

Water quality management in the coastal city in the period of considerable water consumption decrease

R. Bogdanowicz*, J. Drwal*, Z. Maksymiuk** and A. Osinski**

* Department of Hydrology, University of Gdansk, Dmowskiego 16a, 80-952 Gdansk, Poland

** Saur Neptun Gdansk S.A., Walowa 46, 80-858 Gdansk, Poland

Abstract Gdansk water supply system belongs among the oldest in Continental Europe. In 1992 one of the first joint-venture water companies was established in the city. Under a contract concluded between the firm and the municipality, the company was obliged to secure quick and considerable improvement of drinking water quality. At the same time a considerable water consumption decrease was observed. The drop entails new environmental, technical and economic problems. The biggest threat to the supplies of safe and good quality water is the phenomenon of secondary pollution of water resulting from the overdimensioning of the water supply network. Positive aspects of water consumption decrease are related to the opportunity of more rational and sustainable water resources management. The solutions adopted in Gdansk can serve as a starting point for working out the best model for water quality management in the coastal cities.

Keywords Agglomeration; coast; water consumption; water quality management

Introduction

Gdansk water supply system counts among the oldest modern comprehensive arrangements in Continental Europe, historical preconditioning having exerted an important influence on it. Over more than 127 years of the development of the system a characteristic dispersed spatial structure was created. The establishment and subsequent operation of the water supply system of a city like Gdansk is not a merely technical or economic problem. It has always been dependent on diversification of water conditions in the area.

The area directly adjoins the main basis of natural draining – the Gdansk Bay (a sub-region of the Baltic Sea). Hence there exists a real danger of obstructions in a free outflow of surface waters and intrusions of saline waters to ground and surface waters there (Drwal, 1995). The coast is one of a spit-type, with typical balance of fresh and salty water. The south-eastern part of the area is a fragment of the delta of a large river (the Vistula River, with the mean annual flow over 1000 m³/s). On this flat area, partly situated below the sea level, the circulation of water is artificially forced by man.

Currently Gdansk water supply system is composed of 5 central water intakes (including 4 intakes of ground water and one of surface water), 12 local water intakes and 6 reserve water intakes. There are 10 network pumping stations and 3 zone ones, 14 compensation reservoirs of total capacity exceeding 75% of average daily production capacity and 1004 kilometres of water supply pipes.

Reduction of water consumption

Water resources in Europe are distributed highly unevenly. Average availability of water resources in Poland amounts only to about 1,600 m³ per inhabitant annually. Owing to uneven distribution of the resources and their seasonal changes, areas of surface and groundwater deficit in Poland have been spreading. Groundwater level has been lowering and springs and small streams have been disappearing permanently or periodically. At the same time deterioration of ground water quality is observed, particularly in case of the primary level.

Positive trends in water management include reduction of water extraction in Poland by a total of more than 17% in the years 1990–1997, including 16.8% reduction in surface and 18.6% in ground water. Water supplies from public network to the household sector were decreased by 21.0%, although the trend slowed down in the years 1996–1997 (Stodulski, 1999). In Gdansk alone, a marked drop in water consumption has been observed since 1992 (Figure 1).

When analysing the reasons behind the trend, the following phenomena can be identified (among others):

- water charges having been changed from social to market-type ones
- installation of cold and hot water meters at the customers'
- decrease of water consumption for industrial and agricultural purposes
- network survey, improvement of network efficiency and operational level
- elimination of waste of water in private flats (water-saving equipment and fittings).

Two of the above mentioned reasons are of particular importance. The current level of water consumption in Gdansk, being about 120 litres per inhabitant per day, like in Germany and the Netherlands, counts among the lowest not only in Poland, but also in Europe (Kloss-Trebaczkiwicz *et al.*, 1996). Adequate amount of water used in the flat is necessary to secure satisfactory hygienic conditions and for a comfortable life-style, and thus any further drop in individual consumption should be regarded as highly alarming.

Environmental, technical and economic consequences of water consumption decrease

A dramatic drop of water consumption entails both positive and negative effects. New opportunities arise mostly from elimination of local water deficits. The most important of those include an opportunity for a balanced management of water resources. Balanced use of water means the utilisation of natural resources at a pace not entailing deterioration of its quality and allowing the resources to be replenished by nature itself.

Two-thirds of the population of Europe rely on groundwater resources as the supplies of water for drinking and other purposes. In the Gdansk area over 70% of potable water comes from groundwater reservoirs. Should those valuable resources get polluted or be exploited excessively, they can be renewed only after a long period, measured by decades. Therefore, reductions in total water production in the region can save or even restore these reservoirs. This is especially important for water intakes situated close to the seacoast in the spit and delta part of the city, where overexploitation leads to sea water intrusions even into Cretaceous aquifers.

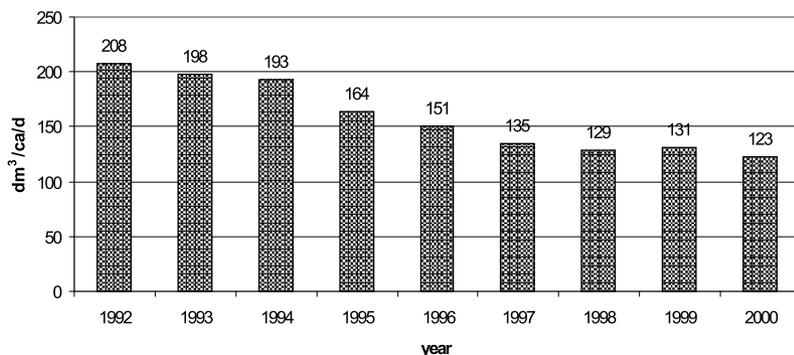


Figure 1 Changes in water consumption in Gdansk households

Losses of drinking water in the distribution systems vary, although they reach the level of about 30% in a majority of countries in Europe. Identification and repair of defects causing the losses is costly, and in a majority of cases the losses do not directly translate into higher water prices. They usually remain unnoticed by inhabitants, and thus many water supply firms are reluctant to solve the problem (*The Problems of Water Stress*, 1997). The decrease of water consumption means also less water in the distribution system and more flexible management of the system. It was therefore, the opportunity for the company in Gdansk to apply the whole package of activities leading to the reduction of water losses within the system (Figure 2).

There is also an opportunity for water intake management, including analysis of parameters of the intakes and operation shutdown of water intakes of lower quality. Based on the example of Gdansk's water intakes, interdependence between intensity of operation and quality of water produced from the intakes can be clearly observed (Figure 3). Positive aspects also include an opportunity for wholesale purchase of quality water, as well as for intensification of network washing, thanks to the greater availability of resources needed to that end (Figure 4).

The main negative technical aspect of a drop in water production, may be identified as a reduction in the flow velocity in water pipes and water's prolonged remaining there. This brings about sedimentation of sludge and earlier clogging of the pipes, the need to adjust metering devices and necessity of secondary chlorinating of water in pipe-ends or other methods of disinfecting.

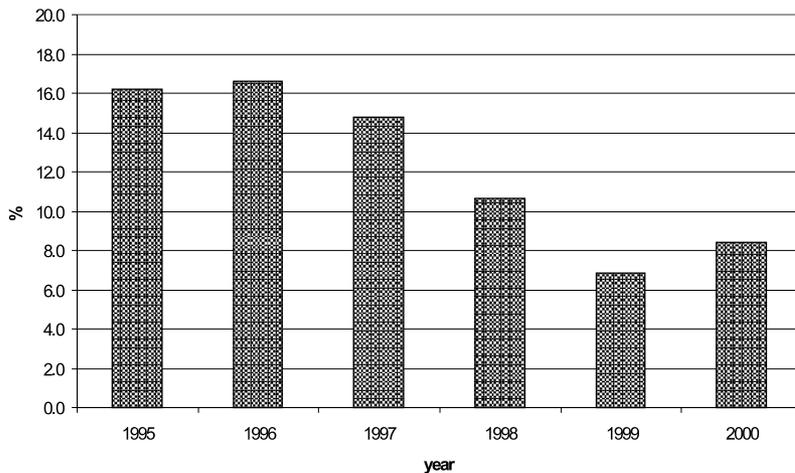


Figure 2 Water loss in Gdansk network as a percentage of total water production

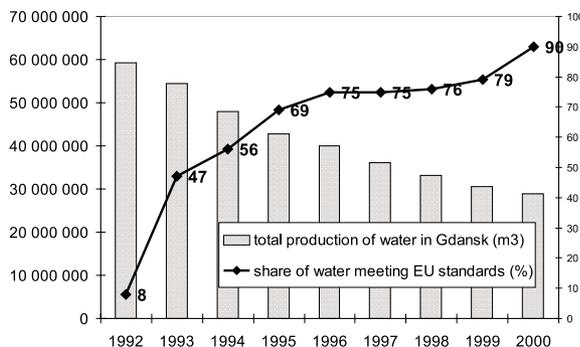


Figure 3 Evolution of drinking water quality vs. drop of water production in the years 1992–2000

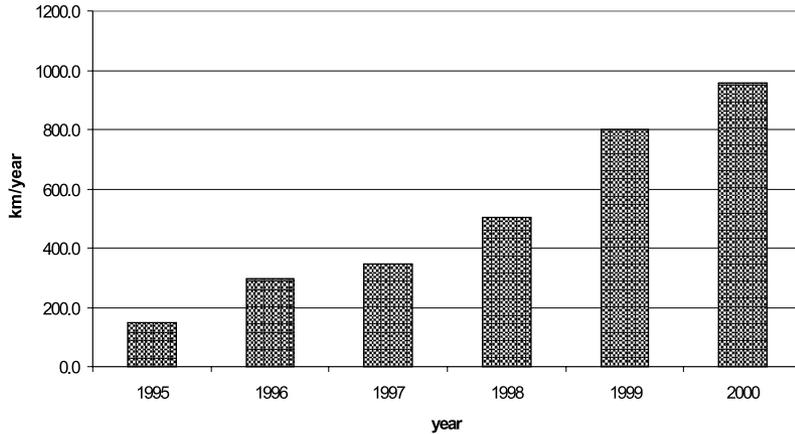


Figure 4 Intensity of water network cleaning in Gdansk

A drop in production also means a considerable drop in income, which – given a high share of fixed costs in the operation of water supply firms – forces them to optimise their expenditures. From the technical point of view the most unfavourable solution is one consisting in lowering the level of expenditures on overhauls and modernisation, as with the ageing and not properly replaced infrastructure degradation of the latter may take place. In order to minimise negative effects of the drop in water production much more has to be invested in repairs and modernisation of the existing network (Figure 5). In the past considerable expenditures were made on network developments, while there were no adequate resources for overhauls.

Water quality management

Saur Neptun Gdansk S.A. is one of Central Europe’s first joint-venture water companies, as it was established as early as in 1992. Under a contract concluded between the newly established firm and the municipality, the company undertook to secure a quick and considerable improvement of the quality of drinking water and its taste, paying special attention to water coming from the surface intake. Problems related to a drop in water production have overlapped the execution of the obligation. The good quality of water achieved at water intakes is in itself not sufficient any more nowadays, since owing to slow velocity of water in the

Failure decreasing activities

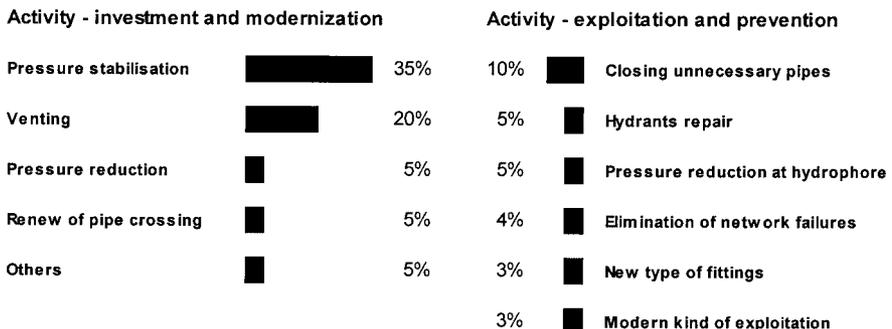


Figure 5 Failure decreasing activities

pipes the duration of its remaining within the network gets unfavourably prolonged. In some parts of the network it varies from a few days up to three weeks.

It even happens that unfavourable conditions of water transportation disrupt the results of technical efforts and financial expenditures made to construct water treatment plants. This is due to the fact that, considering physical, chemical and biological processes taking place within the network, organoleptic qualities of water deteriorate, increased turbidity and bad smell being the signs. In such a situation the operator's efforts must be focused on maintenance of the network and removal of deposited sludge from there.

The operator's necessary reaction to the drop of flow velocity within the pipes should be intensification of systematic water washing and much more effective hydropneumatic washing of the network. In Gdansk more than a half of total length of the network, pipe-ends in particular, is put to washing on an annual basis. Doubts are raised, however, whether keeping the operation of certain elements of the system is reasonable. Besides optimisation of costs of the facilities, intensification of the network operation is extremely important. A tangible indicator of the actions can be the increase of the amount of sludge extracted from the system. On the other hand, a drop in water production makes it possible to conduct a more rational management of water resources and modernisation of water intakes. As a result of investment actions undertaken and abandoning of some water intakes of poor quality at the expense of modernisation of other ones, quality of water in Gdansk keeps permanently improving despite the problems related to the drop in its production.

Conclusions

The phenomenon of a drop in drinking water consumption in the cities is a new one, both in Poland and other countries of Central and Eastern Europe. There is many a premise to believe that in numerous cities the drop has not achieved its lower limit yet, especially as far as water consumption by households is concerned. It should be anticipated that in years to come the phenomenon will remain present, especially in countries of Eastern Europe. The drop entails new concrete environmental, technical and economic problems.

The biggest threat to the supplies of safe and quality water is the phenomenon of secondary pollution of water resulting from overdimensioning of water supply networks. Its negative result is the increased depositing of sludge, not only intensifying hydraulic ageing of pipes, but also being a possible reason for deterioration of water quality and hydrobiological dangers. A recently fresh discovery of pathogens like *Giardia* and *Cryptosporidium*, transferred by drinking water, has enhanced the interest in the issue of potentially dangerous diseases of the digestive tract that may be caused by them.

In the situation of low water flows, water supply system in cities should be disinfected on a mandatory basis not only as newly constructed ones (prior to being put into operation), but also after cleaning, overhauls and major breaks. The operator's proper reaction should be increased activity and intensity of operation, a purpose difficult to achieve considering big fixed costs and decreasing income of water supply companies.

Positive aspects of a drop in water production are related to the opportunity of having a second thought on the earlier adopted investment arrangements and adoption of optimum solutions, as well as selection of best quality water extracted (in terms of quality management). Not just a more rational management of water resources, but also a sustainable management of them, not disrupting the natural process of renewal of the resources becomes possible as a result.

The experience of Gdansk's Saur Neptun Gdansk water company in the time of a dramatic drop of water consumption can serve as a major source of knowledge for other water supply companies in Central and Eastern Europe that can face a similar challenge in the nearest future. The solutions adopted in Gdansk can be therefore a starting point for

working out the best model of water quality management, in coastal agglomerations in particular.

Rererences

- Drwal, J. (1995). Impact of the Baltic Sea on Ground Water and Surface Water in the Vistula Delta. *Journal of Coastal Research*, Special Issue No. 22.
- Kloss-Trebaczkiewicz, H., Osuch-Pajdzinska, E. and Roman, M. (1996). Rational Standards of Water Consumption as a Basis for Water Management Balances. In: *Protection of Water Quality and Resources*, J. Pawelek (ed.), Zakopane, (in Polish).
- Stodulski, W. (1999). *10 Years of Poland's Transformation – Environmental Protection*. Institute for Sustainable Development, Warsaw, (in Polish).
- The Problems of Water Stress* (1997). EEA, UNEP, Copenhagen.