Emission estimates for diffuse sources
Netherlands Emission Inventory

Transboundary riverine inputs into Dutch water catchments

Version dated August 2008

NETHERLANDS NATIONAL WATER BOARD - WATER UNIT
in cooperation with DELTARES

Transboundary riverine inputs into Dutch water catchments

1 Description of emission source

The emission source here is the chemical load brought to the Dutch border every year by three major rivers: the Rhine, the Meuse and the Scheldt. These loads are not real emissions on Dutch territory and are therefore not taken into account in surveys of emissions or surface water pollution. However, the data is included in emission records as a comparator for domestic emissions.
Determining factors for loads in rivers are, among other things, precipitation, discharge characteristics and the extent of surface water pollution in the other country.
The various emission sources are shown in table 1.

Table 1: Sources of emissions in rivers originating abroad

Emission source	ES code	Target sector
Pollution from rivers originating abroad, Meuse	T62311402	Other
Pollution from rivers originating abroad, Rhine	T61311402	Other
Pollution from rivers originating abroad, Scheldt	T64311402	Other

2 Explanation of calculation method

As part of the MWTL programme (Monitoring van de Waterstaatkundige Toestand des Lands; National Water Status Monitoring programme), water samples are taken and analysed for pollutants at locations where the Rhine, Meuse and Scheldt enter the Netherlands (Lobith, Eijsden and Schaar van Ouden Doel). The number of measurements varies per substance and between 6 and 52 samples are taken a year. The results (concentrations) are stored in the DONAR database of Rijkswaterstaat, which also contains values for discharges. The data in this database is used to calculate annual loads.

iBEVER [1] is used to calculate annual loads each year. The concentration measurement used to work out annual loads can be performed in two separate compartments, surface water and suspended matter. The calculation methods used to work out annual loads are different for each compartment [1]:

- Surface water:
  Direct method: A daily load (concentration multiplied by corresponding daily flow rate) is calculated for the days on which concentration measurements are available. The resulting daily loads are then added up and converted into an annual load by multiplying the number of days in the year divided by the number of measurements.
- Suspended matter:
  Weighted concentration method: The concentration weighted for flow rate is calculated for days on which concentration measurements are available. This concentration is then multiplied by the annual flow rate, determined as the sum of daily flow rates for all days in the year.

These determination methods are part of the iBEVER load module. Loads are recalculated every year, using the available parameters[1]in DONAR for surface water and suspended matter (excluding total nitrite/nitrate measured after filtration) for Eijsden (Meuse), Lobith pontoon (Rhine) and Schaar van Oude Doel (Scheldt) as input.
iBEVER output is then subjected to further processing before it can be used in emissions records. A list of substances and the compartment for which annual loads are calculated has been drawn up on the basis of specific bound properties and available measurements in compartments. See appendix 1.

[1] Based on samples. Values below the limit of detection are included in the calculations at half the limit of detection. At least two readings must be above the limit of detection for each annual load calculated.

3 Activity Rates

N/a

4 Emission factors

N/a

5 Effects of policy measures

Measures to control pollution from river loads are primarily a matter for international policy. A Water Framework Directive exists, laying down policies in the relevant countries, and there are international commissions for the Rhine, Meuse and Scheldt (IRC, IMC and ISC).

6 Time series of emission factors

N/a

7 Emissions calculated

The table below contains a summary of calculated annual loads for a limited number of substances. Details of all substances can be found at www.emissieregistratie.nl. In 2006 100 substances were recorded.

Pollution via the Meuse

Table 2: Annual load of pollution via the Meuse in kg or tonnes per year for a limited number of substances

substance name	unit	1990	1995	2000	2005	2006
Annual flow rate	10^6 m3	5,960	10,700	10,000	4,600	6,650
nitrogen	t/year	20,669	38,686	40,192	20,667	30,252
phosphorus	t/year	2,173	2,320	2,525	1,088	1,291
arsenic	kg/year	6,527	11,259	10,017	5,674	8,837
cadmium	kg/year	2,469	2,082	2,283	4,205	12,565
copper	kg/year	23,593	28,894	49,485	22,931	32,990
mercury	kg/year	253	195	179	98	123
lead	kg/year	20,221	36,970	53,921	24,010	36,763
nickel	kg/year	13,284	26,686	30,249	22,376	32,849
zinc	kg/year	349,704	398,340	303,327	175,844	270,663
anthracene	kg/year	129	51	49	24	23
naphthalene	kg/year				61	97
fluoranthene	kg/year	197	525	410	217	398
benzo(a)anthracene	kg/year	86	247	192	91	178
benzo(a)pyrene	kg/year	97	272	225	104	236
benzo(b)fluoranthene	kg/year	160	400	299	148	306
benzo(k)fluoranthene	kg/year	58	159	136	66	141
benzo(ghi)perylene	kg/year	83	257	204	103	242
indeno(1,2,3-c,d)pyrene	kg/year	81	258	233	106	243
simazine	kg/year		430	80	69	56
isoproturon	kg/year		662	352	141	126
diuron	kg/year		570	1.031	261	179
tributyltin oxide	kg/year				0.5	0.3

Pollution via the Rhine

Table 3: Annual load of pollution via the Rhine in kg or tonnes per year for a limited number of substances

substance name	unit	1990	1995	2000	2005	2006
annual flow rate	10^6 m3	58,500	88,100	79,700	60,000	66,000
nitrogen	t/year	328,715	396,922	261,729	221,557	227,017
phosphorus	t/year	17,062	18,344	14,274	8,012	7,702
arsenic	kg/year	118,891	192,535	130,245	97,707	104,303
cadmium	kg/year	5,412	7,942	5,130	4,456	4,443
copper	kg/year	326,232	488,104	332,368	281,596	255,547
mercury	kg/year	2,857	3,282	1,584	1,286	1,085
lead	kg/year	280,426	445,501	241,735	171,422	143,494
nickel	kg/year	208,960	341,092	196,212	195,747	182,688
zinc	kg/year	2,244,609	2,263,734	1,240,479	1,355,856	1,190,306
anthracene	kg/year	1,356	617	252	272	167
naphthalene	kg/year			208	261	251
fluoranthene	kg/year	3,095	3,925	1,866	1,371	1,454
benzo(a)anthracene	kg/year	1,219	1,762	823	570	651
benzo(a)pyrene	kg/year	1,426	1,873	930	713	749
benzo(b)fluoranthene	kg/year	1,992	2,441	1,120	847	879
benzo(k)fluoranthene	kg/year	758	939	532	404	395
benzo(ghi)perylene	kg/year	1,111	1,402	854	717	733
indeno(1,2,3-c,d)pyrene	kg/year	1,104	1,522	808	658	754
simazine	kg/year		1,962	710		
isoproturon	kg/year		5,312	3,339	1,881	1,722
diuron	kg/year		2,931	2,324	1,388	1,105
tributyltin oxide	kg/year			12	4.9	4.3

Pollution via the Scheldt

Table 4: Annual load of pollution via the Scheldt in kg or tonnes per year for a limited number of substances

substance name	unit	1990	1995	2000	2005	2006
annual flow rate	10^6 m3	3,020	5,440	6,050	3,590	3,740
nitrogen	t/year	23,710	38,405	38,357	17,584	19,609
phosphorus	t/year	2,042	2,697	2,606	756	848
arsenic	kg/year	26,451			15,686	18,580
cadmium	kg/year	1,864	2,058	2,037	1,284	1,365
copper	kg/year	29,917	35,615	41,550	16,836	19,877
mercury	kg/year	360	384	367	170	163
lead	kg/year	32,902	34,475	50,647	16,081	19,075
nickel	kg/year	33,876	35,325	38,006	17,184	18,931
zinc	kg/year	159,160	195,690	201,948	99,774	117,815
anthracene	kg/year	102	55	64	33	24
naphthalene	kg/year				53	35
fluoranthene	kg/year	251	387	281	149	126
benzo(a)anthracene	kg/year	122	157	137	62	52
benzo(a)pyrene	kg/year	155	174	164	79	83
benzo(b)fluoranthene	kg/year	261	269	216	112	112
benzo(k)fluoranthene	kg/year	89	101	109	53	47
benzo(ghi)perylene	kg/year	130	135	143	67	68
indeno(1,2,3-c,d)pyrene	kg/year	115	155	162	68	81
simazine	kg/year		903	390	105	135
isoproturon	kg/year		387	612	310	338
diuron	kg/year		2,232	3,763	663	660
tributyltin oxide	kg/year				8.7	7.2

8 Release into environmental compartments

N/a

9 Description of emission pathways to water

Pollution from rivers is not attributed to surface water. It comes under a separate designation ("other emissions") in the emissions inventory, and so does not count as surface water pollution caused by the Netherlands. This source is "upstream pollution" of Dutch surface water.

10 Spatial allocation

Spatial allocation is not applied to river loads. They are assessed at three known discharge points.

11 Comments and changes in regard to previous version

N/a.

12 Accuracy and indicated subjects for improvement

The method used in the Emission Inventory publications has been followed as far as possible in classifying the quality of information [4]. It is based on the CORINAIR (CORe emission INventories AIR) methodology, which applies the following quality classifications:

A: a value based on a large number of measurements from representative sources;
B: a value based on a number of measurements from some of the sources that are representative of the sector;
C: a value based on a limited number of measurements, together with estimates based on technical knowledge of the process;
D: a value based on a small number of measurements, together with estimates based on assumptions;
E: a value based on a technical calculation on the basis of a number of assumptions.

Element Emission calculation	Reliability classification
Activity Rates	n/a
Emission factors	n/a
Distribution among compartments	A
Emission pathways to water	A
Calculated annual loads	See appendix 1
Spatial allocation	A

The most important area where improvements could (possibly) be made is:

- Inclusion of river load from the Eems river.

13 Request for reactions

Any questions or comments on this working document should be addressed to Richard van Hoorn, Centre for Water Management, +31 (0)320 298491, email richard.van.hoorn@rws.nl or Roel Venema, RWS Waterdienst 0320-298895, email roel.venema@rws.nl

14 References

1. RWS RIZA, iBEVER, Gebruikershandleiding Vrachten, versie 1.7.2 van 18 augustus 2007
2. Most, P.F.J. van der *et al.*, juli 1998. *Methoden voor de bepaling van emissies naar lucht en water*. Publicatiereeks Emissieregistratie, nr. 44.

Appendix 1: List of substances

The number of substances for which annual loads are calculated can vary from one year to the next. The number of measurements and their reliability classification can also vary. The table below is based on the substances for which loads were calculated in the last year covered by this fact sheet (2006). This list of substances includes the following information for each substance:

- the compartment for which the annual load was calculated (surface water or suspended matter)
- the quantity, where:
  - surface water is measured in total water as quantity n/a
  - suspended matter is measured on the basis of dry weight (dw).
- the number of water quality measurements per border location in the Meuse, Rhine and Scheldt
- the reliability classification (section 12), where
  - A = daily
  - B = more than once a week
  - C = between once a month and once a week
  - D = less than once a month

substance name	substance code	compartment	qty	Meuse	Rhine	Scheldt	reliability classification
1,1,1-trichloroethane	111TCEa	surface water	n/a	13			C
1,1,2-trichloroethane	112TCEa	surface water	n/a	13		13	C
1,1-dichloroethane	11DCEa	surface water	n/a	13			C
1.2-dichloroethane	12DCEa	surface water	n/a	13	13	13	C
1,2-dichloropropane	12DCPra	surface water	n/a	13			C
1,2-xylene	12Xyl	surface water	n/a		13		C
1,4-dichlorobenzene	14DCB	surface water	n/a	13			C
2,4-dichlorophenoxyacetic acid	24D	surface water	n/a	13			C
2-methyl-4-chlorophenoxyacetic acid	MCPA	surface water	n/a	13			C
Aluminium	Al	surface water	n/a		13		C
Amino-methyl-phosphonic acid	AMPA	surface water	n/a	13	13		C
Antimony	Sb	surface water	n/a	52	26	26	B
Arsenic	As	surface water	n/a	52	26	26	B
Atrazine	Atr	surface water	n/a	13	13	13	C
Barium	Ba	surface water	n/a	13	13		C
Bentazon	BENTZN	surface water	n/a	13	13	13	C
Benzene	Ben	surface water	n/a	13	13	13	C
Boron	B	surface water	n/a	52	26	26	B
Bromide	Br	surface water	n/a	13	13		C
Cadmium	Cd	surface water	n/a	52	26	26	B
Calcium	Ca	surface water	n/a		13	13	C
Chemical oxygen demand	COD	surface water	n/a	13		13	C
Chlorotoluron	CTLRN	surface water	n/a	12		12	C
Chloridazon	ClAZN	surface water	n/a	13		13	C
Chromium	Cr	surface water	n/a	52	26	25	B
Cis-1,2-dichloroethene	C12DCEe	surface water	n/a	13	13	13	C
Cyanide	CN	surface water	n/a	13	13		C
Dibromochloromethane	DBrCMa	surface water	n/a			13	C
Dibromomethane	DBrMa	surface water	n/a			13	C
Dichlorobromomethane	DCBrMa	surface water	n/a	13	13	13	C
Diisopropylether	DiPyEr	surface water	n/a	13		13	C
Dimethoate	DMTAT	surface water	n/a	13		13	C
Diuron	DIURN	surface water	n/a	13	25	13	C
Ethylenediaminetetramethane acid	EDTA	surface water	n/a		13		C
Fluoride	F	surface water	n/a	26	13		C
Phosphate	P	surface water	n/a	52	26	26	B
Iron	Fe	surface water	n/a	52	26	26	B

substance name	substance code	compartment	qty	Meuse	Rhine	Scheldt	reliability classification
Isoproturon	IPTRN	surface water	n/a	11	26	13	C
Potassium	K	surface water	n/a	13	13	13	C
Nitrogen (TKN + sum of NO3/NO2)	N	surface water	n/a	52	26	26	B
Copper	Cu	surface water	n/a	52	26	26	B
Mercury	Hg	surface water	n/a	52	26	26	B
Linuron	LINRN	surface water	n/a			11	D
Lead	Pb	surface water	n/a	52	26	26	B
Magnesium	Mg	surface water	n/a		13		C
Manganese	Mn	surface water	n/a	52	26	26	B
Methobromuron	METBMRN	surface water	n/a			13	C
Metolachlor	MtlCl	surface water	n/a	13	13	13	C
Metoxuron	METXRN	surface water	n/a	13			C
Monochlorobenzene	MCB	surface water	n/a			13	C
Nickel	Ni	surface water	n/a	52	26	26	B
Propazine	PROPAz	surface water	n/a			13	C
Selenium	Se	surface water	n/a	13	13		C
Simazine	Sim	surface water	n/a	13		13	C
Sum of 1,3-xylene and 1,4-xylene	s_1314Xyl	surface water	n/a	13			C
Nitrogen	N	surface water	N	52	26	26	B
Terbutryne	trBTNE	surface water	n/a	13	13		C
Tetrachloroethene	T4CEe	surface water	n/a	13	13	13	C
Tetrachloromethane	T4CMa	surface water	n/a	13			C
Toluene	Tol	surface water	n/a	13	13	13	C
Tribromomethane	TBrMa	surface water	n/a			13	C
Tributylphosphate	TByPO4	surface water	n/a	12		12	C
Trichloroethene	TCEe	surface water	n/a	13		13	C
Trichloromethane	TCM	surface water	n/a	13	13	13	C
Zinc	Zn	surface water	n/a	52	26	26	B
1,2,3,4-tetrachlorobenzene	1234T4CB	suspended matter	dw	12	12	12	C
1,2,3-trichlorobenzene	123TCB	suspended matter	dw	12	12	12	C
1,3,5-trichlorobenzene	135TCB	suspended matter	dw	12	12	12	C
Acenaphthene	AcNe	suspended matter	dw	43		20	C
Acenaphthylene	AcNy	suspended matter	dw	13			C
Anthracene	Ant	suspended matter	dw	47	24	26	B
Benzo(a)anthracene	BaA	suspended matter	dw	47	25	26	B
Benzo(a)pyrene	BaP	suspended matter	dw	47	24	26	B
Benzo(b)fluoranthene	BbF	suspended matter	dw	47	25	26	B
Benzo(ghi)perylene	BghiPe	suspended matter	dw	47	24	26	B
Benzo(k)fluoranthene	BkF	suspended matter	dw	47	24	26	B
Chrysene	Chr	suspended matter	dw	47	25	26	B
Dibenzo(a,h)anthracene	DBahAnt	suspended matter	dw	46	24	26	B
Phenanthrene	Fen	suspended matter	dw	45	24	26	B
Fluoranthene	Flu	suspended matter	dw	47	25	26	B
Fluorene	Fle	suspended matter	dw		7		D
Indeno(1,2,3-c,d)pyrene	InP	suspended matter	dw	47	24	26	B
Mineral oil	MINRLOLE	suspended matter	dw	47	25	26	B
Naphthalene	Naf	suspended matter	dw	42	18	25	B
Pyrene	Pyr	suspended matter	dw	47	25	26	B
Sum of Borneff 6 PAHs	s_PAK6	suspended matter	dw	47	24	26	B
Tetrabutyltin	T4BySn	suspended matter	Sndw		12	13	C
Tributyltin	TBySn	suspended matter	Sndw	12	12	13	C