Decrease of water consumption in Polish towns: its causes and effects

H. Kłoss-Trębaczkiewicz, E. Osuch-Pajdzińska and M. Roman

ABSTRACT

Statistics data show that in Poland and other countries recently drinking water consumption has been going down. There are many reasons to believe that this decrease has not reached its limit yet. This paper is an attempt to explain the causes and effects of water consumption in Polish towns and cities. The decrease in water consumption leads to important consequences such as: an increase in the unit prime costs of the water supply and sewerage utilities, a lowering of the water flow velocity and the extension of the water flow time in ducts, a water supply and sewerage potential efficiency surplus in relation to the water sale and sewage collection and an increase in sewage concentration connected with a fall in unit sewage volume. All these consequences involve further consequences. There is no ideal way available to solve the problems connected with the fall in water consumption.

Key words | water consumption, water consumption forecasting

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INTRODUCTION

Statistics show that from the time after World War II up until the 1990s (so for quite a long time) the drinking water consumption in Polish towns and cities was on a continuous increase, but recently it has been going down (Figure 1). This increase and the subsequent decrease were also accompanied by some changes in the structure of drinking water consumption. The share of household consumption of the public water supply system in Polish towns has grown steadily from 49.8% in 1965 to 73% in 1997.

The beginning of the trend towards the decline in drinking water consumption occurred at the same time as the socio-political changes in Poland in 1989. These socio-political changes initiated a whole series of economic developments consisting mainly of moving from a centrally planned to a market-oriented economy. Without calling this thesis into question, it is worth noticing that the trend towards a decline in water consumption also occurred earlier in other countries, e.g. in Germany, where it would be difficult to link this phenomenon to any important economic changes. One may observe that in the period 1984–1990 the unit water consumption ($l\ cap^{-1}\ d^{-1}$) in Germany stabilised before visibly decreasing in recent years (Figure 2).

This paper is an attempt to explain the causes and effects of water consumption in Polish towns.

SOME CHANGES IN DRINKING WATER CONSUMPTION IN POLISH TOWNS

The statistical data gathered in Poland make it possible to analyse water consumption in relation to three groups of users: households, industrial sector and others, among which, in the first place, there are service institutions.

Traditionally, in Poland water meters were in widespread use. During the period from 1960 to 1970 the installation of water meters slowed down. In that period flat rate tariffs were used. However, starting from the 1980s the rule of metering water use was again put into practice. It can be stated that now almost 100% of water used is measured. Data concerning the water use in buildings result from the amount of water sold and unitary

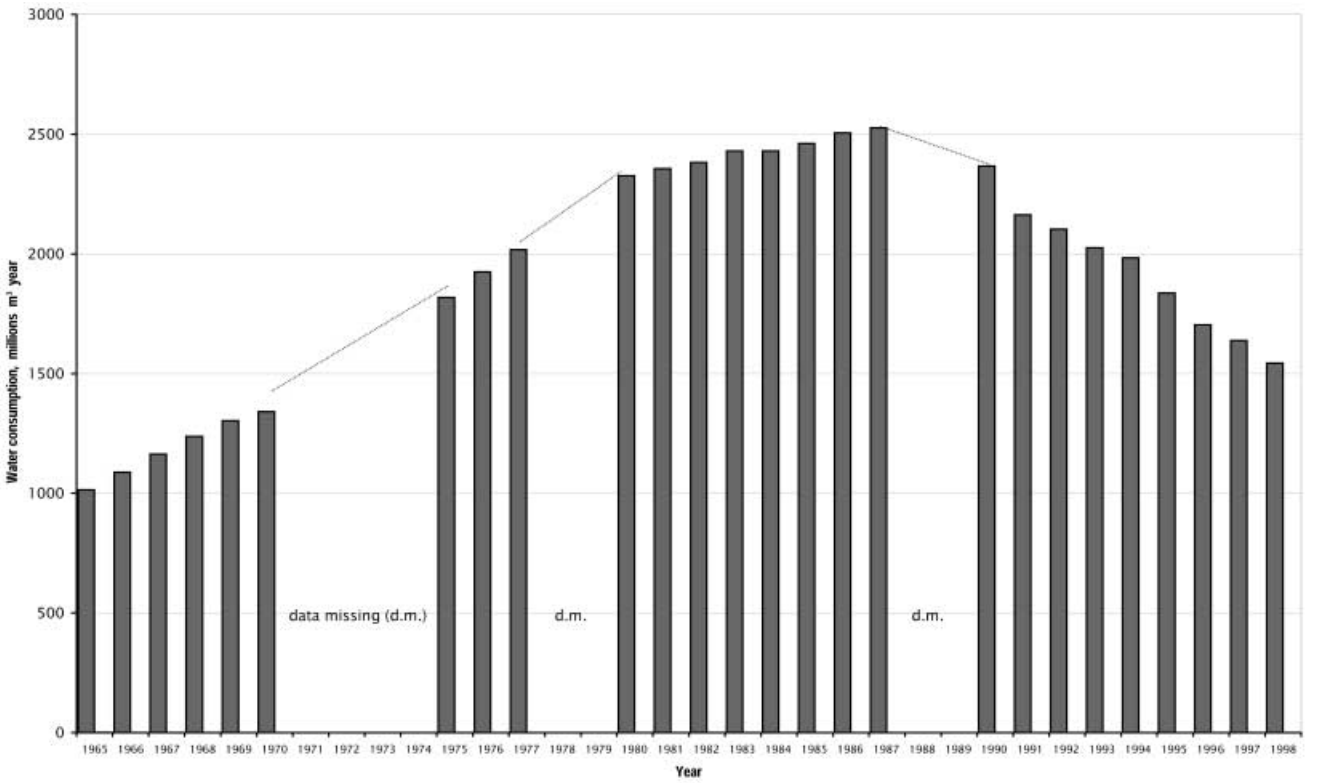

Figure 1 | The changes in drinking water consumption in Polish towns after World War II. (Source: Statistics Year Book, Central Statistical Office (GUS).)

values for water consumption in households are the result of dividing the amount of water sold by the number of water supply network customers. Data concerning the water usage by inhabitants do not take into account the water losses occurring in the distribution network. However the data on total water consumption take into account the water losses in the external distribution systems.

The statistical data concerning water consumption in households cover the overall water consumption as well as the unit water consumption per inhabitant. The values of unit water consumption are calculated in three ways: (i) per inhabitant of every town, (ii) per inhabitant of every town having a municipal water supply system, and (iii) per inhabitant using a water supply network. In order to assess the volume of water consumed in households, the most important value is the third one, i.e. the one calculated in terms of unit water consumption per inhabitant using a water supply network. The value of this indicator is expressed most often in litres per head per day (l cap^{-1} d^{-1}). The statistical data we have at our disposal go back to 1953, so they cover roughly a 50-year period. However, some of the data from the first years of the period in question are missing. That is why for the sake of our paper they have been filled in based on the method of linear interpolation. The calculated values of unit water consumption in households in Polish towns are shown in Figure 3. From the statistical data it follows that in Poland the average individual water consumption in households was growing up to 1988 when it reached the highest value of 218.3 l cap^{-1} d^{-1}. Starting from 1988 the value of this indicator then decreased and in 1998 it reached 141.6 l cap^{-1} d^{-1}. It is reasonable to suppose that the decline in the value of this indicator has not stopped now and will continue in the years to come.

Some similar changes in unit water consumption also took place in particular towns in Poland. Nevertheless,

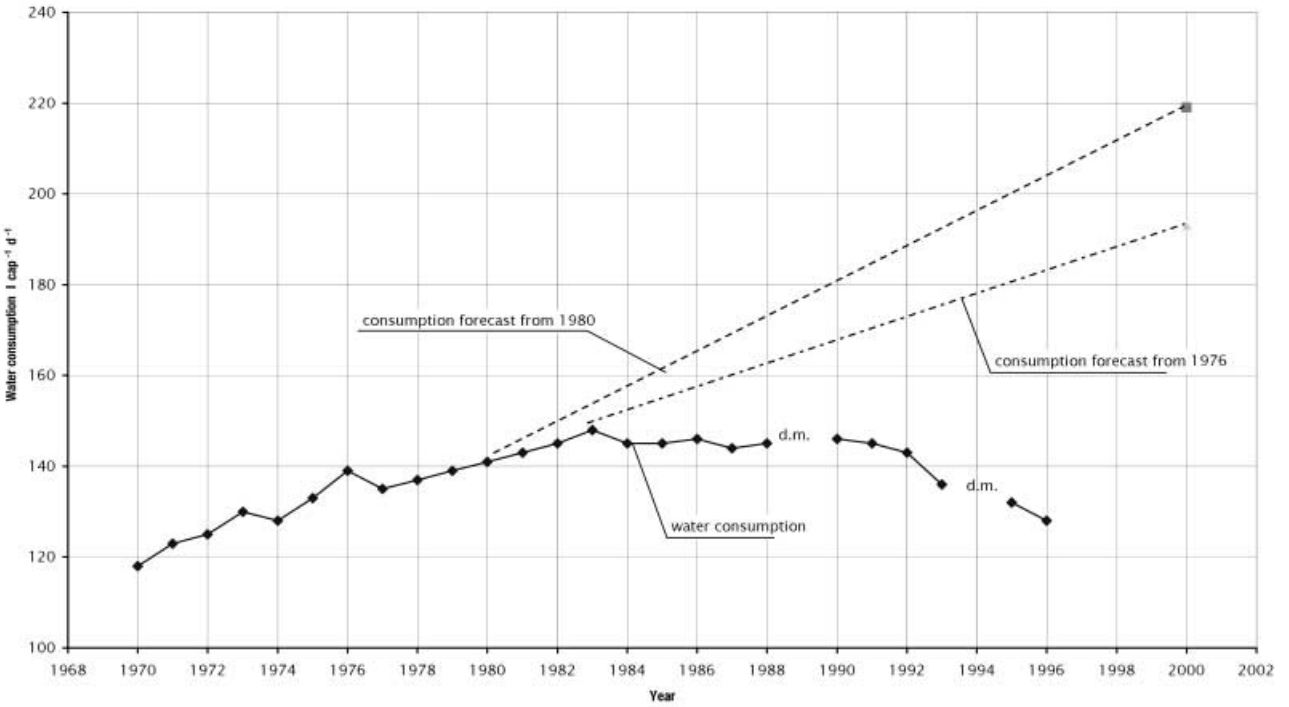

Figure 2 | Household water consumption in Germany and its forecast for the year 2000 (Bundesministerium des Innern 1972; IWSA 1990).

these changes in particular towns and cities of course differed from the changes of the average values of the indicators established for all the cities in Poland—see the data in Table 1. After 1990 a decrease in unit water consumption in households occurred in most of the towns, from 6.6% (Radom) to 55.7% (Gliwice). At present, i.e. in 1998, the value of unit water consumption in relation to these 20 towns varies from 123 l cap^{-1} d^{-1} (Białystok) to 206 l cap^{-1} d^{-1} (Warsaw).

Figure 4 shows the unit water consumption (average values for Polish towns). What follows from these data is a plainly visible fall in unit water consumption in the industrial sector and a much smaller decrease of this indicator in relation to the so-called other users, mainly service companies. It is worth noticing that the unit water consumption by the industrial sector is in fact higher than Figure 4 suggests because the industrial sector in addition takes in water through its own water supply system.

THE CAUSES OF THE DECREASE IN WATER CONSUMPTION IN TOWNS

Analysing the cause of the decrease in water consumption in towns, it makes sense to consider the factors which affected the growth in water consumption in previous years. The increase in water consumption by households was due to both an increase in the number of inhabitants using the water supply system, as well as the increase in individual water consumption expressed in l d^{-1} per inhabitant using the water supply system.

The population growth in those towns having a drinking water supply system has been stemmed because of the general decrease in the population growth rate. At the same time the percentage of the town's population using the water supply system reached 91.3%. This indicator is still growing, but its growth is now very slow because there are some technical and economic reasons which limit the range of the central water supply system.

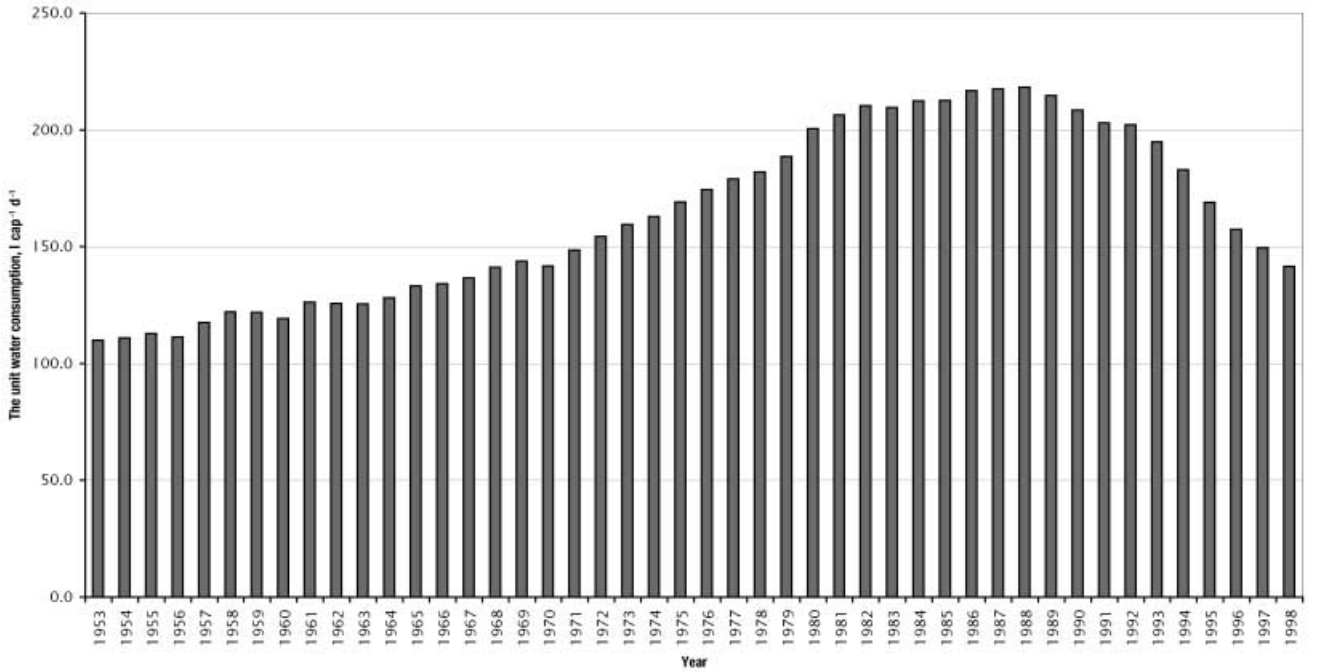

Figure 3 | The unit water consumption in households in Poland after World War II. (Source: Statistics Year Book, Central Statistical Office (GUS).)

The growth of unit water consumption resulted from different factors, among which one should count as the most important the following:

1. an increase in the standard of the water supply and wastewater domestic installations;
2. the development of the water heating utility, including the range of the central supply of hot water to apartments;
3. an increase in the wastage of water due to leakage in faulty installations and unreasonably excessive use of water.

During the years 1950–1988 the standard of household sanitary appliances has significantly increased and this has been without doubt the important factor influencing the increase in water consumption by households during previous years. Nowadays, in towns, sanitary equipment standards in apartments in Poland have reached quite a high level. In this situation a growing number of new apartments equipped with a high standard of water supply and wastewater installation can, to a much lesser degree, influence the growth in unit water consumption than in previous years.

The development of the water heating utility and, consequently, an increase in the apartment space covered by the hot water supply explains the growth in unit water consumption. Lately the pace of water heating utility development, including the central hot water supply to a town's inhabitants, has slowed down considerably. Thus the influence of this factor on the increase in unit water consumption of households has been, to a large extent, eliminated.

The wastage of water in households through the leakage or unnecessary and excessive use of water is not directly accounted for in the available statistical data. Different research projects on this subject conducted in Poland allowed us to draw the conclusion that in many instances the scale of this phenomenon was indeed very large. At one time it was estimated that the waste of water through leakage (mainly leaks in toilet flushing installations) accounted for 30–50% of the overall household water consumption, and in some instances the figure

Table 1 | Unit municipal water consumption in households in towns of over 200,000 inhabitants between 1990 and 1998 in l cap^{-1} d^{-1} (in relation to the overall number of inhabitants).

	Town	Number of inhabitants in thousands	Unit water consumption in l cap^{-1} d^{-1}								
			1990	1991	1992	1993	1994	1995	1996	1997	1998
1	Białystok	283	195	214	193	206	172	150	134	130	123
2	Bydgoszcz	387	186	188	205	204	169	150	138	139	127
3	Bytom	206	306	284	246	262	290	235	218	193	201
4	Częstochowa	259	172	176	171	164	166	145	147	149	144
5	Gdańsk	460	187	203	205	198	193	164	152	136	130
6	Gdynia	253	146	163	155	171	165	156	140	136	126
7	Gliwice	212	332	194	188	194	192	177	167	147	142
8	Katowice	347	234	212	213	215	233	213	202	173	164
9	Kielce	213	205	187	200	213	200	184	179	171	162
10	Krakòw	741	176	187	176	179	178	174	161	160	154
11	Lublin	356	196	196	205	198	173	162	150	142	134
12	Łódź	807	232	222	225	225	217	197	188	178	165
13	Poznań	578	182	171	190	183	180	169	160	147	145
14	Radom	232	181	176	175	187	180	186	180	169	161
15	Sosnowiec	243	365	376	353	308	324	278	149	219	178
16	Szczecin	417	214	213	216	200	192	184	172	168	162
17	Toruń	205	208	204	220	204	239	207	178	169	152
18	Warszawa	1617	264	252	223	246	234	225	217	215	206
19	Wrocław	639	228	210	203	206	191	191	181	167	158
20	Zabrze	200	275	257	240	238	253	241	214	193	147

was even higher. The causes of this phenomenon were numerous:

- faulty drinking water supply installations, in particular faulty fittings which frequently needed repair or replacement;
- faulty functioning of hot water installations (a necessity to let large amounts of water flow down until it reaches a desirable temperature);
- a low price for cold water and lack of a real link between the level of water payments and the level of actual use;

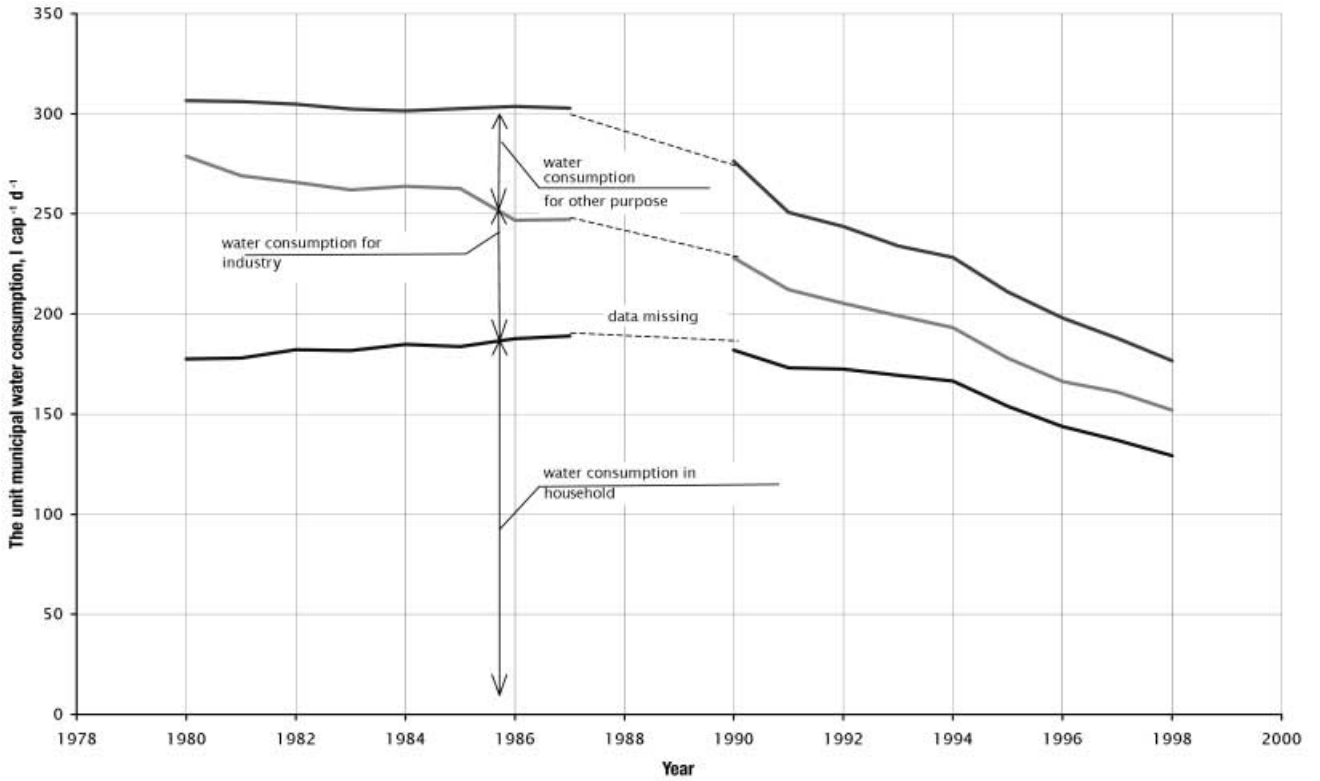

Figure 4 | The unit municipal water consumption for industrial and so-called other users.

- the lump sum payment system for hot water which neither gives any incentives to save it nor makes the indoor hot water installations function more efficiently;
- no real awareness among inhabitants that water saving is indeed a desirable goal and no education campaigns aimed at raising this awareness.

After 1990 there are important positive changes in the factors bringing about the wastage of water. There are now high quality and modern installation materials and fittings available in the market. They work well and do not need frequent repair or replacement. They are installed in new apartments as well as in renovated ones. Besides, a lot of tenants changed the old faulty equipment for the new. All this creates technical possibilities to diminish or even eliminate the waste of water caused by leakage in domestic installations. Modern water supply fittings also create the possibility of more efficient water consumption through using fittings which are better adjusted to use water economically and efficiently.

Apart from the technical conditions leading to the elimination of water wastage, another water-wastage-eliminating factor has appeared, namely the water price which is now relatively much higher than before and high enough to cover the water utility costs, or approaching them. At the same time people's awareness of the necessity to save water is rising. More and more people are interested in installing water meters in their apartments. Municipalities control water supply and sewerage payments, and the problems connected with them are widely publicised by the press, radio and TV. All this creates an atmosphere conducive to efficient water consumption, resulting in a decrease in unit water consumption per household, and, consequently, bringing about a decline in the overall volume of water sold to this group of users.

As in the case of water consumption in households, in previous years an increase in the water consumption in the

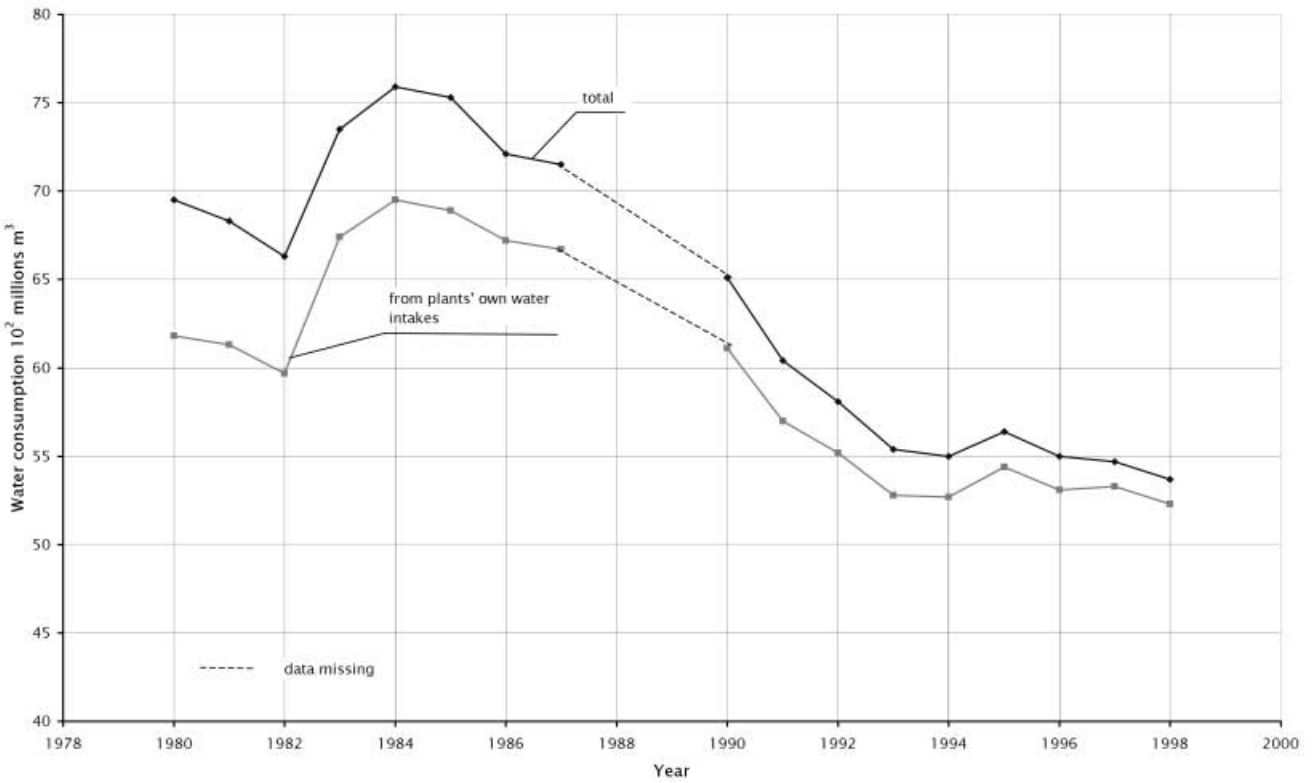

Figure 5 | Water consumption for the industrial sector in Poland. (Source: Statistics Year Book, Central Statistical Office (GUS).)

industrial sector and among other users resulted from two main causes:

- a growth in production volume, service turnover, etc.;
- a growth in the unit water consumption.

The second factor certainly involved many elements of water wastage, although it could result from both applying non-water-saving technologies and not closing water circuits. There were also other economic factors involved, e.g. a low water price and the ease with which one could count costs as part of the product or service price. The tendency towards using excessive amounts of water by the industrial sector in previous years even led to the introducing of formal limits on the water intake from the municipal water supply system, including certain limits on water supplies.

A decrease in water consumption from the municipal water supply system by the industrial sector, which has been observed for some time, certainly stems from the fall in industrial output in the 1980s and the years which followed. However, one cannot exclude advantageous changes in manufacturing technologies and in water supply and sewerage policies in industrial plants. This change one could link to the visible increase in utility water rates and, in the face of growing competition, some difficulty in including the higher costs as a part of the product price.

These explanations are only hypotheses because so far no research has been conducted to identify and quantitatively describe the effects of different causes on the fall in water consumption in the industrial sector.

All these problems are quite complicated because most of the industrial plants use not only the municipal supply water but also water from their own intakes (Figure 5). Based on the data from Figure 5 one must notice that in the last decade the water consumption by the industrial sector is decreasing both in terms of overall consumption and the consumption from the industrial

plants' own water intakes. Unfortunately, based on the published statistics one cannot clearly assess to what extent the industrial sector withdraws from using the municipal supply water for the sake of their own water intake because the data from the official statistics annuals and the data concerning municipal water consumption do not balance.

On the whole, one has to observe that the data concerning water consumption by industrial plants and other non-household users raise various doubts and do not make good grounds for a plausible analysis of the decrease in water consumption in this sector. Proper research on this subject has yet to be conducted.

THE EFFECTS OF THE DECREASE IN UTILITY WATER CONSUMPTION AND THE RESPONSE TO THIS PHENOMENON

There seem to be some important consequences of the decline in the municipal water supply consumption:

1. an increase in the unit prime costs of the water supply and sewerage utilities;
2. a lowering of the water flow velocity and the extending of the water flow time in ducts;
3. a water supply and sewerage potential efficiency surplus in relation to the water sale and sewage collection;
4. an increase in the sewage concentration connected with a fall in the unit sewage volume.

All these consequences involve further consequences.

The increase in the unit prime costs, of course, leads inevitably to the adequate increase in the price of water and sewage. This obviously results from the increase in unit constant cost, which is obvious but unfortunately not to water consumers and self-government bodies as well. That creates various problems for water and sewage. It is worth mentioning that in the course of the public debate on this issue both in the self-government bodies and among water consumers the paramount question is that of the water and sewage price increasing, expressed in terms of zlotys per cubic meter. But what is not taken into account is the obvious fact that, given a decrease in water consumption, the absolute payment for water will be lower. It is true that inflation blurs this picture, which can be the reason that this lower payment escapes people's attention. The decrease in water consumption and sewage volume should not only be constantly monitored and analysed, but also forecast and taken account of as exactly as possible in cost planning, rate setting and revenue planning in the water supply and sewerage utilities. Any negligence in this area and lack of precision may bring the utilities to a serious economic predicament.

The lowering of the water flow velocity in the ducts, particularly in the mains, leads to the negative changes of water quality in its distribution system and makes it necessary to control these phenomena very carefully. In connection with that it is also necessary to prevent the development of biological coating on the duct walls and secondary water contamination.

The water supply and sewerage system potential efficiency surplus opens up an opportunity for widening the range of these systems and makes it possible to search for new utility consumers. Part of these efforts is, among other things, in conducting a policy encouraging industry to use the public water supply system and discouraging it from using its own water supply system. On the other hand, such a situation creates completely new and unknown problems as there are doubts whether it is still desirable to use some of the system's elements, e.g. part of the water intakes, transit ducts and some of the parallel technological lines in water treatment plants. In these conditions it is also difficult to make decisions concerning the updating of the system, not to mention its further development. Prescriptions for solving these dilemmas are difficult to find and even if one can find any they seem premature. Anyway, it is necessary to follow the principle that one ought not to allow the technical degradation of efficacious equipment and ought to focus on efforts leading to a higher quality of the services.

The increase in the sewage concentration connected with the fall in the unit sewage volume has a rather obvious influence on the purification processes and the utilisation of the sewage purification plants. This is connected with a change in the purification plant equipment parameters which also results from the fall in unit sewage

volume. In some cases it may have an influence on the enlargement of the sewage purification plant if such an enlargement had been planned earlier.

FINAL REMARKS

The fall in municipal utility water consumption is a new phenomenon, although it started in the early 1990s. There are many reasons to believe that this decrease has not reached its limit yet, in particular in the area of household water consumption. One should think that this phenomenon is going to continue in the near future. What remains unknown, however, is water consumption in the industrial sector. This issue has not been researched into sufficiently and that is why all the forecasts in this area can be rather dubious.

It is necessary and urgent to analyse the changes in water consumption and its structure in Polish towns and cities. What is indispensable is working out forecasts concerning these changes and systematically correcting them in the context of the continuously incoming updated statistics.

It is impossible to find concrete prescriptions to solve many of the problems connected with the fall in water consumption. But it is necessary to try to solve the dilemmas arising, making use of other countries' experience as the fall in utility water consumption is characteristic not only of towns in Poland but also in other countries.

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