



# 3.6

## Water pollution

	Emissions of organic water pollutants				Industry shares of emissions of organic water pollutants							
	kilograms per day		kilograms per day per worker		Primary metals 2001 <sup>a</sup>	Paper and pulp 2001 <sup>a</sup>	Chemicals 2001 <sup>a</sup>	% of total				
	1990	2001 <sup>a</sup>	1990	2001 <sup>a</sup>				Food and beverages 2001 <sup>a</sup>	Stone, ceramics, and glass 2001 <sup>a</sup>	Textiles 2001 <sup>a</sup>	Wood 2001 <sup>a</sup>	Other 2001 <sup>a</sup>
Afghanistan	..	..	..	..	..	..	..	..	..	..	..	..
Albania	34,785	6,512	0.14	0.29	14.3	0.9	5.5	73.5	0.3	5.0	0.0	0.4
Algeria	106,977	45,645	0.25	0.24	23.4	2.0	5.9	59.5	0.7	8.0	1.0	..
Angola	4,544	1,472	0.19	0.20	7.6	3.0	9.1	65.9	0.3	6.0	4.0	4.0
Argentina	186,686	149,455	0.20	0.23	4.9	7.2	4.2	71.1	0.0	7.0	1.0	4.6
Armenia	37,900	7,104	0.11	0.28	..	..	0.0	77.6	..	22.0	..	..
Australia	186,110	111,658	0.18	0.18	12.4	22.8	5.6	77.1	0.2	5.0	5.0	6.4
Austria	94,121	80,789	0.15	0.13	14.9	18.2	11.1	32.8	0.4	5.0	5.0	12.5
Azerbaijan	53,251	18,672	0.15	0.16	12.5	4.7	16.6	43.7	0.3	15.0	1.0	6.2
Bangladesh	171,087	273,082	0.17	0.14	1.8	6.8	2.5	23.2	0.1	64.0	1.0	0.7
Belarus	..	..	..	..	..	..	..	..	..	..	..	..
Belgium	117,978	102,460	0.16	0.17	13.7	18.0	12.0	40.4	0.2	6.0	2.0	7.6
Benin	..	..	..	..	..	..	..	..	..	..	..	..
Bolivia	8,404	12,759	0.24	0.25	0.9	20.5	6.6	61.4	0.3	7.0	2.0	1.4
Bosnia and Herzegovina	50,741	8,903	0.14	0.18	20.5	13.1	6.6	33.3	0.2	18.0	6.0	2.2
Botswana	4,509	3,543	0.19	0.25	1.7	6.7	5.4	77.9	0.2	10.0	3.0	2.5
Brazil	780,395	629,406	0.19	0.20	17.7	12.9	9.2	44.4	0.1	10.0	1.0	4.7
Bulgaria	149,381	90,976	0.11	0.17	7.9	7.2	8.2	46.8	0.2	22.0	2.0	5.7
Burkina Faso	..	2,598	..	0.22	3.5	1.1	5.4	73.8	0.1	4.0	10.0	2.2
Burundi	1,570	..	0.24	..	..	..	..	..	..	..	..	..
Cambodia	11,823	..	0.14	..	..	..	..	..	..	..	..	..
Cameroon	13,989	10,714	0.28	0.20	3.1	6.3	28.3	52.7	0.0	4.0	6.0	..
Canada	321,471	313,431	0.17	0.16	9.7	22.8	8.3	38.5	0.1	6.0	5.0	9.5
Central African Republic	998	670	0.18	0.17	0.0	..	4.0	62.0	0.0	14.0	20.0	..
Chad	..	..	..	..	..	..	..	..	..	..	..	..
Chile	66,783	72,850	0.22	0.24	6.9	11.3	8.9	62.7	0.1	5.0	3.0	2.1
China	7,038,131	6,088,663	0.14	0.14	20.4	10.9	14.8	28.1	0.5	15.0	1.0	9.2
Hong Kong, China	86,124	34,767	0.12	0.19	1.2	43.3	3.5	30.2	0.1	16.0	0.0	5.8
Colombia	93,253	93,879	0.19	0.21	3.1	16.2	9.7	53.2	0.2	14.0	1.0	2.6
Congo, Dem. Rep.	..	..	..	..	..	..	..	..	..	..	..	..
Congo, Rep.	..	..	..	..	..	..	..	..	..	..	..	..
Costa Rica	27,249	32,914	0.20	0.21	1.8	10.0	7.4	62.2	0.1	14.0	2.0	2.5
Côte d'Ivoire	..	12,401	..	0.24	..	5.5	7.1	71.9	0.0	9.0	6.0	..
Croatia	80,034	43,087	0.15	0.17	6.2	15.4	8.0	47.1	0.2	13.0	4.0	6.0
Cuba	..	..	..	..	..	..	..	..	..	..	..	..
Czech Republic	309,469	..	0.13	..	..	..	..	..	..	..	..	..
Denmark	91,871	83,591	0.18	0.17	4.4	29.1	7.9	44.2	0.2	2.0	3.0	9.3
Dominican Republic	..	..	..	..	..	..	..	..	..	..	..	..
Ecuador	25,567	32,266	0.23	0.27	2.3	10.8	6.2	71.8	0.1	6.0	1.0	1.7
Egypt, Arab Rep.	211,531	203,633	0.20	0.20	11.8	7.9	8.0	49.8	0.3	19.0	0.0	3.3
El Salvador	7,663	22,760	0.22	0.18	2.1	10.2	8.1	43.5	0.1	34.0	0.0	1.9
Eritrea	..	..	..	..	..	..	..	..	..	..	..	..
Estonia	..	..	..	..	..	..	..	..	..	..	..	..
Ethiopia	18,593	20,849	0.23	0.23	1.8	10.4	4.6	61.2	0.3	20.0	1.0	0.7
Finland	79,514	66,877	0.18	0.16	8.7	40.1	6.8	27.0	0.2	3.0	4.0	10.3
France	653,455	281,747	0.15	0.10	14.7	31.0	23.0	37.4	0.3	9.0	3.0	10.7
Gabon	2,018	1,886	0.25	0.26	0.0	6.0	4.9	79.7	0.1	1.0	7.0	1.3
Gambia, The	..	832	..	0.34	..	..	..	..	..	..	..	..
Georgia	..	..	..	..	..	..	..	..	..	..	..	..
Germany	835,019	1,020,145	0.12	0.14	9.0	20.9	11.3	38.7	0.2	3.0	2.0	15.0
Ghana	..	14,449	..	0.17	9.8	16.9	10.5	39.5	0.2	9.0	12.0	2.2
Greece	63,479	43,707	0.18	0.19	8.1	9.7	9.0	55.0	0.3	12.0	2.0	3.9
Guatemala	16,070	19,253	0.27	0.28	4.9	7.2	6.1	72.8	0.1	7.0	1.0	0.8
Guinea	..	..	..	..	..	..	..	..	..	..	..	..
Guinea-Bissau	..	..	..	..	..	..	..	..	..	..	..	..
Haiti	..	..	..	..	..	..	..	..	..	..	..	..

	Emissions of organic water pollutants				Industry shares of emissions of organic water pollutants							
	kilograms per day		kilograms per day per worker		Primary metals 2001 <sup>a</sup>	Paper and pulp 2001 <sup>a</sup>	Chemicals 2001 <sup>a</sup>	% of total				
	1990	2001 <sup>a</sup>	1990	2001 <sup>a</sup>				Food and beverages 2001 <sup>a</sup>	Stone, ceramics, and glass 2001 <sup>a</sup>	Textiles 2001 <sup>a</sup>	Wood 2001 <sup>a</sup>	Other 2001 <sup>a</sup>
Honduras	17,824	34,036	0.23	0.20	1.1	7.8	3.9	55.5	0.1	27.0	4.0	0.6
Hungary	178,002	113,527	0.16	0.15	6.4	11.8	7.6	49.1	0.2	13.0	2.0	10.0
India	1,410,617	1,556,371	0.20	0.20	12.6	7.5	9.3	53.0	0.2	13.0	0.0	4.4
Indonesia	495,594	753,657	0.19	0.18	2.8	8.5	9.6	50.1	0.1	21.0	5.0	4.3
Iran, Islamic Rep.	102,689	140,775	0.16	0.16	17.4	7.0	10.7	43.6	0.6	13.0	1.0	6.7
Iraq	20,352	19,617	0.16	0.16	8.8	14.1	15.1	39.4	0.7	17.0	0.0	4.8
Ireland	34,610	49,144	0.18	0.15	1.3	14.2	11.4	56.4	0.2	3.0	2.0	11.4
Israel	46,359	39,824	0.16	0.14	3.2	8.2	7.7	54.5	0.1	10.0	2.0	14.2
Italy	358,084	495,973	0.13	0.12	9.3	16.8	10.8	30.1	0.3	16.0	4.0	12.6
Jamaica	18,736	17,507	0.29	0.29	6.9	7.2	3.8	70.8	0.1	10.0	1.0	0.1
Japan	1,556,648	1,279,287	0.14	0.15	7.0	21.9	9.0	43.2	0.2	5.0	2.0	11.7
Jordan	8,325	18,682	0.19	0.19	4.9	12.8	12.9	52.4	0.5	11.0	3.0	2.6
Kazakhstan	..	..	..	..	..	..	..	..	..	..	..	..
Kenya	42,588	53,029	0.23	0.25	4.1	11.9	5.7	70.0	0.1	8.0	2.0	2.3
Korea, Dem. Rep.	..	..	..	..	..	..	..	..	..	..	..	..
Korea, Rep.	369,193	309,517	0.12	0.12	11.4	18.2	12.9	26.0	0.2	14.0	1.0	16.3
Kuwait	9,052	11,412	0.16	0.17	2.5	16.4	10.6	49.4	0.4	12.0	3.0	5.7
Kyrgyz Republic	30,885	20,721	0.12	0.21	8.4	4.1	1.6	67.7	0.3	13.0	1.0	3.9
Lao PDR	..	..	..	..	..	..	..	..	..	..	..	..
Latvia	39,887	25,106	0.12	0.19	2.8	8.7	2.7	64.5	0.1	11.0	10.0	5.6
Lebanon	..	14,899	..	0.19	0.9	15.6	4.0	60.7	0.5	10.0	5.0	3.2
Lesotho	2,958	3,123	0.16	0.16	1.2	4.0	0.7	39.7	0.1	51.0	1.0	2.2
Liberia	..	..	..	..	..	..	..	..	..	..	..	..
Libya	..	..	..	..	..	..	..	..	..	..	..	..
Lithuania	53,818	37,539	0.13	0.18	1.2	11.3	5.1	54.8	0.2	18.0	6.0	3.5
Macedonia, FYR	32,419	23,490	0.18	0.18	11.7	9.6	6.2	45.0	0.1	21.0	2.0	4.5
Madagascar	..	..	..	..	..	..	..	..	..	..	..	..
Malawi	10,024	11,805	0.29	0.29	0.0	16.0	3.7	70.0	0.0	8.0	2.0	0.2
Malaysia	104,728	186,198	0.13	0.12	7.8	14.3	15.5	32.9	0.2	8.0	7.0	14.3
Mali	..	..	..	..	..	..	..	..	..	..	..	..
Mauritania	..	..	..	..	..	..	..	..	..	..	..	..
Mauritius	17,813	17,700	0.16	0.15	0.9	6.6	2.6	32.8	0.1	55.0	1.0	1.1
Mexico	174,266	296,093	0.18	0.20	7.8	12.5	10.4	55.6	0.2	7.0	1.0	5.5
Moldova	55,887	34,234	0.15	0.29	0.2	4.0	1.4	81.7	0.2	11.0	1.0	0.6
Mongolia	10,160	7,939	0.18	0.18	1.8	4.3	0.9	64.2	0.3	25.0	5.0	0.9
Morocco	41,710	88,779	0.14	0.18	0.7	7.0	6.4	54.4	0.4	27.0	1.0	3.2
Mozambique	20,414	10,230	0.27	0.31	1.1	7.1	2.7	81.2	0.1	6.0	1.0	0.8
Myanmar	7,663	5,681	0.17	0.14	47.6	5.0	14.9	16.1	1.1	3.0	11.0	1.3
Namibia	..	7,350	..	0.35	0.0	5.0	1.6	90.4	0.1	1.0	1.0	0.9
Nepal	20,894	26,550	0.13	0.14	1.5	8.1	3.9	43.3	1.2	39.0	2.0	1.0
Netherlands	136,686	124,182	0.18	0.18	7.3	26.7	11.3	43.0	0.2	2.0	1.0	8.7
New Zealand	50,243	46,099	0.22	0.22	3.2	21.7	5.2	57.3	0.1	5.0	4.0	3.5
Nicaragua	..	..	..	..	..	..	..	..	..	..	..	..
Niger	..	..	..	..	..	..	..	..	..	..	..	..
Nigeria	52,350	82,477	0.23	0.17	1.4	15.4	11.3	40.2	0.1	23.0	5.0	3.7
Norway	54,996	51,693	0.20	0.19	9.0	31.3	4.7	42.8	0.1	1.0	3.0	8.1
Oman	360	5,936	0.11	0.17	6.7	14.0	8.6	52.8	0.8	10.0	3.0	4.1
Pakistan	104,095	100,821	0.18	0.18	11.6	7.0	8.4	39.9	0.2	30.0	0.0	3.0
Panama	9,700	11,692	0.26	0.32	1.5	13.2	4.6	76.6	0.2	3.0	0.0	1.0
Papua New Guinea	..	..	..	..	..	..	..	..	..	..	..	..
Paraguay	3,250	..	0.28	..	..	..	..	..	..	..	..	..
Peru	56,144	52,644	0.20	0.21	8.1	13.5	8.9	52.8	0.2	12.0	2.0	2.5
Philippines	228,301	201,952	0.21	0.18	5.2	9.8	7.3	54.5	0.2	16.0	2.0	5.0
Poland	428,894	404,285	0.14	0.16	8.4	11.8	7.8	52.4	0.3	10.0	2.0	7.3
Portugal	147,873	131,200	0.15	0.14	3.6	15.3	4.8	36.9	0.4	27.0	6.0	5.9
Puerto Rico	19,026	15,367	0.15	0.14	1.9	14.9	21.9	34.4	0.2	15.0	1.0	10.7



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## Water pollution

	Emissions of organic water pollutants				Industry shares of emissions of organic water pollutants								
	kilograms per day		kilograms per day per worker		Primary metals 2001 <sup>a</sup>	Paper and pulp 2001 <sup>a</sup>	Chemicals 2001 <sup>a</sup>	% of total					Other 2001 <sup>a</sup>
	1990	2001 <sup>a</sup>	1990	2001 <sup>a</sup>				Food and beverages 2001 <sup>a</sup>	Stone, ceramics, and glass 2001 <sup>a</sup>	Textiles 2001 <sup>a</sup>	Wood 2001 <sup>a</sup>		
Romania	413,864	38,395	0.12	0.07	17.1	17.6	9.0	5.1	0.3	29.0	13.0	9.6	
Russian Federation	..	1,484,991	..	0.19	20.3	7.3	7.3	49.1	0.1	6.0	3.0	6.9	
Rwanda	..	..	..	..	..	..	..	..	..	..	..	..	
Saudi Arabia	24,436	24,436	0.14	0.14	4.4	15.9	21.1	45.1	1.0	4.0	2.0	6.5	
Senegal	10,309	6,643	0.32	0.36	0.0	6.6	4.2	87.0	0.1	2.0	0.0	1.0	
Serbia and Montenegro	137,795	98,696	0.15	0.16	9.9	11.8	8.2	47.4	0.0	13.0	2.0	7.7	
Sierra Leone	..	4,170	..	0.32	..	9.6	3.0	82.3	0.1	2.0	2.0	..	
Singapore	32,364	32,250	0.09	0.09	1.4	25.5	16.7	22.7	0.1	4.0	1.0	28.5	
Slovak Republic	77,174	45,011	0.13	0.14	4.2	15.0	8.4	44.2	0.4	15.0	2.0	10.9	
Slovenia	55,640	40,378	0.16	0.17	33.8	15.0	8.2	23.2	0.2	11.0	2.0	6.5	
Somalia	..	..	..	..	..	..	..	..	..	..	..	..	
South Africa	261,618	181,284	0.17	0.19	9.8	19.5	7.9	46.4	0.0	5.0	5.0	6.4	
Spain	320,262	374,589	0.17	0.15	6.7	19.8	8.9	42.5	0.3	9.0	4.0	8.8	
Sri Lanka	53,024	88,943	0.19	0.18	0.5	7.0	6.4	52.3	0.2	31.0	1.0	1.5	
Sudan	..	..	..	..	..	..	..	..	..	..	..	..	
Swaziland	6,586	2,009	0.33	0.23	..	79.8	0.3	..	0.2	17.0	2.0	..	
Sweden	109,582	103,913	0.15	0.14	11.3	35.0	7.8	26.6	0.1	1.0	3.0	15.2	
Switzerland	146,038	123,752	0.16	0.17	24.9	23.6	10.4	25.0	0.2	3.0	4.0	9.0	
Syrian Arab Republic	21,702	15,115	0.22	0.20	4.1	1.5	3.9	69.8	0.9	19.0	0.0	0.7	
Tajikistan	..	..	..	..	..	..	..	..	..	..	..	..	
Tanzania	31,125	35,155	0.24	0.25	1.5	9.4	2.7	69.3	0.1	14.0	2.0	0.9	
Thailand	291,552	355,819	0.17	0.16	6.1	5.3	5.3	42.2	0.2	35.0	1.0	4.8	
Togo	..	..	..	..	..	..	..	..	..	..	..	..	
Trinidad and Tobago	9,951	11,787	0.26	0.28	4.4	10.9	6.7	72.6	0.1	3.0	1.0	1.3	
Tunisia	..	49,337	..	0.14	3.0	5.3	7.0	33.7	0.4	44.0	2.0	4.6	
Turkey	177,264	159,225	0.18	0.18	13.5	8.6	8.7	49.5	0.3	12.0	2.0	5.4	
Turkmenistan	..	..	..	..	..	..	..	..	..	..	..	..	
Uganda	..	..	..	..	..	..	..	..	..	..	..	..	
Ukraine	692,373	445,758	0.14	0.18	28.1	4.2	7.0	46.8	0.4	5.0	1.0	7.5	
United Arab Emirates	..	..	..	..	..	..	..	..	..	..	..	..	
United Kingdom	739,562	604,821	0.15	0.15	6.6	29.0	11.1	34.4	0.2	6.0	3.0	9.8	
United States	2,565,226	1,968,196	0.15	0.12	10.5	11.0	13.8	38.4	0.2	7.0	4.0	15.1	
Uruguay	38,661	16,362	0.23	0.28	1.2	7.2	6.7	75.9	0.1	8.0	1.0	1.8	
Uzbekistan	..	..	..	..	..	..	..	..	..	..	..	..	
Venezuela, RB	96,495	94,175	0.21	0.21	13.7	10.4	10.2	53.1	0.3	8.0	2.0	2.4	
Vietnam	..	..	..	..	..	..	..	..	..	..	..	..	
West Bank and Gaza	..	..	..	..	..	..	..	..	..	..	..	..	
Yemen, Rep.	6,873	7,823	0.27	0.25	0.0	9.1	12.9	71.1	0.0	5.0	1.0	0.9	
Zambia	15,880	11,433	0.23	0.22	3.4	10.8	7.3	63.6	0.0	9.0	3.0	2.8	
Zimbabwe	37,149	26,810	0.20	0.19	5.2	10.2	7.9	54.2	0.0	16.0	3.0	3.5	

Note: Industry shares may not sum to 100 percent because data may be from different years.  
a. Data refer to any year from 1993 to 2001.

## About the data

Emissions of organic pollutants from industrial activities are a major cause of degradation of water quality. Water quality and pollution levels are generally measured in terms of concentration or load—the rate of occurrence of a substance in an aqueous solution. Polluting substances include organic matter, metals, minerals, sediment, bacteria, and toxic chemicals. This table focuses on organic water pollution resulting from industrial activities. Because water pollution tends to be sensitive to local conditions, the national-level data in the table may not reflect the quality of water in specific locations.

The data in the table come from an international study of industrial emissions that may be the first to include data from developing countries (Hettige, Mani, and Wheeler 1998). These data were updated through 2001 by the World Bank's Development Research Group. Unlike estimates from earlier studies based on engineering or economic models, these estimates are based on actual measurements of plant-level water pollution. The focus is on organic water pollution caused by organic waste, measured in terms of biochemical oxygen demand (BOD), because the data for this indicator are the most plentiful and the most reliable for cross-country comparisons of emissions. BOD measures the strength of an organic waste by the amount of oxygen consumed in breaking it down. A sewage overload in natural waters exhausts the water's dissolved oxygen content. Wastewater treatment, by contrast, reduces BOD.

Data on water pollution are more readily available than other emissions data because most industrial pollution control programs start by regulating emissions of organic water pollutants. Such data are fairly reliable because sampling techniques for measuring

water pollution are more widely understood and much less expensive than those for air pollution.

Hettige, Mani, and Wheeler (1998) used plant- and sector-level information on emissions and employment from 13 national environmental protection agencies and sector-level information on output and employment from the United Nations Industrial Development Organization (UNIDO). Their econometric analysis found that the ratio of BOD to employment in each industrial sector is about the same across countries. This finding allowed the authors to estimate BOD loads across countries and over time. The estimated BOD intensities per unit of employment were multiplied by sectoral employment numbers from UNIDO's industry database for 1980–98. The estimates of sectoral emissions were then totaled to get daily emissions of organic water pollutants in kilograms per day for each country and year. The data in the table were derived by updating these estimates through 2001.

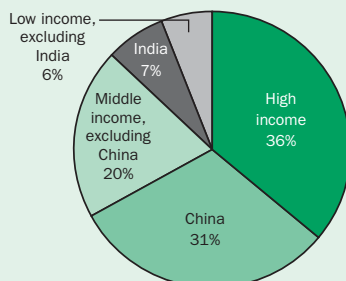
## Definitions

• Emissions of organic water pollutants are measured in terms of biochemical oxygen demand, which refers to the amount of oxygen that bacteria in water will consume in breaking down waste. This is a standard water treatment test for the presence of organic pollutants. Emissions per worker are total emissions divided by the number of industrial workers. • Industry shares of emissions of organic water pollutants refer to emissions from manufacturing activities as defined by two-digit divisions of the International Standard Industrial Classification (ISIC) revision 2: primary metals (ISIC division 37), paper and pulp (34), chemicals (35), food and beverages (31), stone, ceramics, and glass (36), textiles (32), wood (33), and other (38 and 39).

## 3.6a

### High- and middle-income countries account for most water pollution from organic waste

Emissions of organic water pollutants, 1998



Source: World Bank staff estimates.

## Data sources

The data come from a 1998 study by Hemamala Hettige, Muthukumara Mani, and David Wheeler, "Industrial Pollution in Economic Development: Kuznets Revisited" (available at [www.worldbank.org/nipr](http://www.worldbank.org/nipr)). These data were updated through 2001 by the World Bank's Development Research Group using the same methodology as the initial study. Sectoral employment numbers are from UNIDO's industry database.