of the increase of arsenic emissions from WWTP is apparently caused by an increase of industrial emissions treated by WWTP. Households are also an important emission source for arsenic in the Meuse basin. Approximately one third of all arsenic comes from this source. The relative contribution of households to the total emission of arsenic has decreased considerably though over the period 1996-2001, from almost 60 percent in 1996 to 30 percent in 2001. Another important driving force behind the overall increase in arsenic emissions is probably an increase in commercial shipping in the river basin. However, data for this sector are only available for the years 2000 and 2001. In 2001 the share of shipping in total emissions was nevertheless almost 25 percent.

The decrease in the dispersion of metals in Rhine West – conform the national trend - is caused largely by considerable reductions in the emissions of cadmium (Cd) and mercury (Hg). The domestic emission of all metals decreases, but the reduction in cadmium and mercury emissions is most remarkable (Figure 31). In 2001 the total emission of cadmium and mercury in Rhine West (excluding emissions from abroad) is more than half of total emissions in 1996.

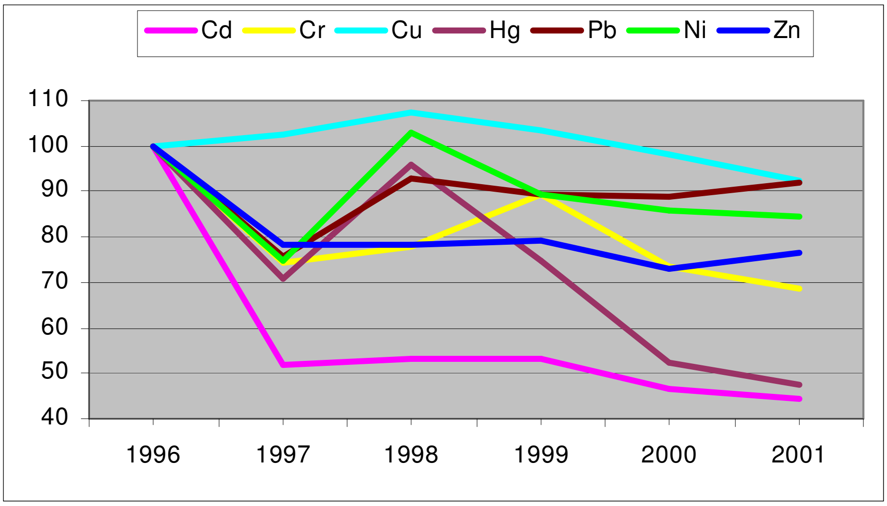

Figure 31: Changes in the emission of various metals within Rhine West (excluding import) over the period 1996-2001 (1996=100)

In the case of cadmium, the reduction can be largely attributed to the decrease in emissions from the chemical industry by almost 90 percent and the decrease in emissions from WWTP in the river basin by about 40 percent over the period 1996-2001 (Figure 32). The relative contribution of the chemical industry to the total emission of cadmium is low though and has not changed between 1996 and 2001 (3% of all emissions originate from the chemical industry). The same applies to the metal industry in the river basin. Emissions in this sector were reduced by approximately 35 percent, but the relative contribution of this industry too is only 3 percent. More substantial is the contribution of WWTP. Between 1996 and 2001 the relative share of WWTP increased by almost 40 percent. The most important sources of pollution are households and agriculture. Although total emissions from these sources stayed relatively stable, their relative share in total emissions doubled over the period 1996-2001.

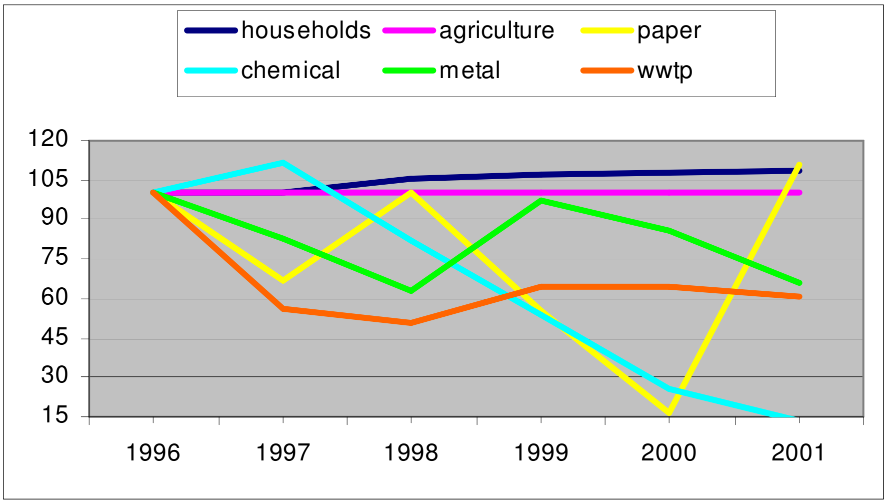

Figure 32: Changes in the emission of Cadmium (Cd) by various sources within Rhine West over the period 1996-2001 (1996=100)

4.4 Current levels of cost recovery

In view of the fact that NAMWA provides information about the production value (at basic prices) of activities, goods and services and contains information about the revenues from water related taxes, it is in principle possible to calculate cost recovery rates for specific water services based on NAMWA. Cost recovery is defined here as the ratio between the revenues paid for a specific service and the costs of providing the service.

A first step in calculating cost recovery rates is to identify the specific water service involved. The following services are generally distinguished in the context of the WFD[17]:

- drinking water supply;
- wastewater collection;
- wastewater treatment.

4.4.1. Drinking water supply

Drinking water is supplied by 22 water companies in the Netherlands to households, agriculture and industry, who pay a market price for the supplied drinking water. Drinking water is therefore considered an ordinary good in NAMWA, the production costs of which are found in cell (3c,1) and the revenues in row 1a. Cost recovery of drinking water supply is always 100 percent (Figure 33).[18]

[17] The formal definition of water services in the WFD is: 'all services which provide, for households, public institutions or any economic activity:
abstraction, impoundment, storage, treatment and distribution of surface or groundwater
wastewater collection and treatment facilities which subsequently discharge into surface water.'

[18] In the Netherlands, all water management costs are recovered, in principle, by charging the users of the services provided. Water pricing policy is, wherever possible, based on the beneficiary and polluter pays principle.

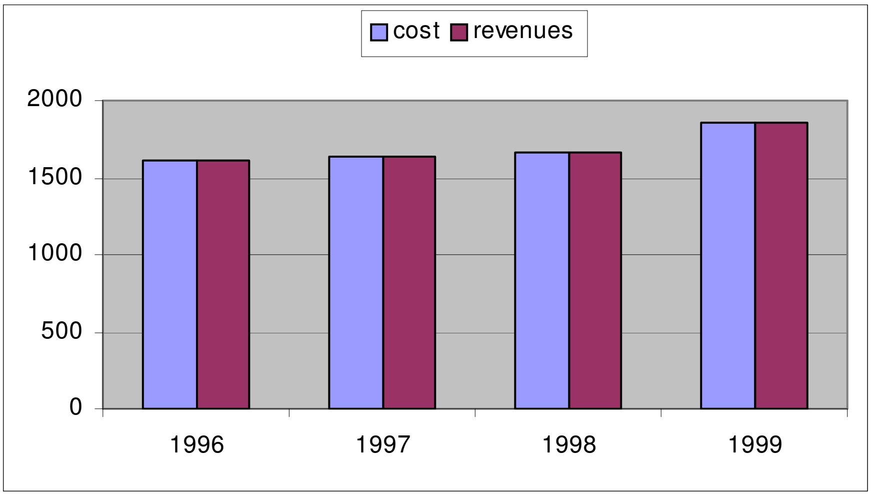

Figure 33: Total costs and revenues of the water service drinking water supply (in million euros)

The costs of drinking water supply consist of the following components: production costs, levy paid for groundwater extraction and other taxes minus subsidies (Table 3). When subtracting the other taxes minus subsidies from the total costs, the cost recovery rate for drinking water supply is higher than 100 percent. The groundwater levy can be seen as the price paid for the environmental and resource costs associated with drinking water supply[19].

Drinking water supply	**1996**	**1997**	**1998**	**1999**
Production costs	1405	1420	1445	1526
Levy on groundwater extraction	147	150	152	154
Other taxes minus subsidies	64	66	67	178
Total	1616	1636	1664	1858

Table 3: Production costs, groundwater levy and other taxes and subsidies related to the provision of the water service drinking water supply

The actual consumption of drinking (tap) water per sector per river basin is also measured in NAMWA in cubic metres. Although it is possible, in principle to allocate all drinking water companies to a specific river basin, for example based upon their location, allocating their supply to one or more river basins proofs to be more difficult. In most cases, drinking water companies supply drinking water to different river basins in the same year. Hence, in order to be able to allocate drinking water supply to these different river basins, individual drinking water companies have to be asked for the addresses of their customers, something which most drinking water companies are not willing to do for privacy and confidentiality reasons. Therefore, only national numbers are currently available.

[19] According to Paragraph 1 in Article 9 in the WFD, member states shall take account of the principle of recovery of the costs of water services, including environmental and resource costs, and in accordance in particular with the polluter pays principle.

4.4.2. Wastewater collection

Wastewater collection is the responsibility of the more than 500 municipalities in the Netherlands. Households and companies connected to the sewer system pay municipalities a sewerage levy for this service. The revenues from this levy (and who pays for them) are included in row 8a3 (see section 2). However, the production costs are included in cell (3,1) in the branch 'municipalities' and cannot be isolated from the municipalities' total water related production costs[20]. The calculation of the cost recovery rate for the water service wastewater collection can therefore only partly be based on NAMWA. Information about the total annual costs associated with the sewerage system has to be collected separately[21].

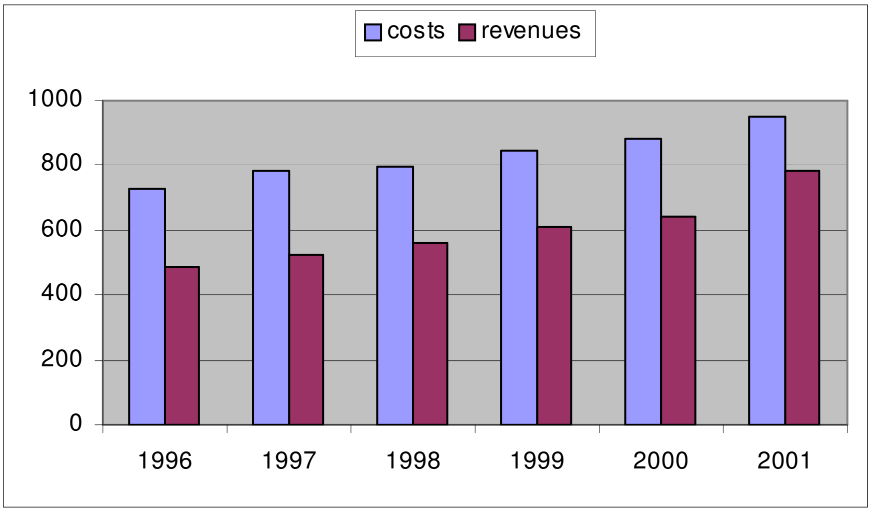

Figure 34: Total costs and revenues of the water service wastewater collection (in million euros)

As for drinking water supply, the cost recovery rate for wastewater collection can *in principle* be calculated both on national and river basin level. As we saw for the economic data from the regional accounts (section 2), municipalities can be allocated to river basins. However, it is currently impossible to track down information about the costs of installing and maintaining the sewerage system from individual municipalities. Therefore only national numbers are currently available (Figure 34).[22] Over the period 1996-2001, the cost recovery rate for wastewater collection has increased from 67 to 83 percent.

[20] The installation, operation and maintenance of the sewerage system are not registered as a separate 'function' (task) in municipalities' accounting system. A recent study concludes that although the municipalities' accounting system is structured according to specific 'functions' (tasks), different municipalities register their costs and expenditures associated with the installation and maintenance of the sewerage system under different 'functions', making it virtually impossible to trace back for all municipalities separately where the total costs of the sewerage system are hidden.

[21] This information is obtained from the 'Stichting RIONED', which collects and publishes data about the national sewerage system, including investment and operation and maintenance costs every year.

[22] Another problem is that contrary to river basins or economic COROP units, municipalities change almost every year, that is, they grow in size or merge with other municipalities. This has consequences for the allocation of economic data to river basins, which has to be done on the basis of a new distribution key every year.

4.4.3. Wastewater treatment

Wastewater treatment is mainly the responsibility of the regional water boards. Households, industry and agriculture pay a water pollution levy to water boards, for this water service, which covers the operation and maintenance costs of the wastewater treatment facilities. The costs of wastewater treatment are included in cell (3f,1c) in the branch government, but contrary to wastewater collection, these costs can be identified separately based on the underlying original data collected from water boards. The revenues from the water pollution levy are given in row 8a1 (see section 2). Besides economic data, also information is available about the production of wastewater by different economic activities.

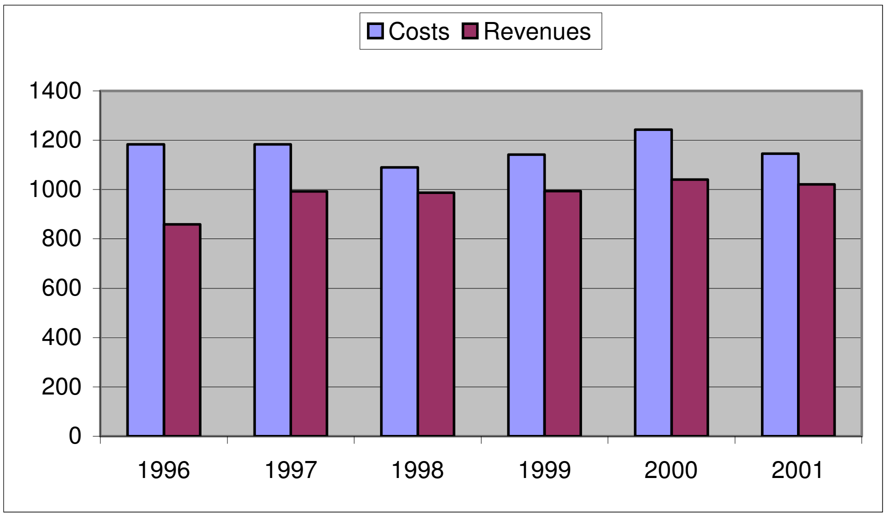

Figure 35: Total costs and revenues of the water service wastewater treatment (in million euros)

On a national level, the cost recovery rate for wastewater treatment varied over the period 1996-2001 between 73 and 91 percent (Figure 35). Based on the location of water boards (and their corresponding service area), the cost recovery of wastewater treatment can be calculated at both national and river basin level. In row 8a1, also the sectors who pay for the water pollution levy are known, making it possible to also assess the relative contribution of each sector to the recovery of the costs of the water service. This was done on the basis of preliminary figures for the year 2002 (Table 4).

River basin	**Cost recovery rate**
Rhine	98
Meuse	95
Scheldt	92
Ems	100
Sector	**Relative contribution**
Households	69
Agriculture	1
Industry	30

Table 4: Cost recovery rate for wastewater treatment per river basin in 2002 and the relative contribution of different sectors

5 Discussion and conclusions

In this paper, we presented the structure and practical usefulness of a new developed river basin information system called NAMWA (National Accounting Matrix including Water Accounts) and NAMWARB (NAMWA at River Basin). The development of NAMWARB is to a large extent driven by the demand for economic information about river basins in the recently adopted European Water Framework Directive (WFD). The success of the new developed information system is shown by the fact that the official river basin characterisations in the Netherlands for the WFD in 2004 (sent to the European Commission) are based on NAMWARB. So, the new information is actually used by water policy-makers and water managers.

Linking available environmental water data to economic data and the disaggregation of both types of data to the geographical river basin level were probably the two most important challenges faced during the development of NAMWARB. In-depth research was needed to assess the compatibility of different types of data collected and published at different levels of detail and in some cases also at different levels of confidence. Some of the main problems encountered include the use of different statistics:

- from different sources;
- with different classifications;
- with different monitoring scales;
- with different sampling and aggregation procedures;
- with different confidentiality procedures;
- from observations, calculations and model simulations.

Table 5 illustrates the different scales identified during the development of NAMWARB at which economic and environmental water data were available. One of the major challenges was to find out how data at these different levels could be made comparable.

Economic accounting levels	Water accounting levels
National	National
12 Provinces	4 main river basins
40 COROP	8 Regional Directorates[1]
129 Economic Geographical Units	17 sub-river basins
> 500 Municipalities	50 water boards
> 5000 Post codes	80 PAWN districts[2]
	>1000 water discharge units

[1] Regional Directorates are responsible for the management of the state-owned water system in their specific region. For example, the river basin of the Rhine is controlled by 2 such Regional Offices and the river basin of the Meuse by 3 Regional Offices.
[2] Districts which were developed in the nineteen eighties for Policy Analysis of Water Management (PAWN).

Table 5: Different economic and water accounting levels identified during the development of NAMWARB

An important disadvantage of NAMWARB compared to NAMWA is that the former cannot be presented in a matrix like NAMWA, because of the fact that although total demand and supply of goods and services are known (by economic activities), their interrelationships are not. It is hence not possible at the level of river basins to see which part of the production of sector x goes to sector y or z. Therefore, NAMWARB is presented in tables and not in a matrix like NAMWA. It would require a lot of additional research to also translate NAMWARB into a matrix form. Statistics Netherlands has regional economic accounting matrices, but only at the level of provinces. These regional matrices would have to be translated to the level of river basins.

Even though the source and destination of the flow of goods and services (and associated water and substance flows) can be traced with the help of the NAMWA matrix, the data from NAMWA still has to be interpreted with the necessary care in view of the fact that possible important indirect relationships are not included in the matrix. For example, the energy sector is responsible for most thermal emissions (cooling water) and only has a limited contribution to GDP (in terms of value added) or employment. Reduction of thermal emissions by tackling the energy sector may therefore seem a cost-effective measure. However, this will obviously have severe impacts on other sectors and branches of industry, which rely for their energy supply on the energy sector.

Hence, it is important to clarify to water policy and decision-makers how to use NAMWA and NAMWARB and how to interpret the information supplied by these information systems. Relating NAMWA to the Driving forces-Pressure-State-Impact-Response (DPSIR) framework, NAMWA and NAMWARB describe the *driving forces* on the water system, such as specific economic activities and sectors. These driving forces exert different types of *pressures* on the water system, such as water extraction and emissions to ground and surface water. NAMWA also contains a water balance, showing the quantitative input and output flows of ground and surface water, but only in a limited way based on a Water Survey, which is carried out only once every five years.

In some cases, pressures, such as the emission of phosphorus or nitrogen, organic pollution and heavy metals, are linked to *state* variables, based on their contribution to environmental themes such as eutrophication, wastewater, and the distribution of heavy metals in the environment. The *impact* of water policy and management *responses* on the water system and their effectiveness can be derived from NAMWA and NAMWARB *in principle* through *time series analysis* of water use and emissions to the water system. In short, NAMWA and NAMWARB describe the pressures exerted on the water system, not the state of the water system or the impact of emissions on this state. Based on time series analysis, one can get an idea about the impact of policy and management responses on these pressures though, but this kind of analysis usually requires also a more in-depth assessment of the various influencing factors that may have played a role in the observed trend.

Based on time series, trends can be identified, which may provide an important input in the scenario's that have to be developed for the WFD, for example in order to select a cost-effective programme of measures in the WFD. The description of the economic situation in river basins helps to determine the economic interests involved in water use and emissions, which in turn plays an important role in the determination of issues in the WFD like disproportionality and derogation. Although NAMWARB provides information about the use of different water services and the associated financial transfers and transactions, the calculation of cost recovery rates for water services for the WFD, requires additional information. Moreover, calculating these rates at river basin level also still proofs to be difficult, mainly because of lack of sufficient information.

In conclusion, by linking water and substance flows to economic flows and doing this systematically for a number of years, insight is gained into the (nature of the) relationship between our physical water systems and the economy. The integration of physical and economic information also allows the construction of integrated indicators. For instance, water use by various economic sectors can be related to the economic interests involved. It is this integration of water and economy at river basin level, which makes NAMWARB an important information tool to support policy and decision-making in the field of integrated water management as advocated by the WFD. By linking information about the physical pressures exerted on the water system by economic agents and the associated economic interests, NAMWARB enables policy makers and water managers at national and river basin scale in a consistent way to assess the necessary measures to reduce these pressures and meet the environmental objectives in the WFD in an integrated way. NAMWARB offers opportunities to analyse the trade-offs between environmental goals and the economic interests involved at the relevant level of analysis, i.e. river basins.

Annex

1. Calculation of environmental themes

The contribution of polluting substances to the environmental themes is calculated using weighted averages. These weights reflect the potential pressures imposed on the environment by the respective substances. Table A1 presents which substance contributes to which environmental theme. This Contribution to the Environmental Theme (CET) is calculated according to Equation A1:

$$CET = \left(\frac{E}{MAC}\right) * D * \rho$$

In this equation, *E* represents the Emission of a certain substance, as presented in column 14, *D* is a decay factor, and *MAC* the Maximum Allowable Concentration, based on the maximal allowable risk. Since this formula is primarily used for dispersion of heavy metals (in which formula *CET* is replaced by *Deq*), the correction factor ρ is included tot take into account that various substances are registered in different unities. The values of the various parameters are presented in the last two columns of Table A1.

Table A1: Contribution to the environmental themes

			Emissions	Contribution to environmental theme				
				Eutrophication	Wastewater (p.e.)	Dispersion of heavy metals	CET	D
			14	14a	14b	14c		
Phosphorous	Mln kg	12a	67	67			1	1
Nitrogen	Mln kg	12b	467	467			10	1
Organic pollution	1000 p.e.	12c	4477		4477		1	1
Cadmium	Kg	12d	8697			43	0,2	1000
Mercury	Kg	12e	1479			49	0,03	1000
Arsenic	Kg	12f	170145			17	10	1000
Chrome	1000 Kg	12g	493			20	25	1000
Copper	1000 Kg	12h	1016			339	3	1000
Lead	1000 Kg	12i	144			6	25	1000
Nickel	1000 Kg	12j	423			-		
Zinc	1000 Kg	12k	2412			80	30	1000

2. COROPs falling in one river basin

CR	Corop40_name	River basin
01	Oost-Groningen	Ems
04	Noord-Friesland	Rhine North
05	Zuidwest-Friesland	Rhine North
06	Zuidoost-Friesland	Rhine North
09	Zuidwest-Drenthe	Rhine East
12	Twente	Rhine East
19	Alkmaar en omgeving	Rhine West
20	IJmond	Rhine West
21	Agglomeratie Haarlem	Rhine West
22	Zaanstreek	Rhine West
23	Groot-Amsterdam	Rhine West
25	Agglomeratie Leiden en Bollenstreek	Rhine West
26	Agglomeratie 's-Gravenhage	Rhine West
27	Delft en Westland	Rhine West
28	Oost-Zuid-Holland	Rhine West
30	Zuidoost-Zuid-Holland	Rhine West
31	Zeeuwsch-Vlaanderen	Scheldt
35	Noordoost-Noord-Brabant	Meuse
36	Zuidoost-Noord-Brabant	Meuse
37	Noord-Limburg	Meuse
38	Midden-Limburg	Meuse
39	Zuid-Limburg	Meuse
40	Flevoland	Rhine Mid

3. Area share of COROPs falling in more than one river basin

COROP	Corop40_name	Ems	Meuse	Rhine Mid	Rhine North	Rhine East	Scheldt	Rhine West
2	Delfzijl e.o.	86,2%			13,8%			
3	Overig Groningen	32,2%			67,8%			
7	Noord-Drenthe	41,5%			27,8%	30,7%		
8	Zuidoost-Drenthe	42,1%				57,9%		
10	Noord-Overijssel			0,3%		99,7%		
11	Zuidwest-Overijssel			3,8%		96,2%		
13	Veluwe			100,0%				0,0%
14	Achterhoek			5,8%		94,2%		
15	Aggl. Arnhem/Nijmegen		0,8%	6,6%		37,3%		55,3%
16	Zuidwest-Gelderland		4,4%					95,6%
17	Utrecht			30,5%				69,5%
18	Kop van Noord-Holland				14,5%			85,5%
24	Het Gooi en Vechtstreek			0,8%				99,2%
29	Groot-Rijnmond		22,6%				1,9%	75,5%
32	Overig Zeeland		0,4%				99,6%	
33	West-Noord-Brabant		86,1%				13,9%	
34	Midden-Noord-Brabant		99,5%					0,5%

4. Available information about emissions from consumers and producers

EMISSION BY CONSUMERS

- Own transport
- Other purposes

EMISSION BY PRODUCERS

- Agriculture and forestry
- Fishing
- Crude petroleum and natural gas production
- Other mining and quarrying
- manufacturing
  - Manufacture of food products, beverages and tobacco
  - Manufacture of textile and leather products
  - Manufacture of paper and paper products
  - Publishing and printing
  - Manufacture of petroleum products
  - Manufacture of chemical products
  - Manufacture of rubber and plastic products
  - Manufacture of basic metals
  - Manufacture of fabricated metal products
  - Manufacture of machinery n.e.c.
  - Manufacture of electrical equipment
  - Manufacture of transport equipment
  - Recycling industries
  - Manufacture of wood and wood products
  - Manufacture of construction materials
  - Other manufacturing
- Electricity supply
- Gas and water supply
- Construction
- Trade and repair of motor vehicles
- Wholesale trade
- Retail trade, repair (excl. motor vehicles), hotels and restaurants
- Land transport
- Water transport
- Air transport
- Supporting transport activities
- Financial, business services and communication
- Public administration and social security
- Education
- Health and social work activities
- Sewage and refuse disposal services
- Other services

OTHER DOMESTIC ORIGIN

- Transport differences

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