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## ASPECTS OF DRINKING WATER SUPPLY IN GERMANY

Before the reunion of Germany in 1990 there was essential difference between the water supply situation in the German Federal Republic and in the German Democratic Republic. After the reunion, water supply in the eastern states of the BRD was step by step readjusted to that in the western states. This paper presents the drinking water supply situation in Germany, especially in eastern states.

### 1. INTRODUCTION

The political changes in Germany, which brought about the reunion of the German Federal Republic and the German Democratic Republic, caused also the changes in water supply, especially in the eastern states. In spite of the positive changes, many problems stemming from the safe water supply still exist.

These problems may be itemised as follows:

- complete groundwater protection in water-protective areas,
- setting of natural catchment areas of water deposits,
- sewerage restauration,
- agricultural cooperation in a groundwater-oriented economy with protection against too high input of nitrate and protection against inputs of pesticides,
- removal of fighting agents which can be hazardous to groundwater,
- rules that define how to deal with substances dangerous to water,
- closing down of small sewage treatment plants (in the eastern states),
- regeneration of producing wells,
- advanced purification of water in order to reduce the content of nitrates,
- restoration of drinking water nets in order to guarantee its safe operation and to minimise the water losses of pipe net, e.g. by trenchless methods of construction,
- replacement of lead house connection pipes,
- installation of operation control systems for vast drinking water nets.

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## 2. INVESTMENTS AND PRICES OF WATER

In 1997, Germany paid about 5.9 billion DM for the public water supply [8], i.e.:

- 61% for the pipe net,
- 10% for production of water,
- 9% for water purification,
- 6% for water storage,
- 14% for remaining investments (counters, other measuring instruments and investments which are not plant components).

At the beginning of the '90s, the cost the of run the water supply in eastern states was estimated at about 21 billion DM [3]. Meanwhile, the construction of nets supplying water has nearly been completed. Table 1 presents the final degree of connection of Sachsen as an example.

Table 1

Degree of connection to the public water supply in Sachsen [2]

	1996	1997
Government district of Chemnitz	98.0%	98.3%
Government district of Dresden	96.9%	97.8%
Government district of Leipzig	99.0%	99.5%
State of Sachsen		98.3%

In table 2 the expenditures on the construction of drinking water supply institutions in 1997 were presented.

Table 2

Construction investments in 1997 [1]

	Western states	Eastern states	Total
Rural regions	531·10 <sup>6</sup> DM	180·10 <sup>6</sup> DM	711·10 <sup>6</sup> DM
Towns	354·10 <sup>6</sup> DM	211·10 <sup>6</sup> DM	565·10 <sup>6</sup> DM
Total	885·10 <sup>6</sup> DM	391·10 <sup>6</sup> DM	1,276·10 <sup>6</sup> DM

Apart from the costs, which result from the water production, additional costs and fiscal extra expenses must be paid (figure 1). The authorities in the most states of Germany impose restrictions on the extraction of ground water for the drinking water production, which costs 500 million DM every year and which is between 5% and 17% of the whole water costs [5]. Several states need money in order to even out the

reduction of the fertilizers used in agriculture. The costs have thus reached the levels being 29% and 70% in the western and eastern states, respectively. These costs are now higher than five years ago [5].

### 3. CHANGES IN WATER CONSUMPTION

People are more and more sparing with drinking water. In Germany the average consumption between 1990 and 1997 decreased from 145 l per person and day to 128 l per person and day, corresponding to a reduction of 12% (table 3). The water consumption in industry decreased by 17% in the same period of time. In contrast to other European countries, German households have more and more water-sparing devices and appliances, and the consumers have changed their behaviour, especially in the eastern states, because of the raising costs of drinking water and waste disposal; enterprises in industrial areas often use water for several times or recycle it. In the

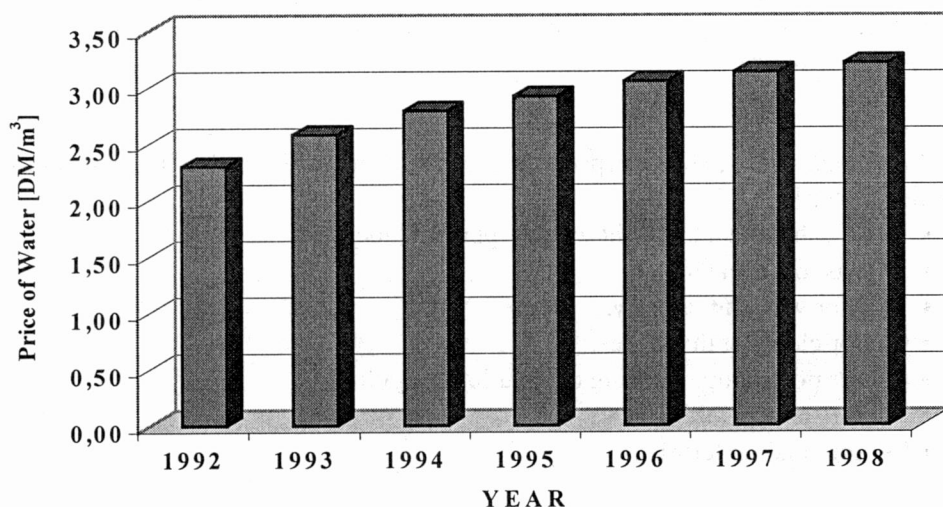


Fig. 1. Changes of the average water price [1]

eastern states of Germany people consumed more than 300 l/d before 1990, but today they need about 100 l/d in towns and only about 70 l/d in villages; since 1990, the consumption of water has been reduced by about 61% in the eastern states and by about 9% in the whole Federal Republic of Germany [5].

In the eastern states a small part of this reduction refers to the replacement of damaged pipe nets, which often crack in winter. An important part of the reduction is caused by the introduction of individual invoices for water consumers. Between 1990 and 1996, 78% of the houses were equipped with house water meters, which costed 700 million DM [5].

Table 3

Average consumption and production of drinking water in Germany [1]

Water extraction or delivery [million m <sup>3</sup> ]	Year							
	1990	1991	1992	1993	1994	1995	1996	1997 <sup>*)</sup>
Ground-water extraction	4339	4138	4013	3863	3805	3725	3707	3647
Source-water extraction	446	459	466	438	459	470	447	441
Surface-water extraction	1982	1919	1829	1727	1666	1615	1549	1518
Total water extraction	6767	6516	6326	6023	5930	5810	5703	5606
Water delivery to households and small enterprises	4234	4145	4085	4011	4020	3999	3976	3956
Water delivery to the industry	1132	1024	929	820	777	736	703	682
Remaining water delivery	616	579	524	413	375	359	341	324
Total water delivery	5982	5748	5538	5244	5172	5094	5020	4962
Water consumption [l per person and day]	145	139	136	136	134	132	128	128

\*)Provisional value

Households and small enterprises use on an average the following percentage of drinking water [5]:

- 36% for having a bath, showering, personal hygiene,
- 27% as toilet water,
- 12% for washing laundry,
- 6% for cleaning the dishes,
- 6% for tidying up, washing car, garden irrigation,
- 4% for food, drinking,
- 9% for small enterprises.

#### 4. LOSSES OF WATER IN HOUSEHOLDS

People still waste an important volume of drinking water because of defective seals of valves or untight cisterns of toilets. This means an unnecessary waste of water and money (tables 4 and 5).

#### 5. ENDOCRINE EFFECTIVE SUBSTANCES IN DRINKING WATER

The substances that are characterised by oestrogene, antioestrogene, androgene or antiandrogene activity are considered as agents with endocrine effects; they have an effect even at the lowest concentrations, and this effect is often irreversible. Some-

times very sensitive analysing techniques allow us to find the remains of medicines in ground and drinking water. Remains of drugs, which are not needed and which have

Table 4

Leakage losses at 5 hPa operation pressure [9]

Leakage diameter [mm]	Liters per		Cubic meters per	
	minute	hour	day	month
0.5	0.3	20.0	0.5	14.4
1.0	1.0	58.0	1.4	41.7
1.5	1.8	110.0	2.6	79.2
2.0	3.2	190.0	4.6	136.8
3.0	8.2	490.0	11.8	352.5
4.0	14.8	890.0	21.4	642.0
5.0	22.3	1,340.0	32.0	960.0
6.0	30.0	1,800.0	43.2	1,300.0
7.0	39.3	2,360.0	56.7	1,700.0

been excreted from human bodies pollute considerably running water and ground water. Also pain-relieving agents, antirheumatic agents, agents decreasing the level of

Table 5

Examples of water losses caused by leaks [9]

Causes of water losses	[l/d]	[l/Mon]	[m <sup>3</sup> /a]	[DM/a*]
Dripping tap (1 drop per sec.)	20	600	7.2	55
Trickling tap	100	3000	36	277
Untight cistern of toilet	200	6000	72	554

\*Based on a price of 7.70 DM/m<sup>3</sup> for drinking water consumption and sewage discharge (average price in the western states of Germany).

cholesterol and antibiotics are found in water. The occurrence of these substances in drinking water should be thoroughly investigated [10].

## 6. NITRATES IN DRINKING WATER

In the '70s, people began to discuss intensively the problem of nitrate-pollution of ground water. Ground water has always been an important source of drinking water;

in practice, this priority has been partly neglected, because the water is considered to gain enough protection because it is capable of self-cleaning when it permeates through the soil. The main reason of water pollution is the agricultural use of the soil; therefore measures between water supply companies and farmers were adopted which allowed better protection of ground waters, e.g. fertilizing according to the weather and the plant demand, no use of fields near rivers, etc. Success of these measures is not expected in short terms. Figure 2 presents some areas with increased concentrations of nitrates in the ground water.

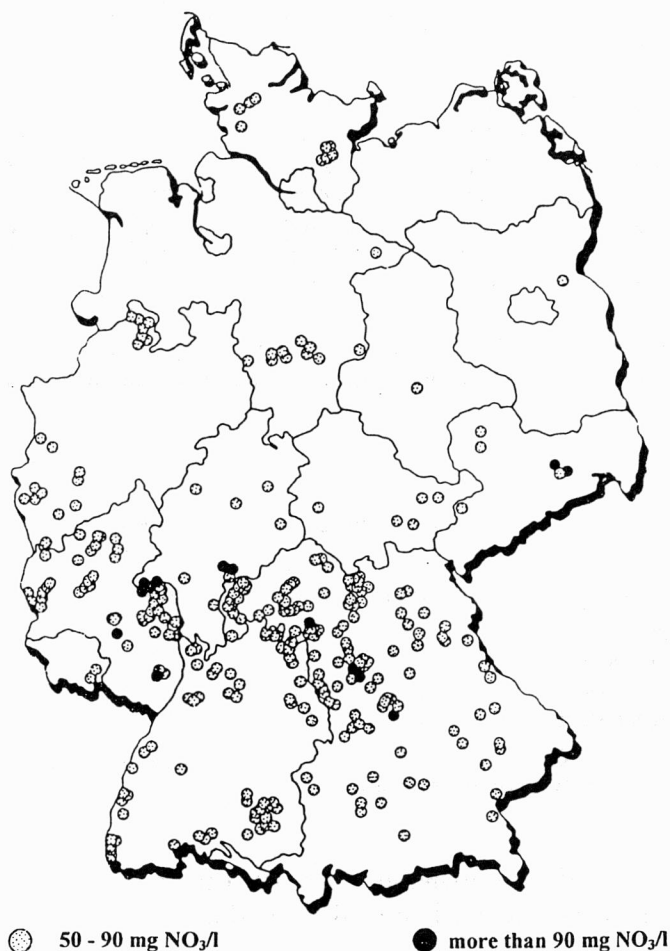


Fig. 2. Increased concentrations of nitrates in ground water

In the GDR, the use of fertilizers, which are considered to increase the yield in agriculture, and pollution of soil by liquid manure from mass live-stock have resulted in a growing nitrate-pollution of ground water and drinking water. Between 1960 and 1980,

the average nitrate content in 13 chosen districts in the areas, where inhabitants are mainly employed in agriculture, has nearly constantly raised from 39.6 mg/dm<sup>3</sup> to 68.7 mg/dm<sup>3</sup>.

Table 6 presents the number of people in the eastern states being affected by the increased nitrate content.

Table 6

Nitrate concentrations in the drinking water (the eastern German states) [11]

Year	> 40 mg/dm <sup>3</sup>	> 50 mg/dm <sup>3</sup>	> 80 mg/dm <sup>3</sup>	> 90 mg/dm <sup>3</sup>	> 130 mg/dm <sup>3</sup>	> 150 mg/dm <sup>3</sup>
1962	650000	n.a.	n.a.	n.a.	n.a.	n.a.
1981	1296000	n.a.	215000	n.a.	n.a.	54000
1985	1496000	n.a.	214000	n.a.	n.a.	34000
1989	1282000	800000*	213000	n.a.	n.a.	4000
1996	465000	98000	5000	2000	0	0

\*Planned concentrations, n.a. – not analyzed concentration.

Since 1990, a profound change of the proportions has been established, especially by closing polluted wells, by new connections to the central net of drinking water and by measures in protected districts. Due to these measures the limit of nitrate (50 mg/dm<sup>3</sup>) is exceeded only in the rural areas with smaller waterworks for about 0.6% of the population [11].

## 7. PESTICIDES IN DRINKING WATER

Undecomposable pesticides used in the agriculture must be removed by drinking water conditioning. According to a study conducted at the University of Hannover, the removal of pesticides in the western states involves costs from 252 up to 312 million DM. The main amount of money is provided by a charge for people's health, which is spent in order to protect drinking water, to control food quality and to protect endangered species [9].

In 1990, primary examinations have shown that in the eastern states the concentrations of pesticides in water were not higher than 1 µg/dm<sup>3</sup>. After testing 545 supply districts, whose ground water was assumed to be polluted with pesticides, it appeared that 13 of them had reached or minimally exceeded the limit of 0.1 µg/dm<sup>3</sup>. This examination also directed our attention to such substances as DDT and nitrofen which were often used in the GDR [6].

## 8. KINDS OF COMPANIES

According to the article 28 of the German constitution, the municipalities have to take care of the water supply. They are allowed to assign this duty to private associations without fixed form of organization; finally, the municipality has responsibility.

In Germany, the water supply has many aspects: about 7000 companies deliver water and 1500 of them satisfy a water demand in 80% [8]. Mostly, these are enterprises within a local administration (communal not-own-management-associations). In the future, entrepreneurial forms of such organizations as communal own-management-associations, institutions of public law, limited companies, functional associations, and so on will control the water economy in Germany and will be confronted with nation-wide and world competition. An increase of performance can be expected due to the merging of enterprises of water supply and waste disposal and because of amalgamation of companies from several communities.

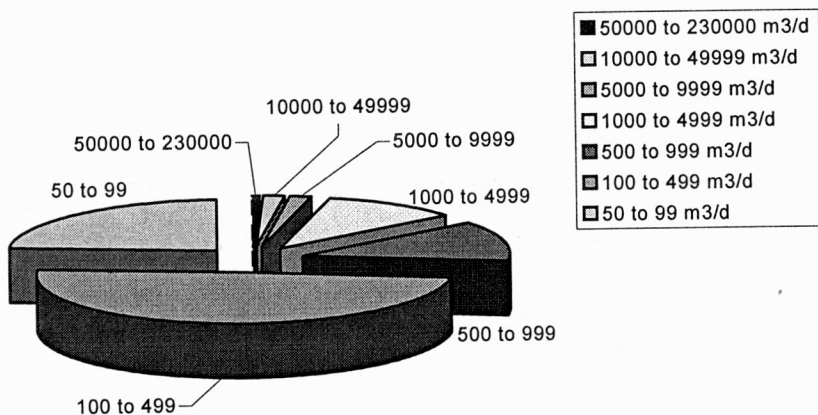


Fig. 3. Distribution of sizes of the water supply plants in the eastern states of Germany [7]

This process of changes has been partly finished in the eastern states. However, of 6262 municipalities only in 394 there is more than 5000 inhabitants [7]. Self-administration often establishes scattered but at the same time small communities. Hygienic conditions of water supply are unfavourable; therefore, over-regional companies, which have a qualified staff and a much better technical equipment, partly run small water works. Figure 3 gives an insight into the distribution of the sizes of water works in the eastern states. Some municipalities still depend on private wells for water supply.

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#### STAN ZAOPATRZENIA W WODĘ PITNĄ W NIEMCZECH

Zaprezentowano stan zaopatrzenia w wodę pitną w Niemczech, zwłaszcza we wschodnich landach, i podano podstawowe problemy związane z dostarczaniem wody o odpowiedniej jakości. Przedstawiono aspekty ekonomiczne obejmujące koszty wody w Niemczech i strukturę zrealizowanych inwestycji w systemach zaopatrzenia w wodę. Omówiono zmiany ilościowe i strukturalne w zakresie zapotrzebowania na wodę w Niemczech w okresie ostatnich siedmiu lat. Zamieszczono analizę zmian i problemy związane z jakością wody pitnej i zawartością w niej substancji szkodliwych dla zdrowia. Ponadto rozpatrzono problematykę dotyczącą zarządzania systemami zaopatrzenia w wodę.

