Statistics in focus

ENVIRONMENT AND ENERGY

THEME 8 – 14/2001

ENVIRONMENT

Waste water in European countries

From waste water collection and treatment to discharges

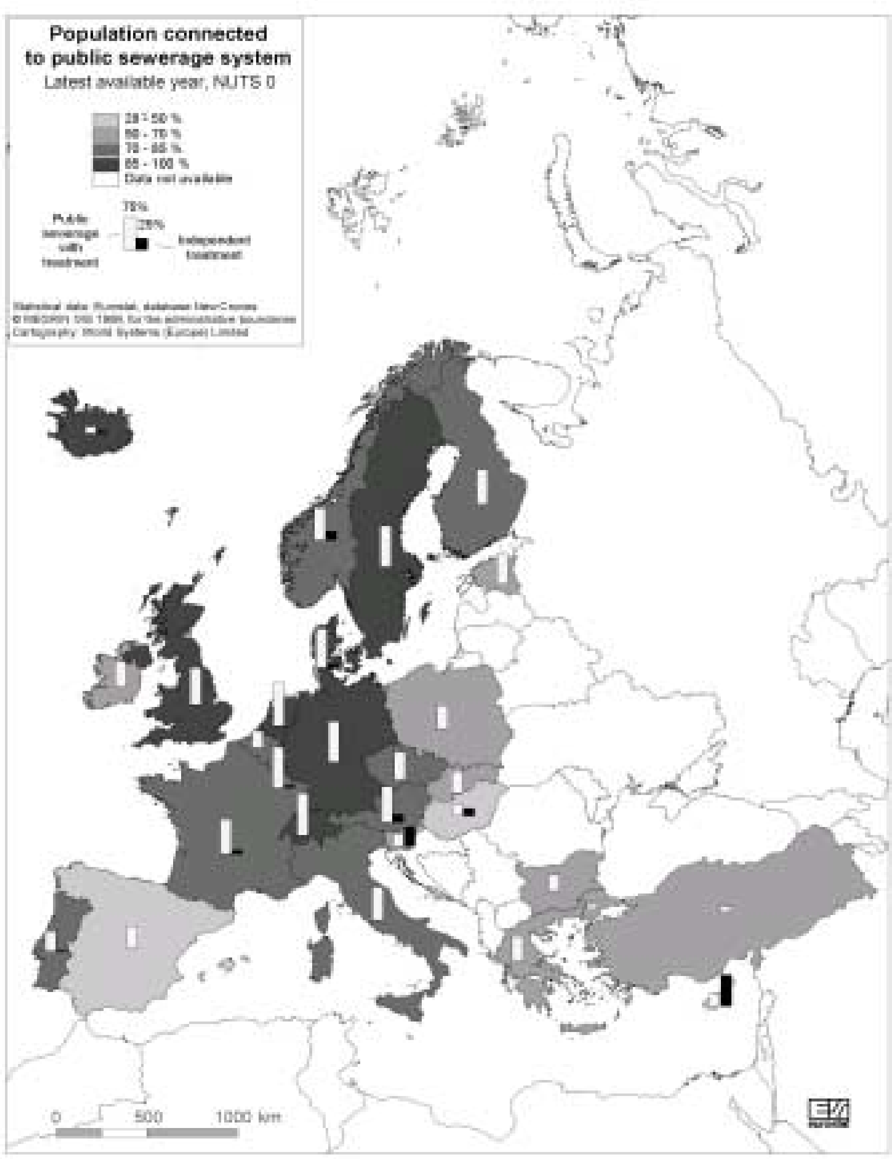
Maria Pau Vall

77 % of the EU population is connected to public waste water treatment plants

A large part of the water abstracted for domestic, industrial or agricultural use is returned to the environment (to rivers, lakes or directly to the sea) as waste water with impaired quality. Public sewerage collects domestic effluent, together with industrial waste water and/or run-off water. Sewage treatment systems, when efficient, preserve the health of water resources, the soil and human health.

Towards the end of the 1990s around 80 % of European Union population was connected to public sewerage systems, and 77 % to waste water treatment plants. In Candidate countries less than 55 % of the population is connected to public sewerage systems and only 45 % to waste water treatment. In the EU over the last 15 years there has been a shift from mechanical (primary) sewage treatment towards biological (secondary) and/or advanced treatment systems (tertiary) while in Candidate countries mechanical and biological treatment are predominant.

According to the **Urban Waste Water Treatment Directive** (91/271/EEC) Member States are required to treat waste water for agglomerations of more than 2000 population equivalents to at least secondary level of treatment and more stringent treatment (secondary plus tertiary) for discharges in areas identified as sensitive by Member States.



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Advanced treatment systems are largely dominant in Nordic countries

Table 1: Population connected to sewerage systems

(%)

	Year	Public sewerage system					Independent sewerage	*of which:* Independent treatment
		with treatment				Without treatment		
		Mechanical treatment	Biological treatment	Advanced treatment	Total			
B	*1998*	-	22.0	16.1	38.1	44.4	17.3	:
DK	*1998*	1.6	3.4	84.0	89.0	0.0	10.9	10.9
D	*1995*	4.1	12.2	72.3	91.5	0.6	7.9	:
EL	*1997*	32.4	14.2	9.6	56.2	11.3	32.2	:
E	*1995*	10.6	34.4	3.3	48.3	:	:	:
F	*1995*	:	:	:	79.0	2.0	:	10.0
IRL	*1995*	24.0	31.8	1.8	57.6	:	32.0	:
I	*1995*	2.9	36.1	24.1	75.0	:	:	:
L	*1999*	:	:	:	93.0	-	7.0	7.0
NL	*1998*	-	19.6	78.1	97.7	-	2.3	:
A	*1998*	0.5	17.2	63.7	81.4	0.1	18.5	18.5
P	*1998*	17.8	26.0	2.3	46.0	36.0	18.0	4.7
FIN	*1999*	-	-	80.0	80.0	-	20.0	:
S	*1998*	-	6.0	87.0	93.0	-	7.0	:
UK	*1997*	12.0	52.0	20.0	84.0	10.0	6.0	:
IS	*1999*	16.4	-	-	16.4	73.6	10.0	6.0
NO	*1999*	21.0	1.0	51.0	73.0	7.0	20.0	20.0
CH	*1999*	-	22.0	73.8	95.8	-	4.2	:
BG	*1998*	0.9	35.0	-	36.7	30.0	33.3	:
CY	*2000*	-	-	29.3	29.3	-	70.7	70.7
CZ	*1999*	:	:	:	64.8	9.8	25.4	:
EE	*1999*	1.0	31.0	37.0	69.0	1.0	30.0	:
HU	*1998*	3.0	20.0	3.0	26.0	22.0	52.0	17.0
LV		:	:	:	:	:	:	:
LT		:	:	:	:	:	:	:
PL	*1999*	4.3	32.0	15.7	52.0	6.0	42.0	:
RO		:	:	:	:	:	:	:
SK	*1998*	:	:	:	48.8	5.2	46.0	:
SI	*1999*	15.0	15.0	-	30.0	23.0	47.0	45.0
TR	*1995*	8.5	3.6	:	12.1	50.4	37.5	:

Source: *Eurostat.*

Within EU countries, the percentage of population connected to public waste water treatment plants varies widely. The Netherlands, Luxembourg and Sweden have the highest rates (98 % and 93 %), while Belgium has the lowest percentage (38 %).

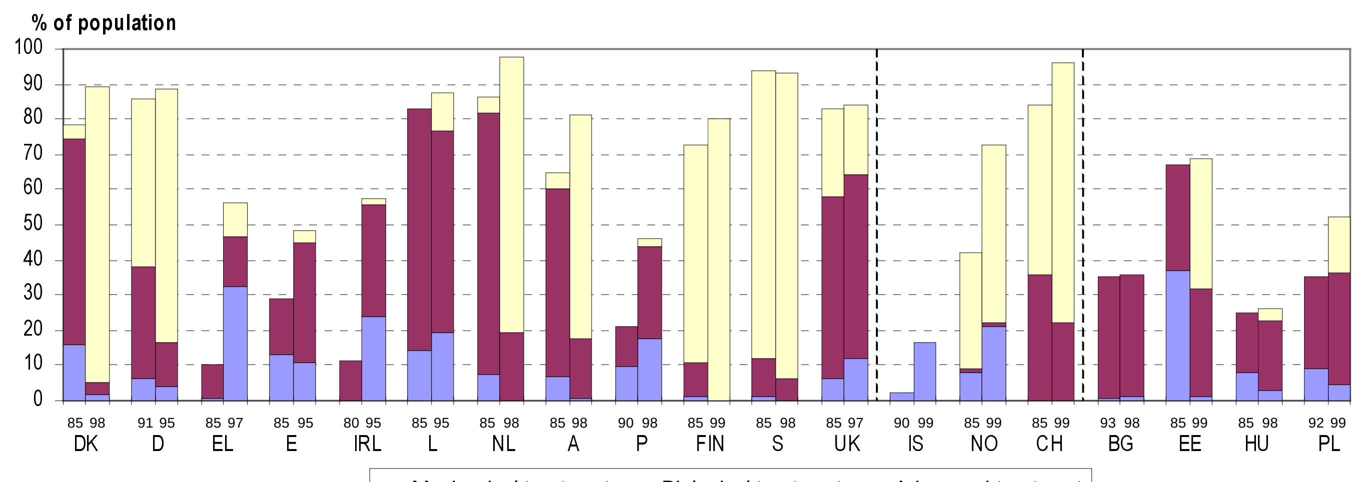
More than 80% of the population in Sweden, Denmark, and Finland are connected to advanced waste water treatment systems, the highest in the EU, followed by the Netherlands (78 %), Germany (72 %), and Austria (64 %).

In other EU countries, biological treatment is the most common, with the exception of Greece, where mechanical treatment prevails (32 % of the population).

Outside the EU, 96% and 73% of the population of Switzerland and Norway respectively are connected to sewage treatment plants, for the most part advanced treatment systems, compared with 45% for Candidate countries, where the treatment is mainly biological.

The available data show that independent treatment plays a role in countries such as Norway, Austria, Denmark and France, and is very important in Cyprus, Slovenia and Hungary. This kind of treatment can be an efficient treatment in rural areas or scattered settlements. But sufficient information on the efficiency of the different types of independent treatment systems is not available.

Figure 1: Evolution of the population connected to public sewage treatment plants in selected countries



Source: *Eurostat.*

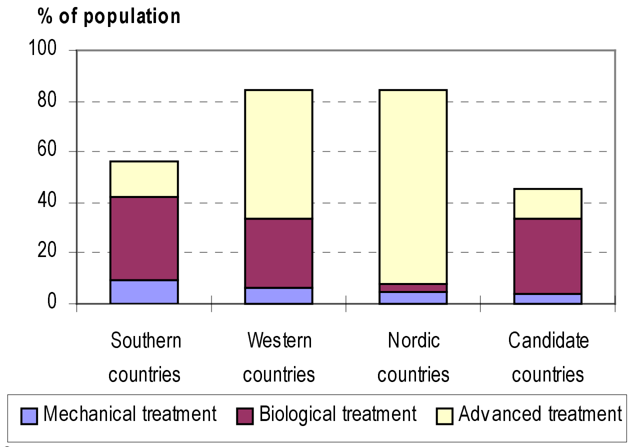
Over the past 15 years marked changes have occurred in the proportion of the population connected to waste water treatment as well as in waste water treatment technology (Figure 1). Most of the countries with the lowest connection rates in the early 1980s have seen great improvements: increases from 10 % to 56 % in Greece, from 28 % to 48 % in Spain, from 11 % to 58 % in Ireland, from 20 % to 46 % in Portugal and from 42 % to 73 % in Norway.

There has also been a striking improvement in the type of waste water treatment utilised, with much more of the population connected to either biological or advanced treatment in comparison with mechanical treatment. Especially noteworthy are the changes in Denmark and the Netherlands with a shift from biological (58 % and 74 **%** in 1985) to advanced treatment (84 % and 78 %) respectively.

In Candidate countries, advanced treatment is used in Estonia, Cyprus, Poland and to a lesser extent in Hungary.

The distribution of predominant types of treatment grouped by geographical areas shown in Figure 2 illustrates that the highest percentage of population connected to advanced treatment systems occurs in Nordic and Western countries whereas in Southern and Candidate countries biological treatment is predominant.

Figure 2: Geographical distribution of public waste water treatment



Source: *Eurostat.*

Waste water generated and discharged pollution: few data available

Waste water from point sources (fixed sources where emissions of pollutants can usually be quantified and checked before discharge into the environment) is mainly generated by the domestic sector (households and small businesses) and industry. It is discharged into the environment, either directly or after treatment. The impact of water pollutants on the environment depends on the quantity and physio-chemical characteristics of pollutants discharged, and on the sensitivity of the receiving waters.

Table 2 presents data provided by some countries on waste water generated by manufacturing industry and by the domestic sector on a per capita basis. Although the scarcity of statistics means no precise conclusions can be drawn, the existing data reveal a high level of waste water generated by manufacturing industry in Sweden, Finland and Norway whereas the Netherlands, Austria and the Slovak Republic have the highest level of waste water generated by domestic sector in the countries shown.

Table 3 shows the data available on waste water generated by manufacturing industries for some countries. **Manufacturing industry uses large quantities of water for cooling purposes**. Process water as well as cooling water are included. Part of this water is delivered to public waste water treatment plants but the major part is treated by the industry itself.

The generation of waste water is determined largely by the structure of a country's industry. In the EU countries for which data is available, it is the 'Chemicals and refined petroleum' industry which generate most of the waste water: 57 % in Germany and 20 % in the Netherlands. The 'paper and paper products' industry leads waste water generation in Finland (79 %) and Sweden (43 %). In Norway and Candidate countries the largest percentage of waste water is generated by the 'chemicals and refined petroleum' industry.

Table 2: Waste water generated

(m ^{3} / capita / year)

	Year	Manufacturing industry	Domestic sector
B	*1998*	88	:
D	*1995*	76	45
E	*1999*	:	58
L	*1999*	16	20
NL	*1990*	30	81
A	*1998*	:	77
P	*1998*	35	54
FIN	*1998*	128	:
S	*1995*	233	:
NO	*1999*	122	:
BG	*1998*	43	33
CZ	*1999*	:	59
PL	*1999*	14	28
RO	*1999*	8	:
SK	*1998*	60	94
SL	*1997*	47	33

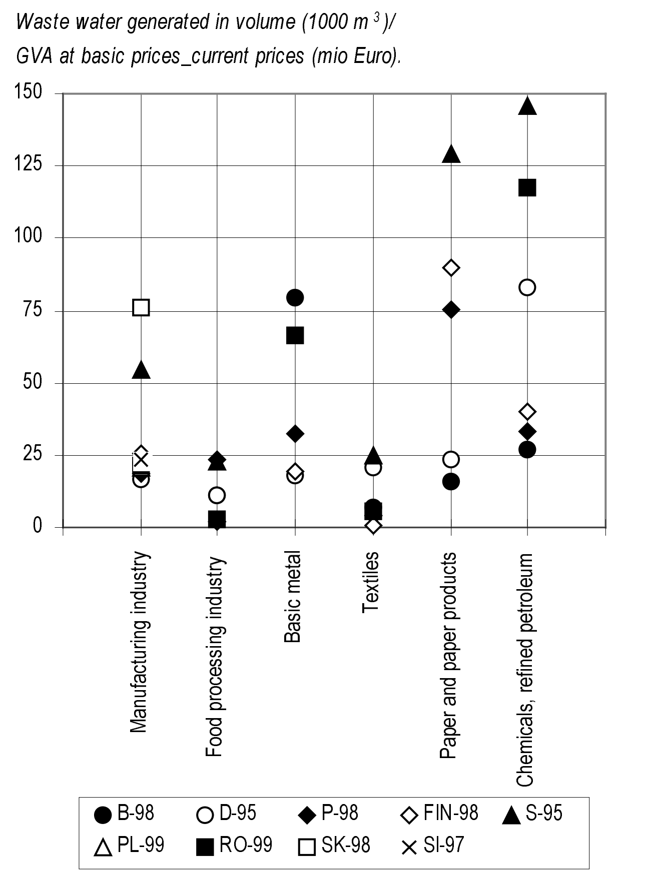
Source: *Eurostat.*

Table 3: Waste water generated by types of manufacturing industries in selected countries *(mio m ^{3} / year)*

Countries	B	D	NL	P	FIN	S	NO	BG	PL	RO	SK	SI
Year	1998	1995	1990	1998	1998	1995	1999	1998	1999	1999	1998	1997
Total manufacturing industry	896.6	6 224.0	447.5	326.9	658.1	2 054.6	540.2	355.1	560.3	496.8	321.0	92.5
of which:												
- food processing industry	60.8	394.9	:	66.3	4.0	70.1	3.1	37.7	39.1	22.6	8.9	8.0
- basic metal	477.9	897.9	8.0	39.0	53.3	:	152.2	95.0	198.6	155.9	28.4	25.2
- transport equipment	:	13.9	:	3.8	-	:	-	3.1	5.4	6.5	:	0.8
- textiles	15.9	198.9	16.4	13.9	0.4	11.3	0.9	13.0	43.8	11.6	1.6	5.7
- paper and paper products	52.0	670.9	16.4	126.2	521.6	882.9	1.4	30.5	89.8	:	39.0	23.8
- chemicals, refined petroleum	226.9	3 537.9	89.4	38.1	78.8	513.6	301.9	126.0	113.2	300.2	179.7	14.0

Source: *Eurostat.*

Figure 3: Waste water generated by unit of Gross Value Added



Source: *Eurostat*.

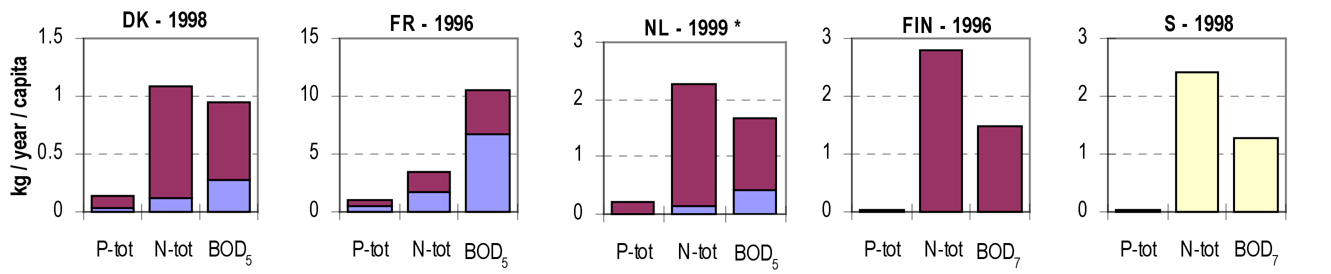
Another way to look at the amount of waste water generated by industry can be seen by calculating the ratio of waste water volume produced by a given economic activity to the Gross Value Added (GVA), an economic indicator that represents the wealth (the income to labour and capital) it generates. This is done in Figure 3 for manufacturing industry and for several of its component activities from data available in a few countries. The volumes of waste water include waste water for cooling purposes which in many cases represents an important part of total waste water. In Sweden, for instance, cooling water makes more than 90% of waste water for the activity chemicals and refined petroleum. Volumes of waste water generated cannot be directly linked to the amount of pollution generated in terms of nutrients, organic load, etc. The main environmental effect of cooling water is an increase in the temperature of receiving waters but can also affect the ecosystems.

The actual ratio calculated has to be interpreted with caution due to the fact that any methodological differences in the calculation of the parameter 'amounts of waste water' biases its value. It has the advantage nevertheless of creating 'similarity' among countries and activities that are intrinsically different.

Within the industries, the highest ratio is for 'chemicals and refined petroleum' (Sweden, Romania and Germany) with large differences between countries. A similar picture can be seen for 'paper & paper products', the second industry with large waste water generation (Sweden and Finland). The ratio for 'textiles' and for 'food processing industry' are smaller and more similar for all countries.

Whenever it is possible to create a time series for one country and one economic activity, the trend obtained will reflect clearly whether or not the environmental performance of this activity is improving.

Figure 4: Discharged pollution from public sewerage in selected countries



Note: NL: BOD refers to 1990.
Source: *Eurostat*.

Figure 4 shows the data available on discharges from public sewage treatment plants of nutrient (P-total and N-total) and organic matter for five EU countries. On a per capita basis, discharges of BOD, N and P are highest in France compared to the other four countries, due to the high level of untreated discharges.

Table 4 shows the average treatment efficiency of public waste water treatment plants for a few countries based on removed pollution for P-Tot, N-Tot and BOD. This is calculated as a percentage of the P-Tot, N-Tot and BOD content in discharges (effluents) of waste water in relation to the waste water influent content for the same pollutants. The best treatment efficiency appears for phosphorus and BOD.

Table 4: Efficiency of treatment plants

(%)

Countries	F	NL	FIN	S
Year	1996	1999	1996	1998
P-tot	40	78	93	98
N-tot	40	61	31	47
BOD	73	95	93	95

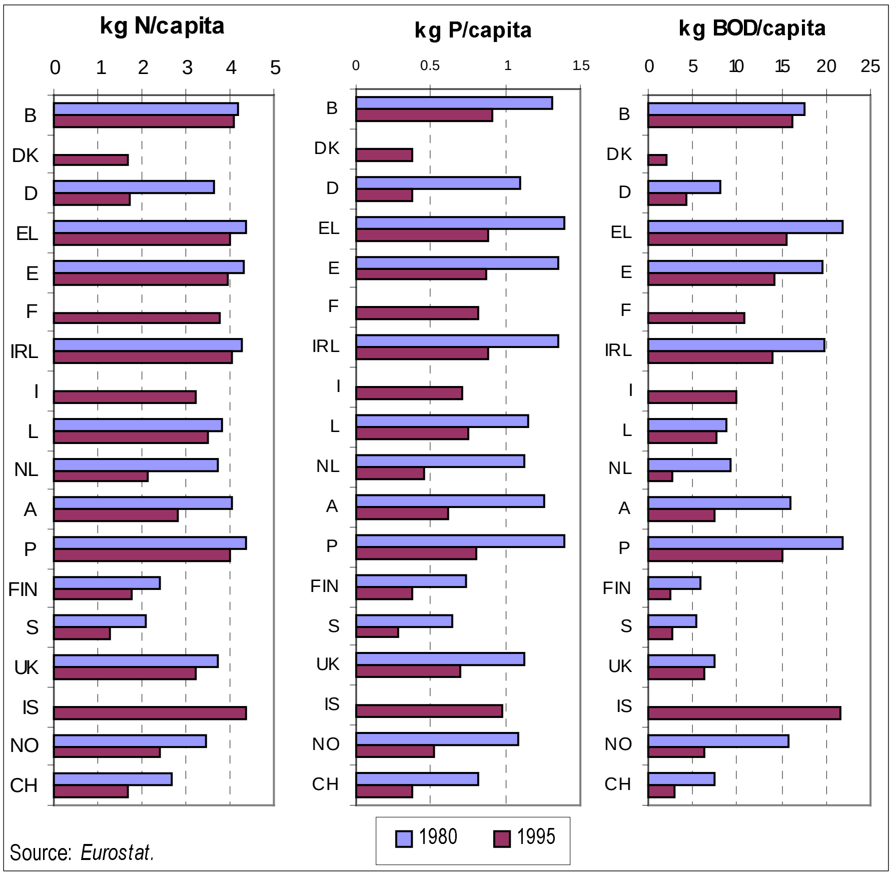
Notes: BOD refers to BOD_5 except for FIN and S (BOD_7).
NL: BOD refers to 1990.
Source: *Eurostat*.

Estimates on BOD, N and P emissions from households show a general trend downwards

Data on emissions are not yet produced regularly in all EU countries. The following indicators extracted from the publication '*Environmental pressure indicators for the EU*', combine official data with theoretical emissions coefficients to estimate nutrient (N and P) and organic matter (quantity of organic matter measured in terms of BOD) emissions from households to water, after treatment.

Phosphorus is one of the most significant parameters in the assessment of eutrophication, particularly in lakes and freshwaters. Nitrogen compounds can affect the water quality for drinking purposes (*nitrates*) and can be toxic to aquatic fauna (*ammonium)*.

Figure 5: Emissions from households, after treatment



Source: *Eurostat.*

During the 1980s estimated emissions from households ranged from 2 to 4.4 kg/capita for nitrogen, from 0.7 and 1.4 kg/capita for phosphorus and from 5.5 and 22 kg/capita for BOD.

Although the rates of improvement are not uniform between countries, by the mid-1990s, a slight reduction in N emissions and a significant reduction in P emissions (over 30 % in all the countries and 65 % in Germany) can be seen, a consequence of the increase in advanced treatment plants and of the reduced phosphate content of detergents. The countries with the highest reduction in nitrogen emissions are the Netherlands, Germany, Austria and Switzerland.

Organic matter emissions from households have also declined in many parts of Europe. The highest reductions occur in Norway, Finland, Sweden, Austria and Switzerland with a decrease of 50 % or more. Portugal and Spain have reduced their emissions by about 30 %, but the values still remain among the highest in the EU.

Agriculture takes up 32 % of sewage sludge produced in EU countries

Sludge is a residual product of waste water treatment plants composed of nitrogen-rich material decanted from waste water. Its composition varies substantially from one plant to another, depending on the type of treatment used and on the type of waste water.

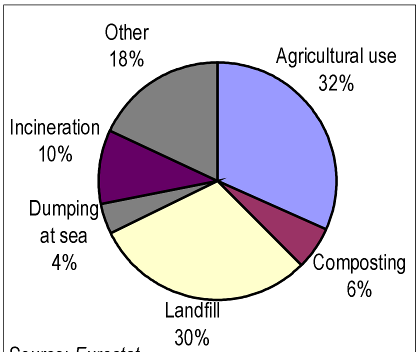
On average in the EU-15 about 8 Mio tonnes of sludge are produced and disposed of in different ways: 32 % in agriculture, 30 % sent to landfill and 10 % incinerated, with wide variations between countries. For Denmark, Germany, Luxembourg, and the United Kingdom, agriculture is the main disposal option. However, sewage sludge cannot be used for agricultural purposes if the content of certain heavy metals exceeds the limit values. In Candidate countries, 42 % of sewage sludge is disposed to landfill, and 35 % is used in agriculture.

Other sludge management options include incineration and composting. The category 'others' which include unknown disposal is an important part (18 %) of the total disposal in EU countries: Portugal (58%), Austria (31%), Finland (29%) and Italy (27%).

The Urban Waste Water Directive required that by December 1998 the disposal of sludge to surface waters by dumping from ships, by discharge from pipelines or by other means should be phased out. Three countries (United Kingdom-1998, Spain-1996 and Ireland-1995) make up the 4% of disposal by dumping at sea.

Figure 6: Sewage sludge disposal in EU

(Estimation based on latest available year)



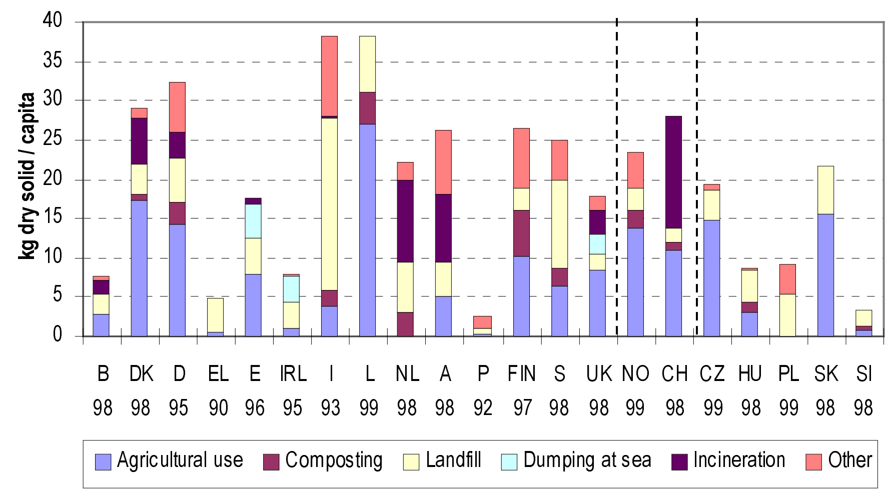
Source: *Eurostat.*

The production of sewage sludge varies between countries, in parallel with the percentage of population connected to sewage treatment plants.

In kg of dry solid per capita, Italy and Luxembourg have the highest per capita sludge production, followed by Germany and Denmark. Belgium, Spain, Ireland, and Portugal have the lowest sludge production per capita.

For most countries where data are available, the quantity of sludge produced per inhabitant has increased over the last 10 years due to the increase in waste water treatment plants.

Figure 7: Sewage sludge production and disposal, latest available year



Source: *Eurostat.*

Investment by industry for waste water treatment and prevention

Industry invests on waste water treatment in order to reduce pollution and to take care of the wastewater generated. Table 5 shows the amount of investment in waste water management by different economic activities.

Investment by industry in waste water treatment and prevention included here refers also to ground water and soil protection activities except for Germany, France, the Netherlands and Portugal where a separate identification of this item is possible. However waste water represents the dominant part of the amounts shown in this table for all countries. It should be noted that investments are subject to large fluctuations over the years and long time series are not yet available.

In **EU countries, manufacturing industry** accounts for more than 90% of total investments in waste water with the exception of France (65%) and Greece (15%) where a significant part of the investments are in the 'Energy & water' industry. Within manufacturing industry, the largest investments are shared by the 'Chemicals, rubber & plastic' industry, the 'Food products' industry, the 'Coke & refined petroleum' industry and the 'Pulp, paper and publishing' industry. Some exceptions are the 'Textiles & leather products' industry in Portugal and Greece (first and third position respectively), and the 'Fabricated metal products' in Belgium, Austria and United Kingdom (first and second position respectively).

In **Candidate countries**, 5 countries out of 9, Estonia, Hungary, Latvia, Lithuania and Slovenia invest mainly in 'manufacturing industries', the rest spending mostly in the 'Energy & water' industry.

As for manufacturing industries, the investments in Candidate countries are mainly placed in the industries: 'coke and refined petroleum', 'Chemicals, rubber & plastic', 'Food products' and 'Fabricated metal products'. Some exceptions are Slovenia with 15% of the investments in the 'textiles & leather products' industry and Latvia where data is only available for the 'Wood and wood products' industry and the 'Other non-metalic mineral products' industry.

Table 5: Investment by industry in waste water management

(mio ECU)

Countries	B	D	EL	F	NL	A	P	FIN	UK	BG	CZ	EE	HU	LV	LT	PL	RO	SI
Year	1996	1995	1996	1994	1997	1998	1999	1998	1997	1998	1999	1999	1999	1998	1998	1999	1998	1998
Mining and quarrying	0.37	22.02	0.03	3.91	2.80	2.53	1.66	2.61	17.33	8.66	4.36	0.03	4.81	:	:	11.33	8.35	:
Food Products	19.67	124.33	8.59	59.55	22.30	17.21	8.74	10.01	67.89	0.26	2.20	0.47	10.05	-	0.13	15.34	0.27	0.15
Textiles & leather products	2.98	13.46	2.36	6.36	2.85	2.85	11.76	0.53	2.89	0.62	2.58	0.04	0.49	-	0.13	5.15	0.02	0.44
Wood and wood products	0.94	9.71	0.38	0.39	-	1.34	1.38	1.79	1.44	0.00	0.03	0.13	0.04	1.97	0.00	2.14	0.00	0.01
Pulp, paper and publishing	4.40	46.16	0.17	12.49	6.47	10.55	7.76	48.40	37.56	0.02	4.23	0.01	0.45	:	0.04	6.79	0.05	0.04
Coke, refined petroleum	3.13	103.92	0.82	11.31	22.44	-	1.82	5.17	7.22	1.68	7.56	0.08	20.59	:	0.47	19.64	4.91	-
Chemicals, rubber & plastic	33.16	189.98	3.53	56.03	33.25	10.89	2.81	0.61	309.11	0.44	12.20	0.13	7.70	-	0.44	15.41	4.04	0.62
Non-metalic mineral products	2.60	21.53	0.48	3.56	2.17	6.05	5.63	0.38	14.44	0.01	1.22	0.08	0.47	1.82	0.02	1.83	0.26	0.10
Basic metals	11.60	59.48	0.13	7.52	1.81	6.13	1.19	4.80	50.56	0.71	2.36	-	1.11	:	0.00	4.37	1.49	0.01
Fabricated metal products	34.23	25.75	0.06	5.53	2.53	15.33	4.11	15.04	36.11	0.17	6.91	0.23	2.63	-	0.28	5.51	2.10	1.61
Machinery and equipment	2.98	120.89	0.13	17.86	4.52	1.16	0.55	0.02	-	0.00	0.14	0.02	0.07	:	0.00	0.38	0.10	0.01
Energy and water	10.88	:	96.29	91.48	0.769	1.59	3.2	0.69	10.11	14.7	46.9	0.65	17.1	0.3	0.32	91.34	76.2	0.93
Total	126.92	737.22	113.00	275.96	101.91	75.62	50.61	90.06	554.67	27.29	90.71	1.86	65.48	4.09	1.84	179.23	97.84	3.91

Notes: D and F: source Eurostat (SERIEE) questionnaire. Other countries: source joint Eurostat and OECD questionnaire.
Domain: water & soil for all countries except D, F, NL and P.

Source: *Eurostat.*

➢ ESSENTIAL INFORMATION – METHODOLOGICAL NOTES

Most of the data used in this *Statistics in focus* is from the Joint OECD/Eurostat questionnaire except for Turkey (source: OECD Compendium 1999). The definitions used are based on the UNECE standard classification of water use (CES/636) and systems of water statistics in the ECE Region (ECE/water/43).

The definition of the parameters used in this *Statistics in focus* are given below:

Waste water: water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, waste water from one user can be a potential supply to a user elsewhere.

Waste water treatment: a process to render waste water fit to meet applicable environmental standards or other quality norms for recycling or reuse. Three broad types of treatment are distinguished: mechanical, biological and advanced.

Mechanical treatment: processes of a physical and mechanical nature, which result in decanted effluents and separate sludge. Mechanical processes are also used in combination and/or in conjunction with biological and advanced unit operations. Mechanical treatment is understood to include at least such processes as sedimentation, flotation, etc.

Biological treatment: processes which employ aerobic or anaerobic micro-organisms and result in decanted effluents and separated sludge containing microbial mass together with pollutants. Biological treatment processes are also used in combination and/or in conjunction with mechanical and advanced unit operations.

Advanced treatment: process capable of reducing specific constituents in waste water or sludge not normally achieved by other treatment options. Advanced treatment covers all unit operations, which are not considered to be mechanical or biological. This includes e.g. chemical coagulation, flocculation and precipitation, break-point chlorination, stripping, mixed media filtration, micro-screening, selective ion exchange, activated carbon adsorption, reverse osmosis, ultra-filtration, electro-flotation. Advanced treatment processes are also used in combination and / or in conjunction with mechanical and biological unit operations.

Waste water treatment plant: installation to render waste water, sludge, storm water or cooling water fit to meet applicable environmental standards or other quality norms for recycling or reuse.

Public sewerage: sewerage networks for the evacuation of domestic and other waste water, operated by governmental, federal or local authorities, by communities, water authorities or sewage/waste water collection, discharge and treatment associations. This does not necessarily include waste water treatment.

Non-public sewerage (or independent sewerage): individual private facilities installed to evacuate domestic and other waste water in cases where a public sewerage network is not available.

Public sewage treatment: all treatment of sewage in municipal sewage treatment plants (MSTP) by public authorities or by private companies (on behalf of local authorities), whose main purpose is sewage treatment.

Industrial waste water: water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process waste water is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process waste water is understood to be subjected to ex-process in-plant treatment.

Independent treatment: individual private treatment facilities to treat domestic and other waste water in cases where a public sewerage network is not available. Examples of such systems are septic tanks.

Sewage sludge: the accumulated settled solids separated from various types of water either moist or mixed with a liquid component as a result of natural or artificial processes.

For the section on 'Emissions estimates' the data are taken from the publication *'Environmental Pressure Indicators for the EU*, Data 1985-98*'*.

Nutrient (N and P) and organic matter emissions from households are estimated by means of data on population connected to treatment plants, emission factors and the theoretical efficiency of the treatment plants.

BOD_5 / BOD_7: refers to the dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water measured for a period of five or seven days.

Total Phosphorus (P-Total) is made up of ortho-phosphates, polyphosphates and organically bound phosphates.

Total Nitrogen (**N-Total**) is the sum of Kjeldahl nitrogen (organic N plus ammonia (NH_3)), nitrate-nitrogen (NO_3) and nitrite-nitrogen (NO_2).

For the purpose of this publication, some groupings have been made as follows:

Nordic countries: Denmark, Finland, Sweden, Iceland, and Norway

Southern countries: Greece, Italy, France, Portugal, and Spain

Western countries: Belgium, Germany, Ireland, Luxembourg, Austria, the Netherlands, Switzerland, and United Kingdom

Candidate countries: Bulgaria, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, Estonia, Latvia, Lithuania, Cyprus, and Turkey

Further information:

➢ **Databases**

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