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Industrial Water Demand in the Netherlands

Some forecasts and a few factors which affect industrial water consumption.

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Summery

Industrial water consumption in the Netherlands amounts to about 4,000 million cubic metres per annum. Many industrial plants are sited in places where there is little or no fresh groundwater. There are also many problems associated with supplies from surface-water sources because of the pollution of the Rhine. Research on industrial water consumption and the factors which affect it began in 1974. The results of the research and the forecasts for water demand, made with the aid of economic growth predictions, are summarised in chapter 2. Chapter 3 discusses the changes in economic activity and legislation which, the research shows, have affected industrial water consumption.

Resumen:

En nuestro país el consumo de agua por la industria asciende a unos 4 mil millones de m^3. Una gran parte de la industria se encuentra establecida en lugares donde no hay o escasean las aguas dulces freáticas. Debido a la contaminación del Rin, el suministro de agua de la superficie implica también serios problemas. Desde 1974 se tiene en estudio el consumo de agua por la industria y los factores que en él influyen. El capítulo 2 recoge los resultados de dicho estudio y los pronósticos hasta ahora hechos partiendo de las predicciones sobre el desarrollo económico.
En el capítulo 3 se examinan los cambios operados en la actividad económica y legislación que, según las prospecciones, han repercutido en el consumo de agua por la industria.

Résumé:

Aux Pays-Bas, l'industrie consomme environ 4 milliards de m^3 d'eau. Une grande partie de l'industrie est établie dans des régions où il n'y a pas, ou guère, d'eaux souterraines. L'approvisionnement en eau de surface est également difficile en raison de la pollution du Rhin.
Depuis 1974, la consommation d'eau par l'industrie et les facteurs qui l'influencent ont été étudiés. Les résultats de cette étude et les prévisions qui été établies à l'aide des prévisions de croissance économique sont résumés au chapitre 2.
Le chapitre 3 expose les modifications de l'activité et de la législation économiques qui semblent avoir influencé la consommation d'eau par l'industrie.

1. Water supplies in the Netherlands

In the Netherlands as in other West-European countries industrial development has played an important role throughout the century, changing the country from an agricultural to an industrial one. Dutch industry is concentrated around the ports of Rotterdam and Amsterdam in the west of the country because of the good communications they provide. There is an agglomeration of oil refineries and chemical industries at the "Europoort", in the immediate vicinity of Rotterdam. As Fig. 1 shows, it is in those very areas in the western Netherlands with the greatest concentrations of industry and the highest population density that fresh groundwater is scarce or non-existent.

The Rhine could be an ideal source of fresh water, as it is both rain-fed and glacial and has a fairly regular flow determined by rainfall and evaporation and the amount of snow in its basin. The Rhine's rate of flow at the Netherlands border, averaged over many years, is about 2,200 m^3/sec, the lowest recorded rate being 620 m^3/sec. Unfortunately industrial development has turned the Rhine into the sewer of Western Europe. The contents of the 80 x $10^9 m^3$ of Rhine water which flowed into the Netherlands in 1979 contained, amongst other substances, 13 x 10^6 tonnes chloride, 156 x 10^3 tonnes phosphate, 80 tonnes cadmium, 6 x 10^6 tonnes sulphate, 960 tonnes chromium, 24 tonnes mercury, 27 x 10^3 tonnes nitrite, 1200 tonnes copper, 1200 tonnes lead, 1 x 10^6 tonnes nitrate and 7200 tonnes zinc.

Amsterdam and the coastal province to the north of the city use Rhine water as the raw material for their domestic water supply. However, before it is fit for human consumption, it has to undergo a lengthy and expensive purification process. Artificial infiltation into the dunes along the coast plays an important role in this process.

In 1974 and 1976 respectively the cities of Rotterdam and The Hague turned from the Rhine to the better quality Maas water for their supplies. The Maas, however, is a pluvial river and its volume therefore depends on the rainfall in the river basin. The rate of flow at the Dutch border averaged over many years is about 260 m^3/sec dropping to a minimum daily rate of only a few cubic metres per second.

The fluctuating level of the Maas and the need to bridge periods in which disaster makes Maas water temporarily unuseable, made it necessary to construct reservoirs. The dunes are used for water-storage for The Hague, as for Amsterdam, and three reservoirs have been built in the Biesbos to supply the extensive industrial estates of Rotterdam. They are situated about 25 km to the south of the city and have a total capacity of 81 x 10^6 m^3, which, given a bridging period of four months, can supply a draft of 250 million m^3 per year.

Water is supplied in the Netherlands by some 100 water works which together produced 1,053 x 10^6 m^3 in 1979; 688 x 10^6 m^3 from fresh groundwater, 144 x 10^6 m^3 from surface water infiltration and 221 x 10^6 m^3 direct from surface waters.

In areas where there is insufficient fresh water of a reasonable quality, a limited amount of brackish surface water and sea water is ditilled. Two of the three plants (Fig. 1) make use of waste heat from power stations while the other uses waste heat from a refuse incineration plant. A total of 14.2 x 10^6 m^3 of distilled water was produced in 1979, of which 0.7 x 10^6 m^3 was added to the fresh water supplies for potable water production; the rest was supplied direct to industry as feed water for boilers.
In addition, 41 x $10^6 m^3$ of water was supplied to industry as a semi-finished product: surface water which has undergone a preliminary purification and which is otherwise further purified for potable water.

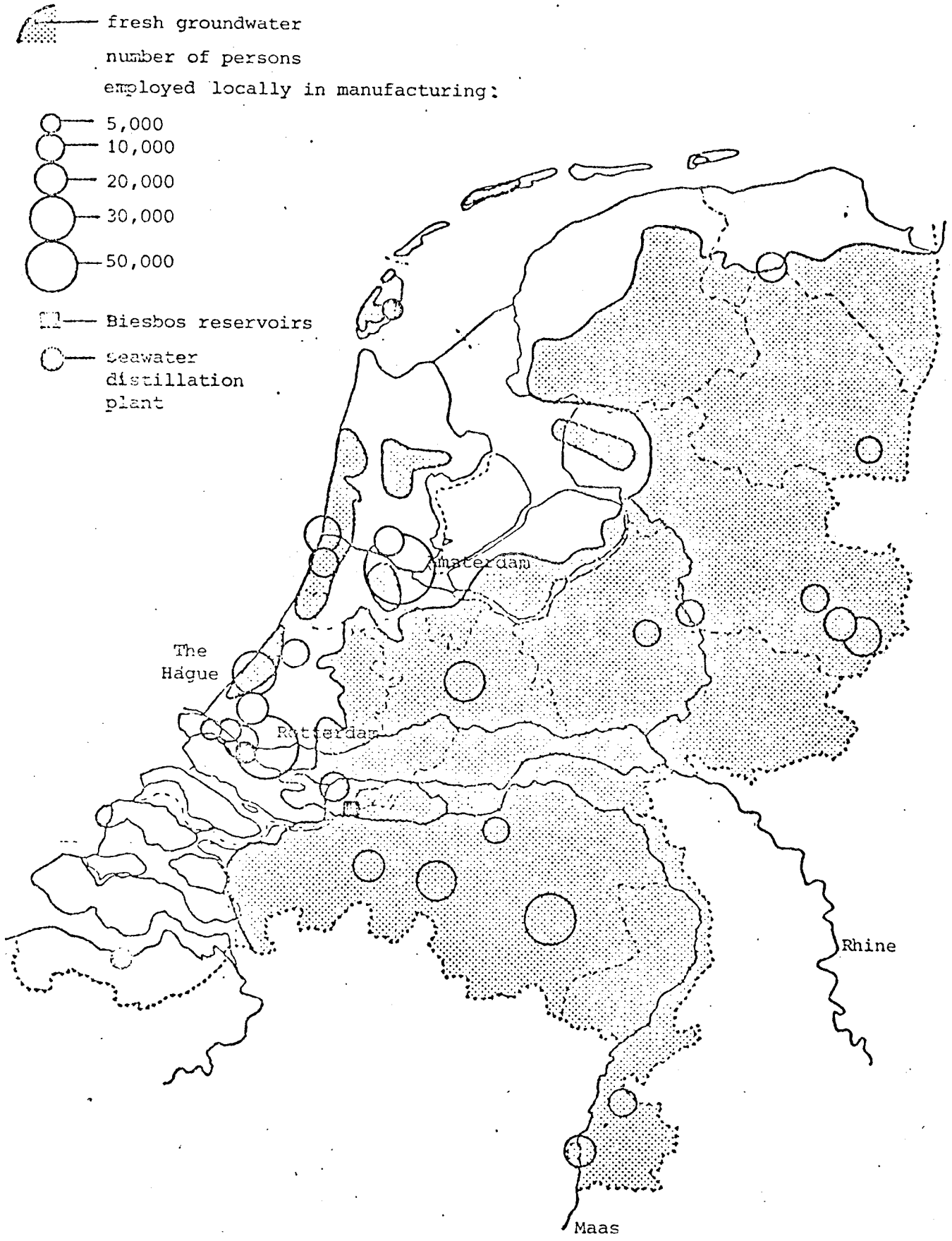

fresh groundwater
number of persons
employed locally in manufacturing:
5,000
10,000
20,000
30,000
50,000
Biesbos reservoirs
seawater
distillation
plant
Amsterdam
The
Hague
Rotterdam
Rhine
Maas

Fig.1

Only rough figures are available on the distribution of potable water consumption over industry, households and all other users since 1976. Precise data on industrial consumption is obtained every five years from a national survey on industrial water consumption carried out by the Central Bureau of Statistics. Table 1 summerises the latest available figures which date from 1976.

Table 1 Industrial water consumption in 1976
(quantities in 10^6 m^3)

	total	amount of total used for cooling
Public water supply	200.4	54.2
including: potable water	149.6	
distilled water	8.6	
partially purified water	42.2	
Own supply	3701.7	3428.3
including: fresh groundwater (<300 mg/l Cl^-)	354.9	173.8
salt groundwater (>300 mg/l Cl^-)	78.5	78.5
surface water (excluding sea water)	3268.3	3176.0
Total water consumption	3902.1	3482.5

About 72% of the total amount of water used was consumed in the two western provinces where industry is most concentrated. Because of its limited availability in these provinces, fresh groundwater constituted only about 5% of the national figure.

2. Forecasts for industrial water demand

A study of industrial water consumption was begun in 1974 with the cooperation of Dutch industry. By means of sample surveys at a few firms in a particular branch, or written questionnaires for a whole branch of industry, a correlation was sought between water consumption and a factor determining production. In many cases this factor was the tangible output of a firm or the quantity of raw materials processed. It was concluded that the level of specific water consumption (= consumption per unit of output or raw material) has dropped considerably in the past few years. The amount varies according to the branch of industry, and very large deviations can be observed within a single branch. A national scenario for the development of specific water demand was made on the basis of the data for each branch of industry and additional figures from the Central Bureau of Statistics. In order to combine the figures, it was necessary to convert the forecast for water demand in each branch to water demand per unit of gross added value in 1970 prices.

The study disregarded the quantities of surface water used for industrial cooling purposes, because these abstractions do not affect the scope of present or future infrastructural works of the water works. The study devoted much attention to the expectations within each branch with regard to specific water demand in the future. Table 2 summarises the results of the study; figures are given for specific water consumption in the past and the expectations for each branch up to the year 2000.

Table 3 shows production by Dutch industry in guilders in gross added value and in fixed prices (1970). The forecasts are based on studies conducted by the Central Bureau of Statistics, the Ministry of Economic Affairs and the Advisory Council on Government Policy. There are two possible scenarios according to the last forecast; one based on continuous economic growth and a satisfactory level of employment and a second one based on stunted economic growth and a growing awareness that nature and the environment must not be subject to any further harm. A forecast for the water demand for the various branches of industry and for industry as a whole is obtained by multiplying the figures for specific water demand (Table 2) by those for production (Table 3). This forecast is set in Table 4.

Table 2 Specific water demand of Dutch industry in m^3 per 1,000 guilders added value

Branches of industry	industrial classification	specific water demand 1957	1962	1967	1972	1976	1980	1985	1990	2000
Food, beverages and meat processing,	20/21	70.7	67.6	60.2	47.3	32.3	22.9	19.8	17.3	14.6
including: animal products	201/203	.	.	94.2	91.8	63.5	41.5	35.0	29.1	23.2
other food products	204/213	.	.	53.4	35.7	23.9	18.0	15.7	14.3	12.6
drink and tobacco	214/217	.	.	28.4	19.6	14.0	11.0	10.1	9.2	8.4
Textile and clothing (excluding footwear)	22/23	.	.	36.8	16.0	15.6 } 17.7	15.6 } 21.5	16.4 } 23.3	16.7 } 24.2	16.7 } 26.6
Footwear and other leather products excluding clothing; rubber and plastic products	24,31	.	.	19.6	12.0	21.4	31.2	34.6	36.6	38.6
Paper, paper products, printing, publishing and allied industries	26/27	69.4	60.2	48.8	34.8	30.6	22.5	17.5	12.8	7.9
Chemical industries, man-made and synthetic fibres (except glass)	29/30	.	.	43.2	37.0	25.8	19.2	16.1	15.0	13.5
Petroleum industry	28	.	.	49.9	39.9	31.8	21.5	30.3	29.1	27.2
Metal Industries	33	23.5	24.5	21.3	27.6	32.8	29.6	29.9	29.9	30.2
Manufacture metal products excluding machinery; transport equipment, mechanical engineering, electrical engineering	34/36	.	.	13.3	8.1	5.4 } 5.5	} 5.3	} 5.1	} 4.9	4.7
Other manufacturing industries	25,32 37/39	.	.	7.9	6.4	5.8				
Total manufacturing industry excluding construction	2/3	39.4	34.6	30.4	23.1	18.1	14.7	13.0	12.0	10.8
Mining and quarrying	1	63.3	59.9	80.4	38.3	45.9	37.9	39.9	41.0	41.6
Total excluding natural gas	1/3	41.1	36.2	32.3	23.4	18.4	14.9	13.2	12.2	11.0

Table 3 Production forecast for Dutch industry in 10^6 guilders added value (1970 prices) figures up to 1976 based on data from the Central Bureau of Statistics (CBS)

Branches of industry	industrial classification	(CBS) 1957	1962	1967	1972	1976	optimistic forecast 1980	1985	1990	2000	pessimistic forecast 1980	1985	1990	2000
Food, beverages and meat processing,	20/21	2829	3551	4362	5301	6211	6749	7490			6749			
including: animal products	201/203	752	976	1161	1398	1622	1791	2026			1791			
other food products	204/213	1695	2084	2501	2974	3307	3538	3849			3538			
drink en tabacco	214/217	382	491	700	1009	1282	1420	1615			1420			
Textile and clothing (excluding footwear)	22/23	.	.	1765	1860	1381								
Footwear and other leather products excluding clothing: rubber and plastic products	24, 31	.	.	811	864	838	2369	2579			2369			
Paper, paper products, printing, publishing and allied industries	26/27	1124	1610	2121	2606	2690	3087	3667			3087			
Chemical industries, man-made and synthetic fibres (except glass)	29/30	.	.	2466	4659	5755	8035	12193			8035			
Petroleum industries	28	276	368	438	813	785	950	1207			950			
Metal industries	33	426	694	1105	1830	1728	1983	2355			1983			
Manufacture metal products excluding machinery: transport equipment, mechanical engineering, electrical engineering	34/36	.	.	6442	9054	10273								
Other manufacturing industries	25, 32 37/39	.	.	3975	5140	5070	18752	24254			18752			
Total manufacturing industry excluding construction	2/3	13071	18395	23521	32266	35281	41925	53745			41925			
Mining and quarrying	1	1106	1235	850	520	220	270	300			270			
Total excluding natural gas	1/3	14977	19630	24371	32766	35501	42195	54045	64070	94270	42195	48100	54400	63900

Table 4 Forecast water demand Dutch industry

Branches of industry	industrial classification	water demand in 10^6 m^3 1957	1962	1967	1972[2]	1976[2]	optimistic forecast 1980	1985	1990	2000	2010	pessimistic forecast 1980	1985	1990	2000	2010
Food, beverages and meat processing,	20/21	200[1]	240[1]	262.8	254.4	200.8	154.6	148.3				154.6				
including: animal products	201/203	.	.	109	128	103	75	71				75				
other food products	204/213	.	.	134	106	79	64	61				64				
drink en tobacco	214/217	.	.	20	20	18	16	16				16				
Textile and clothing (excluding footwear)	22/23	70[1]	70[1]	64.9	29.8	21.6	50.9	60.1				50.9				
Footwear and other leather products excluding clothing; rubber and plastic products	24,31	15[1]	11[1]	15.9	10.4	17.9										
Paper, paper products, printing, publishing and allied industries	26/27	78[1]	97[1]	103.4	90.7	82.4	69.5	64.2				69.2				
Chemical industries, man-made and synthetic fibres (except glass)	29/30	.	.	106.6	172.2	148.7	154.3	196.3				154.3				
Petroleum industry	28	.	.	21.9	32.5	25.0	30.9	36.6				30.9				
Metal industries	33	10[1]	17[1]	23.5	50.5	56.7	58.7	70.4				58.7				
Manufacture metal products excluding machinery; transport equipment, mechanical engineering, electrical engineering	34/36	40[1]	55[1]	85.5	73.3	55.3	99.4	123.7				99.4				
Other manufacturing industries	25,32 37/39	.	.	31.5	33.1	29.4										
Total manufacturing industry excluding construction	2/3	546.1	637.1	716.0	746.8	637.8	618.3	699.6				618.3				
Mining and quarrying	1	70[1]	74[1]	68.4	20.0	10.1	10.2	12.0				10.2				
Total excluding natural gas	1/3	616.1	711.1	784.4	766.8	647.9	628.5	711.6	781.7	1037.0	1290	628.5	634.9	663.7	702.9	742

. no figures available

1) estimated figure

2) adjusted CBS-figures

3. Factors affecting industrial water consumption

a. Economic activity.

The production forecast in chapter 2 was based on economic expectations from 1975. At that time 4.4% annual growth was expected in total industrial production between 1976 and 1980. For the 1980 to 1985 period 5% annual growth was predicted in the optimistic forecast and 2.7% annual growth in the pessimistic one. The predictions were wrong; we now know that the average annual growth for industry from 1976 to 1978 was 1.1%. In 1979 it was 3.1% and in 1980 0.6%. The present forecast for annual growth between 1980 and 1985 is about 1.5%. Fig. 2 shows how this will be reflected in production figures of industry and mining. materials.

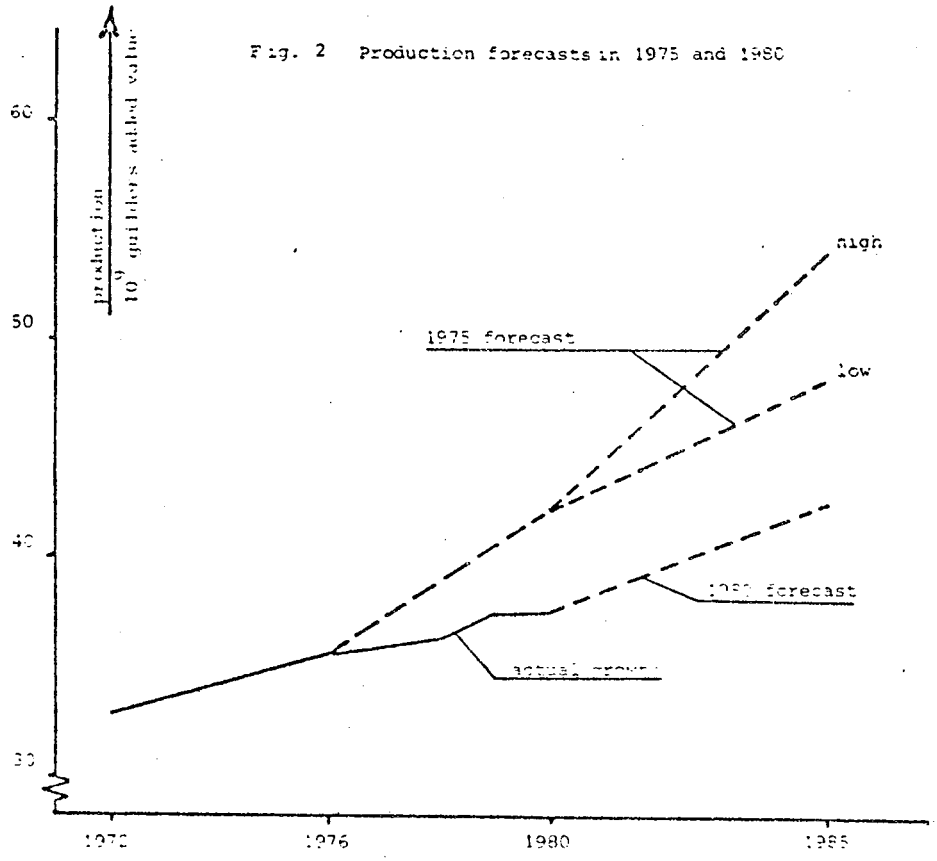


Fig. 2 Production forecasts in 1975 and 1980

What effect this will have on industrial water consumption is not yet known. Detailed figures on industrial water consumption will not be published until 1982 when the Central Bureau of Statistics will have processed the results of its 1981 survey.

Differences arise in economic growth and growth in the demand for water as a result of differences in the specific water demand of the various branches of industry and the uneven distribution of the growth in production in the various branches of industry.

Rough estimates for 1979 showed that the 2% growth in the economy could mean a growth of about 3.8% in industrial water demand because the branches of industry which require large amounts of water were expanding faster than branches with low specific water requirements.

Figures are now available for total water consumption* in the Netherlands, i.e. industrial water consumption plus domestic, commercial, government, agricultural and recreational requirements. Figure 3 shows the 1975 forecast for total water demand against actual consumption up to 1979. Actual consumption has been extrapolated on the basis of current data on water demand and an economic growth of about 1.5% per year, to show that water consumption will be considerably lower in 1985 than was forecast in 1975. The difference in the forecasts is largely due to economic stagnation.

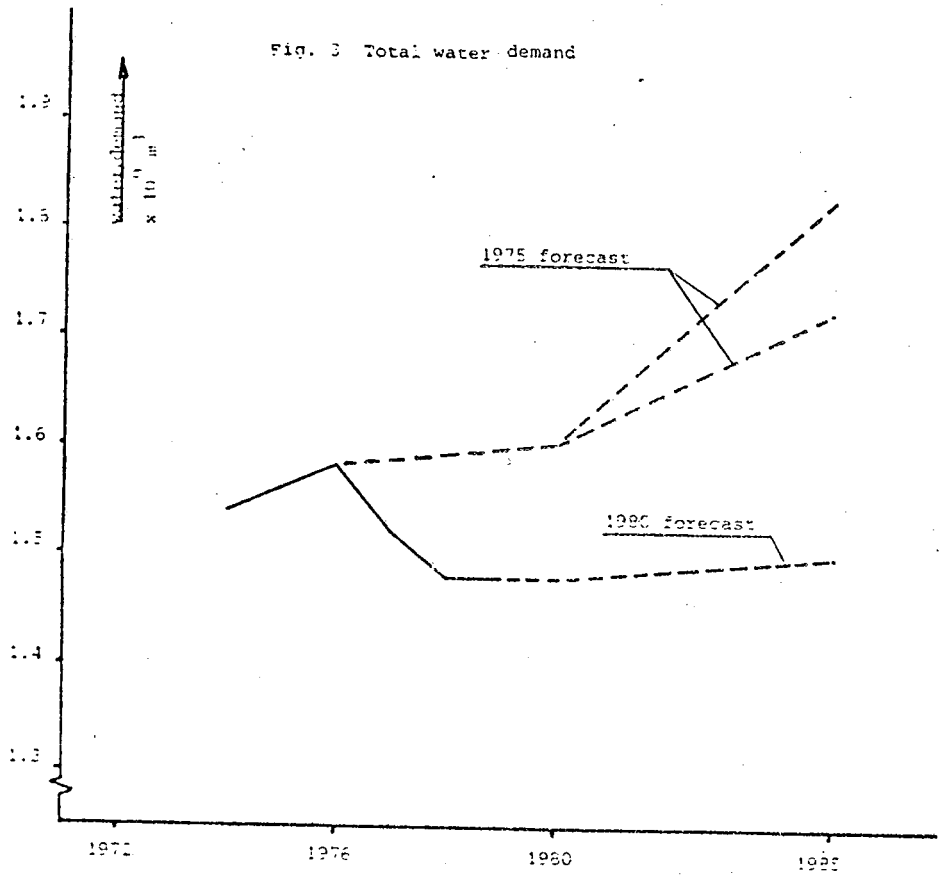


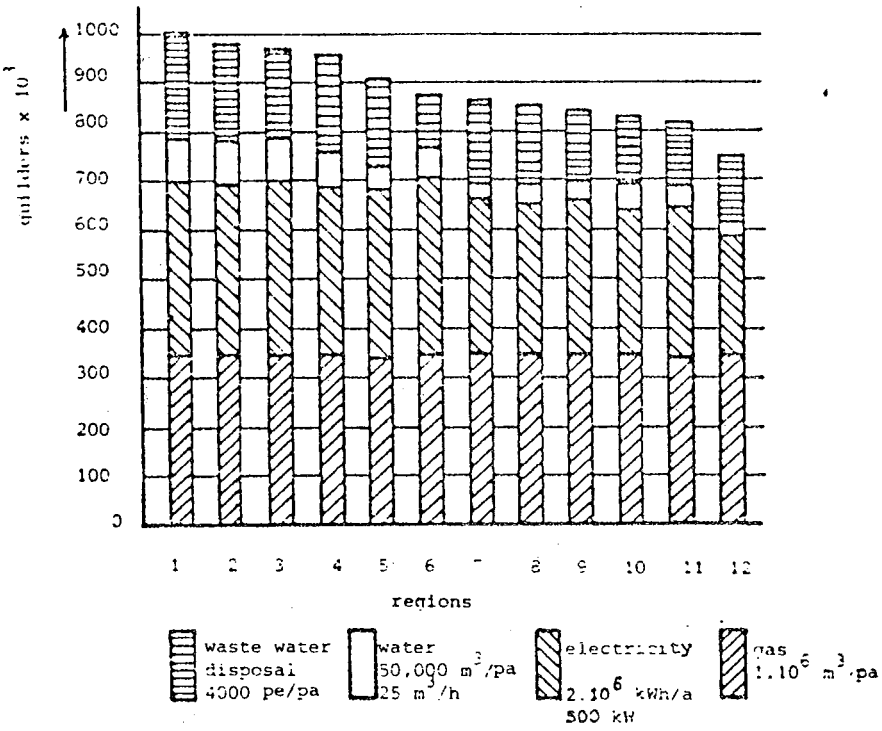
Fig. 3 Total water demand

b. The Pollution of Surface Waters Act

Under the Pollution of Surface Waters Act, which came into force in 1970, levies can be imposed on the principle that "the polluter pays". The levies are linked primarily to the degree of pollution, expressed in polpulation equivalents (p.e.) but the volume correction is also very important as surcharges can be imposed or reductions granted according to the volume of waste discharged.

* fresh water excluding surface water for cooling purposes.

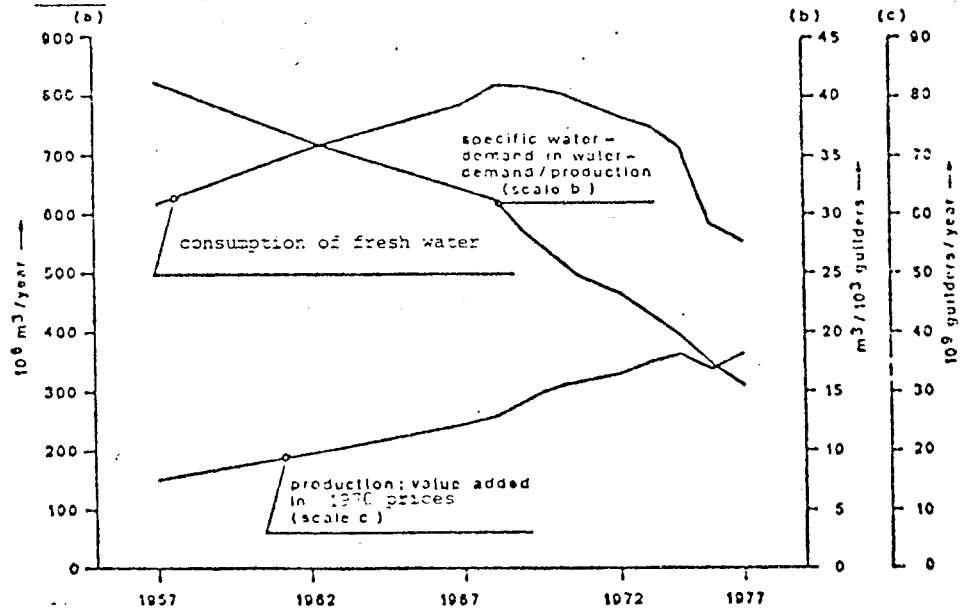
fig. 4 Energy en wat[illegible]ost



These levies meant a considerable rise in costs for industry. Figure 4 shows the costs that have to be met in 12 regions in the Netherlands by an average firm, requiring 2 x 10^6 kWh of electricity, 1 x 10^6 m^3 of natural gas and 50,000 m^3 of water annually, discharging waste water with a degree of pollution of 4,000 p.e. It is clear from this figure that the cost of water alone is of little significance but that the cost of water combined with waste water levies as gas and electicity charges are high enough to make the firms concerned aim to reduce these overheads.

Efforts by firms to limit costs by discharging as little waste as possible or by purifying the waste water themselves resulted in a reorganisation of all aspects of industrial water management. This produced an automatic reduction in consumption, as shown in Figure 5.

fig. 5 Average specific water demand



It is difficult to produce scientific proof of the connection between the levies and reduced consumption. Specific water demand did decrease more sharply after 1970 than before but there is only circumstantial evidence as to whether the decrease was due solely to the Pollution of Surface Waters Act or whether other factors were involved.

It is a fact, however, that when interviewed, managerial staff in industrial concerns have always cited the Act as the major reason for economising as much as possible on water consumption.

c. Legislation governing the use of groundwater.

Groundwater management is at present regulated by:

1) the Water Supply Undertakings (Groundwater) Act which governs the abstraction of groundwater for the public drinking water supply;
2) the Provincial Ordinances which govern the abstraction of groundwater for all other purposes.

At present a Groundwater Bill is under discussion in Parliament. It will replace the legislation referred to above and will govern the abstraction of groundwater for all purposes.

The present Provincial Ordinances contain regulations on the registration of groundwater abstractions and the issuing of licences. Compulsory registration was introduced in the various provinces between 1966 and 1974 and in general applies to abstractions of more than 10^3 m^3/hr, though some provinces register all abstractions. Licences became compulsory between 1966 and 1977 and, depending on the province, were required for abstractions exceeding 2 to 30 m^3/hr with a total abstraction of over 200 to 20,000 $m^3/month$.

There are seperate regulations for well-pointing, test pumping and sprinkling in the agricultural sector. Licence and registration regulations may vary from province to province, as the local availability of groundwater is taken into account. Conditions may be attached to licences, for instance in cases where abstractions by water works would suffer or where industrial abstractions could cause environmental or agricultural damage. The abstraction registers are open to the public.

It is also difficult to demonstrate a direct link between the reduction in the amount of groundwater abstracted by industry and compulsory registration and licensing. However, investigations into industrial water demand have shown that compulsory licensing has contributed to a reduction in industrial groundwater demand while industrial activity has increased.

Figure 6 shows the total registered amount of groundwater. In 1974 the last two of the twelve provinces introduced compulsory registration and since then the total amount of groundwater abstracted per concern has decreased. Remarkably, this is largely due to the decrease in the amount of groundwater abstracted for cooling purposes.

Fig.6[a] Total volume of abstracted groundwater

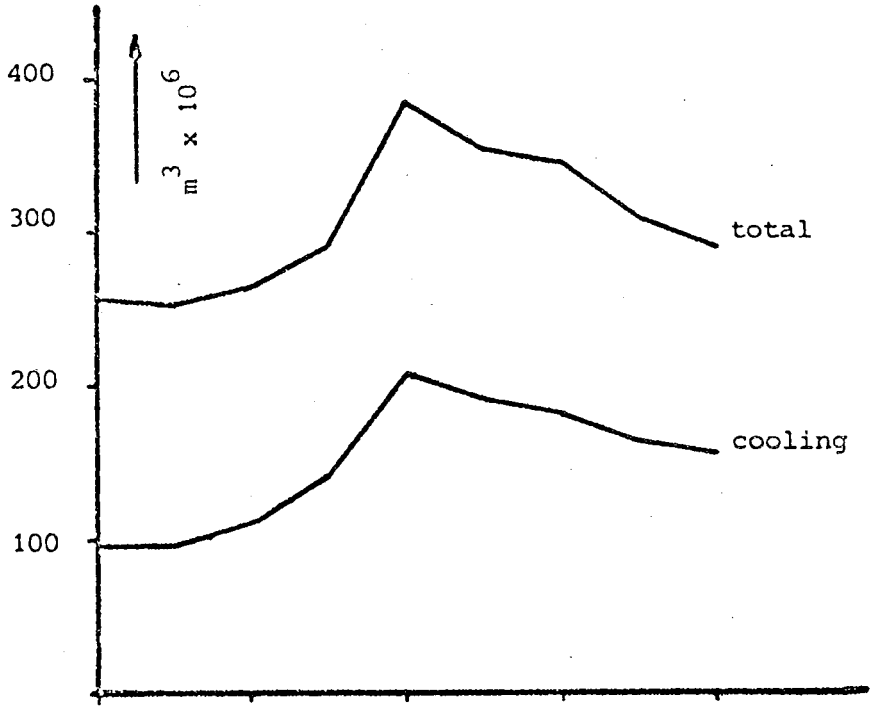


Fig.6[b] Number of abstractions