An approach to sustainable management of scarce water resources in urban areas.
A case study – the province of Katowice (Poland)

Master’s Thesis

By

Katarzyna Sledzinska

Address: Mazowiecka 7, 40-732 Katowice, Poland
Tel: +48 32 2525 802
E-Mail: kasia761128@yahoo.com

Supervisor
Dr Peder Hjorth
Department of Water Resources Engineering, Lund University
P.O. Box 118, SE-221 00 Lund, Sweden
Visiting address: John Ericssons väg 1
Tel: +46 46 222 4871
E-mail: Peder.Hjorth@itvl.lth.se

Lund, Sweden
November, 2001
Acknowledgments

I am grateful to so many people that it's really hard to write compact acknowledgments, without having an apprehension that somebody can be omitted.

Studying at Lumes was a great experience, which enabled me to understand important things from different perspectives. Therefore, my first thanks go to the Lumes staff for creating such programme that gives the hope that things can be changed and motivation to change them.

Furthermore, I would like to express my gratitude to my supervisor Dr Peder Hjorth for his methodological help, precious advices and patience during the thesis writing process.

Collecting necessary data is time consuming and often difficult task to accomplish, that's why I would like to acknowledge Mr Ludwik Smogorzewski, from The Office of Communal Building Planning in Katowice, for helping me with data collection and for devoting his time to provide me with the information I needed.

Since thesis-writing process strongly relies on the computer's reliability, my special thanks to Rafael Przybyszewski, because without his help my whole work would have vanished in the broken system.

I would like to say thanks to all my friends for their support in difficult moments and for the wonderful memories I will take with me home.

Finally, my very special thanks go to the most important people in my life – my parents, without their love and support I wouldn’t have a chance to study in Sweden.
Mum, Dad- Thank You!
Table of contents

Abstract .................................................................................................................. 4

1. Introduction ........................................................................................................ 4
   1.1 Background information .................................................................................. 5
   1.2 Objectives ....................................................................................................... 6
   1.3 Materials and methodology .......................................................................... 6
   1.4 Scope and Limitation .................................................................................... 6
   1.5 Theoretical structure .................................................................................... 6

2. Polish legislation regarding the protection of water resources ....................... 8
   2.1 Regulations on municipal water provision ....................................................... 9
   2.2 Requirements on potable water quality ........................................................ 10
   2.3 Discussion ..................................................................................................... 11

3. Economical instruments for managing water resources in Poland .................. 12
   3.1 Financial system of subsidising environmental policy in Poland .................... 12
   3.2 Participation of enterprises in subsidising environmental protection .......... 13
   3.3 Financial losses resulted from poor water quality ......................................... 14
   3.4 Foreign aid and the EU requirements regarding protection of water resources 15

4. Optimisation of urban water usage ................................................................. 17
   4.1 Rainwater harvesting .................................................................................... 17
   4.2 Wastewater re-use ....................................................................................... 18
   4.3 The importance of stormwater management ............................................... 19
   4.4 Separation sanitation ................................................................................. 21
   4.5 Possible water savings by households ........................................................ 22

5. Case study – the province of Katowice (Upper Silesian region) ...................... 24
   5.1 Hydrological conditions of the Upper Silesian region .................................. 24
   5.2 Condition of groundwater resources and their impact on the Silesian environment 26
   5.3 Municipal water distribution ...................................................................... 28
   5.4 Municipal water consumption by individual households and industry ....... 29
   5.5 Regional potential for mine water exploitation .......................................... 33
   5.6 Pollution sources and sewerage treatment .................................................. 34
   5.7 Potable water treatment ............................................................................. 36

6. Discussion ......................................................................................................... 37

7. Conclusions .................................................................................................... 41

8. List of references ............................................................................................ 42

9. Appendix 1 ...................................................................................................... 46

10. Appendix 2 .................................................................................................... 48

List of figures

Figure 1 The Causal Loop Diagram ........................................................................ 7
Figure 2 Scale of investments in environmental protection in Poland 1990 - 1996 ........................................................................................................ 14
Figure 3 Foreign aid donated for the environmental protection 1991 - 1996 ............. 16
Figure 4 The length of municipal water supply and sewerage network in km. (the province of Katowice) ........................................................ 29
Figure 5 Daily water consumption per capita in litres (Katowice province) ........... 30
Figure 6 Distributional losses in municipal water supply network in the province of Katowice ................................................................................ 31

List of tables

Table 1 The use of financial resources from FOSiGW for water protection in 1995 ........................................................................................................ 13
Table 2 The scale of the financial losses originated from the water economy for the national economy ................................................................. 15
Table 3 Categories and the specific examples of the water reuse ........................... 19
Table 4 Water use comparison ............................................................................ 23
Table 5 Municipal water usage for the needs of the national economy by sectors in cubic in millions ........................................................................ 31
Table 6 Analysis of water provision in the province of Katowice .......................... 32
The Republic of Poland protects its independence and inviolability of its territory, ensures human and citizen liberties and rights as well as its citizens' safety, stands on the guard of its national heritage and ensures environmental protection in accordance with the sustainable development principle.

(The Constitution of Poland, Article 5)

Abstract

Urban areas rely on sufficient water supplies, however at the same time, the contamination originated from the communal discharges seriously degrades water quality in many rivers, lakes, and groundwater sources, effectively decreasing the supply of freshwater. Additionally, the hydrological conditions can also threaten the factual availability of the water resources in the region. Hence, the water deficit cannot be only related to the quantity of supplied water, but also to its quality, on which depends health and living conditions of the city dwellers.

The following study analyses the causes of urban water shortage in the province of Katowice (Poland). Furthermore, on the basis of the conducted investigations it aims to provide environmentally sound options for sustainable water management in the area. The approach towards desirable improvements should involve the integration of the financial, managerial, and political capacity to implement them. Moreover, the social aspects cannot be neglected, since the society as such has the potential to enhance the reforms by putting pressure on the local authorities and by changing own water consumption patterns. Although the steps initiating the reforms in water management in the investigated province have been introduced, the dispersion of responsibilities on different levels of governance coupled with financial constraints hinders the progress. The conducted investigation in this study shows that the spectrum of the current problems ranging from insufficient communal sewerage treatment, industrial pollution and inappropriate potable water treatment, often exceeds the technological and financial possibilities of the communes. On the other hand, the optimisation of the water consumption patterns on a household level is feasible to be introduced what is displayed in the paper. Thus, the assessment of the existing situation and the potential for desirable improvements in urban water management are the main focus of this study.

Keywords: Katowice province, Poland, water consumption, contamination, legislative requirements, financial outlays, optimisation of water use, sewerage treatment, water treatment, municipal water distribution

1. Introduction

The management of urban water gained its importance when the scarcity of freshwater resources became one of the biggest threats for the global population. Regardless of the geographical location and climatic conditions, the deficit of drinkable water coupled with its insufficient distribution, are forcing contemporary societies to change patterns of water consumption and find the ways to increase efficiency in water usage. Poor water quality and resulting health hazards are not only problems faced by the Third World countries. Cities rely upon a clean supply of fresh water for their economic well being, yet the expansion of urbanized areas together with industrialization can threaten water resources. The progress in technology, medicine, chemistry and other domains of applied science, besides providing undoubted benefits for the humanity, also lead to the increase in usage of new domestic, industrial and agricultural chemicals, hormones, pesticides and other previously not used substances, which bring new risks of water contamination. Thus, to enhance sustainable management of such scarce resource as freshwater, the change in existing paradigm is needed. The
challenges in urban water management include not only basic changes in applied technology but also require alterations in economical and social attitude towards water utilisation. The possibilities of water recycling and re-use should be considered as steps towards sound water management that would gradually eliminate existing problems and create new opportunities and solutions.

1.1 Background information

Although, Poland’s geographical location might be seen as a favourable one regarding availability of water sources, in fact the reserves of water in terms of water supply per capita are very small, ranked as twenty-second in Europe what makes them slightly bigger than those, which Egypt has (Nowicki 1992).

Unfavourable hydrological conditions of Poland are coupled by significant contamination of surface and ground waters together with limited storage capacity of man-made water reservoirs. As the result many areas of the country experience acute shortages of drinking water. The problem is most severe in the Upper and Lower Silesian regions and in the central and eastern parts of the country.

The region of Katowice (Upper Silesia) is highly industrialised, being for many decades a centre for heavy industry and coal mining that held a cherished place in the minds of former communist governments. The Silesian soil rich in mineral resources has been exploited since the Industrial Revolution, when coal began to be truly in demand. After World War II, the industrialisation took forms that were far from being sensible, causing enormous environmental pollution and land degradation.

Nowadays, Silesia is facing the difficult legacy of the past, as well as equally difficult prospects of the future.

Due to the unfavourable hydrological conditions and contaminated surface and groundwaters, Silesian Voivodship suffers from water deficit. The available water resources in the region are scarce and their quality falls below the requirements for potable use. Resulting from that there is an urgent need to change water consumption pattern into more efficient one, as well as reduce the levels of water contamination. Thus, the study of the factors influencing urban water deficit in the
region, and possibilities to alleviate existing problems is useful for the alteration in current paradigm of water usage.

1.2 Objectives

The objective of this investigation is to analyse the factors contributing to water shortage in Upper Silesian region, as well as to find the potential for the improvement in urban water management in the area. The possibilities described in the theoretical framework serve to analyse the practical implementation of desired changes that can be applied in the region of Katowice.

1.3 Materials and methodology

The following research is based on the available data collected from the Central Statistical Office, information rendered by the Voivodship Enterprise of Water Mains and Sewers in Katowice, together with data assessed from academic sources, Journals of Law and personal communications. In order to present circular interactions within investigated urban water system, Causal Loop Diagram was designed.

1.4 Scope and Limitation

This study is a conceptual analysis of factors influencing urban water cycle. The research is limited to municipal water supply system in Upper Silesian region and it mainly takes into consideration communal water usage. However, since Silesia is highly industrialised the impact of industry on water resources couldn’t be omitted. Thus, the industrial contribution into urban water issues was delimited to the usage of municipal water provision network and impact of industrial activities on water quality.

1.5 Theoretical structure

In order to visualize interdependencies and feedback within investigated system, the Causal Loop Diagram was designed. It presents mutual interactions and the circular relations between chosen variables. External factors, such as unfavourable hydrological conditions, legislation, financial outlays and technical improvements are influencing investigated water cycle, targeting on increase in efficient water provision and improvement in the quality of supplied water.
The internal limitation of the water supply subsystem such as poor technical condition of pipes (occurring leakages) result in significant water losses estimated at 32% of the distributed water (NIK 2001). Improvements in the technical condition of municipal water supply network would be fostered by provision of necessary financial outlays, which assignment depends on regional water management policy.

The negative impact of industrial activity not only results in water contamination through discharging untreated wastewater into rivers, but also causes damages to the water mains system (especially extractive industry) at the same time hindering the possibilities to extend collective water supply network. The need to develop sufficient methods of wastewater treatment is especially important in densely inhabited urban centres, where communal wastewater effluents significantly contribute in water contamination (Leitman 1995).

Furthermore, poor quality of water resources not only poses health hazards on the people, but also additionally influences the water deficit in the Silesian region resulting from unfavourable hydrological conditions. The scarcity of the water resources in the area combined with their inappropriate quality lead to the shortage of available water, which can serve as the suitable source for municipal water distribution system. Hence, in order to secure water supplies for the communal needs, desired water supplies are "imported" from the neighbouring provinces.

Significant financial outlays are also necessary to improve the treatment of the potable water, since currently its quality doesn’t meet the requirements denominated by the Ministry of Health and Social Care (Dziennik Ustaw 2000, NIK 2001).
Current trends of reducing the activity of mining and heavy industry in the region can be seen as “green light” towards more efficient usage of water. Decreasing contribution of industry in using communal water supply network, can lead to significant savings, which can secure the provision of water for the inhabitants.

The potential savings in used water can be also achieved due to waste water reuse by the industrial plants, as well as by the households, when implementing necessary technological changes. Furthermore, the use of alternative water resources, as rainwater, can reduce the amount of potable water used for non-consumptive purposes. Hence, the amount of desired potable water demanded by households would remain on necessary level to meet requirements of decent living conditions and hygienic standards.

2. **Polish legislation regarding the protection of water resources**

As the effect of constant increase in demand for water supplies, the issues of economical management of available water resources and their protection are of the main concern in Poland. The principle indications for water economy and water protection against pollution are included in the Act of Protection and Shaping of the Natural Environment (Strzalko, Mossor-Pietraszewska 1999). According to this act, surface waters, ground waters and the marine environment are under the legal protection of the country. Specified details regarding rational management and protection of water resources are indicated in the Water Law from 1974 (Dziennik Ustaw 1974).

Significant meaning for the economically sound management of water resources has the classification of waters denominated in the Water Law, which specifies the possibilities and the extend of water resources usage (Strzalko, Mossor-Pietraszewska 2000). The technical criterion of water classification constitutes the basis for the denomination of legal rights regarding water usage. It also specifies the competences of the authorities responsible for issuing the permissions to exploit surface and groundwaters by the individuals and entities of national economy (Ibid.).

It is important to point out that the Polish law denominated three kinds of water usage (Dziennik Ustaw 1974). **Common right to use water resources** provides for the society the possibility to make use of the water resources values, through making them available for recreation and living conditions (under the condition that no special devices such as water mains will be used).

**Ordinary water use**, according to the Water Law regulations, covers exclusively stagnant waters and waters cover the ditches, which are part of the properties that belong to the owner of the ground where they are located (Ibid.). Only the ground owner is in favour to exploit mentioned water resources, as well as to make use of the devices such waterworks, etc (Ibid.).

**Specific use of water resources** is allowable due to the special permission issued on a basis of the decision of administrative unit in the area, which denominates the conditions of water usage for the authorized person (Ibid.).

The purpose of such specification of the rights regarding the use of water is to protect its resources from overexploitation and the threat of possible contamination.
According to the Polish legislation also mineral resources in solid, gaseous and liquid state including thermal and mineral waters, are non-renewable resources and as such are protected by the regulations of the geological and mining law (Sadurski 2001). Thus, the issues connected to the groundwater resources and its exploitation requires specific resolutions according to the current legislation.

2.1 Regulations on municipal water provision

Complicated hydraulic systems on the city area coupled with hydrographical conditions and extensive urbanisation play an important role in estimating future water demand, accessible water resources and impact of the urban water use on the local environment (Niemczynowicz 1999). Furthermore, the economic value of water related infrastructure in urban areas requires certain economic input to maintain its functionality (Ibid.).

State Enterprise of Water Mains and Sewers perform the management of the existing water – supply network. The spectrum of its obligations and demands towards the customers (households and industry) is specified in the Water Supply Act signed by the Polish government in June 2001 (Dziennik Ustaw 2001).

Beside the maintenance of water mains and sewers, the enterprise is also responsible for defining the tariffs for water usage, which are fixed for the specified groups of customers (Dziennik Ustaw 2001). Prices and rates of tariffs are based on the supplied documentary evidence for differences in costs of collective water supplies and sewerage. The preparation of such documentary is the responsibility of each commune, while the commune council ratifies water tariffs prepared annually by the State Enterprise of Water Mains and Sewers (Ibid.).

Since the quality of drinkable water is of the main concern of the communes, the board of each commune is obliged by the law to inform its inhabitants regularly about the quality of used water (Dziennik Ustaw 2001).

Monitoring and the control of discharged municipal sewage are performed by regional enterprise of water mains and sewerage cooperating with local units of sanitary inspection. The Water Supply Act regulates the permitted volume of discharged sewage as well as kinds of its constituents, defining penalties for exceeding allowable permits, according to the “polluter pays” principle. Technical maintenance of the pipelines and the implementation of modern methods of both water purification and its treatment are another substantial factors in the management of urban water resources.

Technical support within water mains maintenance is provided by the regional enterprise of water mains and sewerage. On the basis of the agreement between the commune and the enterprise, the enterprise is obliged to secure the condition of water mains and sewerage, in order to supply the customers continuously with demanded amount of water under the required pressure, as it is specifically stated in the Water Supply Act (Dziennik Ustaw 2001).

The enterprise is also responsible for the sewerage off taking, as well as it secures the quality of the provided water and off taking sewerage.

* Different tariffs are issued for the industrial water use and households’ use.
The customers are responsible for further maintenance of the possessed hydraulic installations unless there is a specific regulation in the contract with the water supplier (the enterprise) regarding additional technical support (Ibid.).

The commune as governmental unit indicates the direction of water network development considering the land cultivation in the commune area within the overall plan of regional development (Wojewoda Katowicki 1998). Constructions of urban related water infrastructure, i.e. pipes, water mains and even shaping of the streets, in the planning stage must predict how those constructions would affect the water flows in the city and what activities should be taken to avoid damage on man – made constructions (Niemczynowicz 1999).

The President of the Residence and Urban Development Office coordinates the scope of the planning phase of urban water related issues, especially those one connected to the collective water provision and sewerage off take (Dziennik Ustaw 2001).

As the result, the development plans that are prepared by the order of the communal authorities include the analysis of possibilities and constraints regarding further urbanisation and related changes in physical properties of land surface. Such changes as the increase in the paved areas can lead to decrease in soil permeability and slower infiltration, what in result could cause significant side effects on the whole river basin downstream in the city (Niemczynowicz 1999). Hence, urban planning requires detailed assessment of the impact caused by planned initiatives on the surrounding ecosystems.

2.2 Requirements on potable water quality

Poland's Water Law of 1974, it's modifications and several other related documents categorize river water in three categories of decreasing cleanliness (Dziennik Ustaw 1974):

Class I – suitable use in municipal water supply;
Class II – suitable for animal consumption, agricultural and recreational uses;
Class III – suitable for industrial use.

In current usage, there is also a working term for a fourth class "beyond categories" that denominates the lowest quality of the rivers, usually contaminated to such extend that cannot be classified as suitable to any use.

Water is identified as being class I, II, or III based on the analysis of 57 of its physio-chemical and biological characteristics. If water is deemed to be worse than class III water, it is considered "non-classified" (Ministry of Environmental Protection 2001).

It should be also pointed out, that water in nature is neither chemically nor biologically pure. Various salts, minerals organic substances, gasses, not to mention industrial effluents, enter the water cycle and hence the natural waters as such are not suitable for drinking purposes (Baltic Sea Project 1999).

Not before special treatment (chlorination, ozonization, filtration etc.) the rivers denominated as first class of purity are used as the sources of potable water.

Stringent classification requirements set out in the Polish law mean that non compliance for even one indicator (from about 50 parameters denoted) ensures the inclusion of the given river sector in a
lower quality class, even though marked improvements can be observed in the remaining indicators, and a general reduction in the pollution loads discharged to surface waters (Ministry of the Environmental Protection 2001).

The legal basis for the water protection and its quality is being progressively modified to meet EU directives, and all new decrees are assessed according to their compliance with the EU legislation (Resource Renewal Institute 2001). Although, the restrictions on pollution parameters (e.g. benzene, lead) were significantly tightened (Dziennik Ustaw 2000), the authorities from the sanitary – Epidemiological Station do not enforce issued regulations regarding benzene concentrations, as well as other chemical and physical parameters including the number of carcinogenic substances (Czapla 2000).

Such situation results from the lack of suitable amendments to the decree of sanitary inspection (Dziennik Ustaw 1985). It is also influenced by the lack of financial sources and suitable equipment to conduct such measures, since Sanitary - Epidemiological Stations as governmental units are financed from the voivodships’ budgets and as such are usually facing the shortage of necessary financial outlays (Ibid.).

2.3 Discussion

Paradoxically, despite of establishing very restrictive regulations regarding the standards of potable water (see Appendix 1), its quality still falls below the legal requirements and international standards.

On the practical side, the tightening on water quality restriction poses a financial burden on the enterprises distributing water. Since the enterprises were not given the adjustment time to prepare suitable means required to meet new regulations, they would have to spend significant amount of money on penalties for distributing water of low quality (Ferenc 2001). It should be pointed out that, if the law would have quarantined the adjustment time, instead of paying fines the enterprises could have designated their financial sources for the necessary investments.

For the consumers such situation mirrored in increase in water prices related to the financial commitments posed on water distributors.

It should be also stressed that current resolution (issued on September 2000) on water quality has aroused the protests from the Polish Mains Economical Chamber (Izba Gospodarcza Wodociagi Polskie 2000). The Chamber, as the representative for all Polish Mains and Sewers Enterprises, questioned the norms for the potable water quality as “harmful for the national economy” and “impracticable” (Ibid.). The enterprises responsible for water distribution countrywide were obliged by law to meet the requirements denominated in the water quality resolution. However, the strict norms (stricter than the EU directives and WHO guidelines) exceeded the technological possibilities of the enterprises. Furthermore, the lack of the adjustment time for measuring the parameters, as iron or manganese, resulted in penalties paid by the enterprises for insufficient water treatment (Ibid.).

Such situation can be seen as the example of divergences between binding law that meets the EU directives and factual condition of the Polish water market, which is not yet ready to compete with European standards.

---

* Voivodship – Polish administrative unit of country division.*
On the other hand, the achieved improvements in upgrading water quality cannot be undermined, just to mention the successful introduction of "polluter pays principle" that led to the increase in municipal and industrial wastewater treatment countrywide. As the result 86% of all communal and industrial wastewater discharged into rivers is being treated (Eurostat 2000). It presents the increase of about 10% in wastewater treatment from 1995 (Ministry of Environmental Protection 1998).

3. Economical instruments for managing water resources in Poland

Usually, costs are easier to measure than benefits. Attributing explicit monetary values to benefits — such as the value of life saved, diseases avoided or improved beauty of the landscape is difficult to accept for some people. However, measuring benefits in terms of monetary value help to base policy decisions on transparent and rational criteria. For example, decision makers usually know in monetary terms the private (internal) benefits and costs associated with individual projects or development programs.

Although, the activities and investments to improve water supplies quality and its treatment, have been undertaken by the governmental agencies and local authorities, followed by state owned and private enterprises, the struggle with existing levels of pollution requires significant amount of investment and financial outlays that considerably exceed financial capability of the voivodship’s budget (Budnikowski 1998).

The financial system of subsidising the environmental protection in Poland consists of non - budget target funds, ecological funds that administer mainly the financial means coming from the foreign aid and Ecofund Foundation coupled with the activities performed by the Bank of Environmental Protection. Additionally ecological activities are subsidised by the central budget, gminas* and enterprises’ own financial means (Gorka, Poskrobko, Radecki 1998).

3.1 Financial system of subsidising environmental policy in Poland

A bulk of environmental policy responsibilities, in particular for environmental infrastructure, was devolved from Warsaw (ministries and national government) to locally elected governmental bodies. The multiplication of public actors creates however the risk of duplication of functions and dilution of responsibilities (Peszko, Lenain 2001). The challenge is to ensure concerted actions of various public bodies and to better integrate environmental objectives in overall government policies.

The main target fund operating independently from the central budget is the Environmental Protection and Water Economy Fund. This fund is divided into three units that operate on different levels of national administration:

- National fund
- Voivodship funds
- Gmina’s funds

*Gmina — territorial division unit of Poland. Gmina is a smaller unit than voivodship and consists of the biggest city in the area and neighbouring towns and villages.
FOSiGW* incomes come mainly from the payments (including usage of water resources) and environmental penalties paid by the polluters, which were estimated at 80% of the total Fund’s income (Ibid.). 55% of the collected money from the payments and ecological fines are designated for the voivodships and 10% for gminas (Ibid).

It should be pointed out that the real value of the Fund’s incomes were much lower than the expected one, due to the insufficient execution of the outstanding payments (only 70% were collected) and fines - 15% collected (Ibid.).

Table 1 The use of financial resources from FOSiGW for water protection in 1995

<table>
<thead>
<tr>
<th>Specification of expenditures</th>
<th>National fund</th>
<th>Voivodship funds</th>
<th>Gminas funds</th>
<th>Total amount in billions PLN</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water protection</td>
<td>270.6 billions PLN</td>
<td>206.3 billions PLN</td>
<td>80.6 billions PLN</td>
<td>557.5</td>
<td>35.4</td>
</tr>
<tr>
<td>Water economy and flooding prevention</td>
<td>-</td>
<td>37.3 billions PLN</td>
<td>33.6 billions PLN</td>
<td>70.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Waste disposal and management</td>
<td>44.8 billions PLN</td>
<td>46.5 billions PLN</td>
<td>15.1 billions PLN</td>
<td>106.4</td>
<td>41.3</td>
</tr>
<tr>
<td>Ecological monitoring</td>
<td>9.7 billions PLN</td>
<td>11.6 billions PLN</td>
<td>1.5 billions PLN</td>
<td>22.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Sewerage purification</td>
<td>-</td>
<td>204.1 billions PLN</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Source: Glowny Urzad Statystyczny (GUS) 1995.

On the national and regional levels environmental funds operate as public, independent legal entities, managed by Executive Boards under the oversight of Supervisory Councils, but with government-appointed managers and councils’ members. Regional Environment Funds are the instruments of the locally elected administration at the Voivodship level. The Minister of the Environment controls the National Fund. Historically, Environment Funds have played a key role in financing environmental investments, although their share has been gradually shrinking from about 50 per cent in 1992 to less than 30 per cent in 1999 (Peszko, Lenain 2001)

3.2 Participation of enterprises in subsidising environmental protection.

Significant amount of financial outlays designed for environmental protection including water resources comes from the means owned by the enterprises. The contribution of the enterprises includes mainly the implementation of new technologies and modernisation of the equipment that is used for the production purposes, as well as instalment of devices, which are designed for environmental protection (e.g. filters, water treatment devices) (Kruszewski, Koscik 2000).

* FOSiGW is an abbreviation that stands for the Polish name of the Environmental Protection and Water Economy Fund.
Ecological investments including the activities subsidises by the commercial credits constituted of about 32% of all investment outlays for the environmental protection in Poland (Ekonomia i Środowisko 1993).

However, due to undergoing economical and political changes, the economical situation of considerable number of enterprises has worsened. As the result the expenditures for the environmental protection by the enterprises have been reduced (Gorka, Poskrobko, Radecki 1998).

The disproportion in undertaking ecological investments by companies has been noticed. The enterprises that have stabilised position on the market (often after ownership changes and technological restructuring) have been much eager to invest in environmental protection than the companies that have disturbed financial liquid and thus caring more about remaining on the market than investing into ecology (Ibid).

Moreover, such companies often don’t meet the requirements posed by the banks to get preferential credits (e.g. they don’t have required means to begin the investments), and on the other hand due to failures in remitting ecological penalties or payments they have difficulties in getting financial subsidies from the Environmental Protection Funds (Gorka 1992).

In spite of the unfavourable changes in financing ecological investments by the enterprises’ own means, the overall state of subsidies for environmental protection in Poland have the tendency to increase over time.

![Figure 2 Scale of investments in environmental protection in Poland 1990 - 1996](image)

Adapted from: Kruszewski, Koseik 2000.

### 3.3 Financial losses resulted from poor water quality.

Current condition of environment in Poland, especially in the urbanized and highly industrialized regions, such as Upper Silesia, requires continuous financial and technological outlays that would reduce or even suppress the ecological backlogs of the past.

An important incentive to invest into environmental protection is to reduce the losses for the national economy caused by the excessive pollution of the natural resources (Famielec 1999). For example, the losses in the water economy resulted from the pollution of surface and ground waters contribute in significant financial loses in the local budgets of voivodships and smaller administrative units, as well as in the national economy (Famielec 1999).
As it can be observed from the table the annual losses for the national economy caused by water pollution amounted to 63,2 bln PLN. Such amount of money could have been designated for the voivodships, where the condition of water resources requires immediate actions (e.g. Silesian Voivodship).

3.4 Foreign aid and the EU requirements regarding protection of water resources

An essential factor in combating water pollution is linked to the political status of Poland, as the country applying for the membership in the European Union. The structural adjustment plan of the future enlargement comprises also of the requirements concerning the quality of drinkable water (Budnikowski 1998).

Two main tasks are to be achieved regarding water issues. The first one is directed to create sufficient conditions to fulfil the requirements posed by the EU, regarding the quality of potable water. While the second task, which could be more difficult to implement, concerns the issues of municipal sewerage purification plants. In case of Poland, the fulfilment of such directive is connected to the great financial effort linked to the necessity of erection sewerage purification plants in the small cities (Ibid).

The costs of compliance with the EU directives in water sector (drinking water, sewers, wastewater treatment) is estimated to be 12.2-20.7 billions Euro, which is 48-50% of the total costs (World Bank 1999). Meeting the EU regulations regarding collecting and treating wastewater is the largest portion of the total cost (Ibid.)

Currently 80% of the surface waters do not meet the EU standards (World Bank 1997). Moreover, only 15% of urban wastewater is in compliance with the EU requirements (Ibid.).

In addition to the severe shortage of wastewater treatment plants, many of the existing plants do not perform well. The EU requires that by 2005 almost all urban areas with a total waste discharge for a population over 2000 have a wastewater sewer system and go through at least secondary treatment.

" 1 Polish zloty (PLN)= 0.39 USD in 1998
One of the major burdens associated with harmonisation will thus be for Poland to install the secondary treatment plants in small rural settlements. In fact, 25-40% of the rural population will be required to have sewage system (World Bank 1997).

In addition, drinking water directives will raise the current Polish standards with respect to lead, pesticide residues and by-products of chlorination (Ibid.).

According the German institute IFO, Poland has to designate around 30.4mld ECU during 15 years for the environmental protection, which is equal to 4%GDP annually (Budnikowski 1998.). Such costs are considerably higher than those estimated by the Polish government.

The international ecological help granted by the Western European countries and EU had a form of unilateral donation, which was granted directly or through PHARE programme (Poland Hungary Aid for Restructuring Economy), to implement specific investment projects (Ibid.).

Most of the funds coming from the international subsidies are directed to combat air pollution and secondly for the water protection. The material means are designated for water purifying installations and devices as well as for the licenses and elaborations of the technical projects that aim to improve water quality (Ibid.).

The factor that to some extent could decrease the volume of the ecological benefits, is linked to the fact that part of the donated help does not cover the Polish priorities in a field of the environmental protection. Polish side would like to designate majority of the funds coming from the foreign aid for the protection of water resources and water economy. Especially after the flooding in 1997, the demand for additional aid significantly increased, whereas, most of the foreign donations were directed for the reduction of the air pollution (Ibid.).

Although, the foreign subsidies for environmental protection was appreciated by the Polish society and the government, the possibilities and the scientific potential of the country were underestimated by the foreign donators (Budnikowski 1998).

It mirrored in insignificant use of existing expertises prepared by the Polish scientists, as well as in inconspicuous cooperation with Polish experts during the realization of the early stages of aid projects (Ibid.)
4. Optimisation of urban water usage.

Development of collection and management of the alternative water sources like rainwater or wastewater (grey water) is aiming to save and re-use water supplies. The implementation of those methods would increase the efficiency in water usage (Niemczynowicz 1992). Expanding residential areas around the cities create the possibilities to implement considerate and efficient water use methods on a household level.

The reuse of wastewater or reclaimed water can be a feasible method to reduce the demand on available surface and ground waters. The immediate benefit from establishing water re-use programmes is their contribution in delaying or eliminating the necessity to expand potable water supply and treatment facilities (U.S. Environmental Protection Agency 1998).

4.1 Rainwater harvesting

Water sources orginated from rainwater collection can be considered as important component of domestic water usage. Currently, the issues of rainwater harvesting are often related to worldwide need to achieve sustainable water management. Thus, the necessity to alleviate „global thirst” forced contemporary scientific communities, policy makers and water consumers to reestablish traditional methods of water collection, as rainwater harvesting. The need to implement reforms in water consumption patterns emphasises the importance of rainwater collection, as a valuable tool and an entry point for poverty reduction, sustainable development and the instrument for integrated management of water resources (Water Supply and Sanitation Collaborative Council).

One of the possible solutions for sustainable water use could be the collection of rainwater, and its further use for irrigation (especially in relation to small scale gardening) or car washing. For example, through roof gutter system rainwater can be collected and stored in a plastic barrel or cistern and afterwards used when needed (Canada’s Office for Urban Agriculture - COUA 2001).

The rain saver

Another method of re – using the collected rainwater is intending it for flushing the toilets, what would also free up sources of potable drinking water.

An interesting and fairly doable solution is Solar Water Disinfections (SODIS), idea presented at the Water Symposium in Stockholm 1999 that might be seen as a future solution for converting rainwater into drinkable water (Niemczynowicz 2000). The invention was based on black painted coca-cola bottle filled in the morning with the polluted water and exposed to the sun for the whole sunny day.

Source: City Farmer, Canada’s Office of Urban Agriculture
After the circulation through the bottle and black painted loop of plastic pipe, water was disinfected by the evening (Niemczynowicz 2000.)

One of the advantages of rainwater harvesting systems is their flexibility. A system can be as simple as a barrel placed under a rain gutter downspout for watering a garden (as presented on the graph above) or as complex as an engineered, multi-tank, pumped and pressurized construction to supply residential and irrigation needs (Gerston 2001).

However it should be also mentioned that lack of dependability and reliance on the variability and vicissitudes of climate for its water source is a main constraint for effective rainwater harvesting.

4.2 Wastewater re-use

Another solution for alternative supplies and use of water is grey water, derived from residential water uses (water from baths, showers, washing machines and sinks). Grey water can be most suitably used for irrigation needs, toilet flushing and other non-consumptive purposes, covering significant percentage of exterior water needs (COUA 2001).

The idea behind the concept of water reuse is that separation of sanitation should be implemented, since once mixed different kinds of wastewater contain both useful organic materials and highly polluted pathogen organisms (Niemczynowicz 2000). Hence, the collection of grey water should take place in separate septic tank, and after suitable treatment e.g. through sand filters use for intended purposes (Roughing Filters Technology 2000). Untreated grey water can be used for irrigation of non-consumptive crops or flushing toilets (Niemczynowicz 2000).

The interest in water reuse has gained its importance due to the several motivational factors (Asano 1991):

- Water reuse can alleviate pollution loads to the receiving streams
- Water reuse can provide a highly treated effluent available for beneficial uses
- Water reclamation can serve as a water supply to meet increasing water demand

Reclaimed wastewater can be utilised for many purposes where potable water is being used. The feasibility of specific water reuse applications depends on regional needs and the quality of the water available for reuse; treatment requirements depend of the nature of the specification.
Table 3 Categories and the specific examples of the water reuse

<table>
<thead>
<tr>
<th>General category</th>
<th>Specific Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural irrigation</td>
<td>Crop irrigation, commercial nurseries</td>
</tr>
<tr>
<td>Landscape irrigation</td>
<td>Parks, schoolyards, freeway medians, golf courses, cemeteries, greenbelts, residential</td>
</tr>
<tr>
<td>Groundwater recharge</td>
<td>Groundwater replenishment, salt water intensification, subsidence control</td>
</tr>
<tr>
<td>Recreational and environmental reuse</td>
<td>Lakes and ponds, marsh enhancement, stream flow augmentation, fisheries, snowmaking</td>
</tr>
<tr>
<td>Non potable urban reuse</td>
<td>Fire protecting, air conditioning, toilet flushing</td>
</tr>
<tr>
<td>Potable reuse</td>
<td>Blending in water supply, pipe to pipe water supply</td>
</tr>
</tbody>
</table>

Adapted from Asano 1991.

4.3 The importance of stormwater management.

The issues of effective stormwater management in relation to urban areas are important factors in managing water quality and urban planning. The city itself affects the runoff pattern and the state of ecological systems, not only within the area of the city but also in and around a whole river system downstream (Niemczynowicz 2001). Traditional stormwater management paradigm treats stormwater as waste product of urban development (Walker 2001).

Large percentage of cities' areas is covered with impervious -paved surfaces that prevent the water from infiltration to the soil at the same time blocking the recharge of groundwater (Rocky Mountain Institute). As the result, the runoff waters are carrying oils from cars, parking lots, maintenance yards and storage areas, as well as significant amount of heavy metals from old construction materials (Ibid.)

Through the drains and conduits, located under or along the streets, stormwater with the load of contaminants is flowing into the municipal sewerage system (Niemczynowicz 2001). Since, majority of the Polish cities as well as agglomerations in former Eastern European countries are equipped with combined sewerage network, their capacity often fails to convey runoff during rainstorms. Hence, the systems become overloaded what leads to combined sewers overflow (Dziopak, Niemczynowicz 1999). As the result raw sewerage often enters the stream flows polluting available freshwater resources (Rocky Mountain Institute).
Combined Sewer Overflow

In combined sewer systems, water from the inside of buildings (wastewater) together with water collected in roof drains of the houses and street drains is gathered in combined sewer lines. Thus, the sewer system capacity is surcharged by the additional amount of water (stormwater) which results in combined sewer overflow (Rocky Mountain Institute). It should be also stressed that except of the negative impact on the riparian environment, the technical failures of the stormwater conduits cause also street and basement flooding in the cities, what brings traffic problems and economical losses for the residents (Niemczynowicz 2001).

Source: Rocky Mountain Institute

The asphalt surfaces, as well as concrete ones are impermeable; hence the water runoff is immediate, what results in high peak flows in urban areas (Colorado State University).

To alleviate the problems related to the urban runoff, the choice of surface material covering urban areas should be reconsidered. Instead of impervious materials such as asphalt or concrete, porous pavements and greenbelts can be a feasible option to implement to increase infiltration and channel away the water flow from parking lots and streets (Civil and Environmental Engineering).

From the economical point of view it should be considered that costs of maintenance and repairs of existing stormwater infrastructure would increase in the future requiring new expensive investments (Niemczynowicz 2001).

Investing in increased sewer conveyance and treatment capacity without economical evaluation of other possible scenarios might increase the economical burden on the municipalities' budgets (Ibid.). However, for example the reduction of the stormwater flows into sewers can cost less than investments in the increase of their capacity. At the same time, such solution can also result in additional benefits for the environment and in upgraded quality of life of the residents (Rocky Mountain Institute).

On the other hand, stormwater can be also seen as important source of water (Niemczynowicz 1999). While taking into consideration that 100 mm of rain on 1 km$^2$ impermeable area gives 100 000 m$^3$ of water and if estimating the water usage per capita at 150 l/daily, then as the result it could be counted that 1830 people would be able to use this amount of water for the year (Ibid.). Hence, such volume of water should be perceived as an important resource.

However, stormwater harvesting and utilization requires basic reforms in applied methods of stormwater management (Ibid.) It should be also stressed that, although the technical problems could be overcome, in most cases the economical and social issues will influence the design of chosen pattern of stormwater management (Ibid.) Thus, it could be assumed that traditional stormwater infrastructure would be still used in central parts of the cities worldwide, especially in the countries, where the economical incentives are the main constraints for implementing environmentally sound management of natural resources.
4.4 Separation sanitation

Health condition and the quality of the surrounding environment depend on a large scale on well functioning sewerage system. However, the conventional sewerage system consumes a significant amount of freshwater, as well as dilutes nutrients and organic substances, that only small amount of them can be further reclaim for agricultural purposes (Niemczynowicz 2001).

The issue of environmentally sound sanitation is of a great importance in relation to densely populated human settlements, where failing sewage system causes health hazards and subsequently lowers the quality of living conditions (Mwaiselage 2001).

As a result of high water table, together with inappropriate sewerage system, the sewerage run on the ground, polluting drinkable water sources. While water supplies in the Poland are limited, the concept of separation sanitation seems to be feasible solution for improving the existing situation.

The example of sustainable sanitation system with urine separation.

Presented graph shows one of the possible ways of separation sanitation methods. It visualises how the separation of urine from faeces can be applied for further reuse. In this example grey water is mixed with faeces in the septic tank to be used for soil fertilization.

This graph does not however illustrate that grey water can be also reuse for irrigation purposes and for flushing toilets.

Main advantages from introducing separation sanitation are based on closing and separating water and nutrient cycles, avoidance of hygienic problems due to the separation of faeces from the water cycle. Moreover, considerable freshwater savings are to achieve because of the water saving toilet system (dry toilets, separation). Finally, the nutrients coming from human organisms can be reclaimed for agricultural purposes as fertilizers (Niemczynowicz 2001).

Due to the implementation of separation sanitation the hygienic conditions would increase, reducing the danger of water born diseases. The treatment of separated wastewater and sludge would be more effective, while taking into account the elimination of wastewater from the septic tank. However, the technical methods related to the described options won’t be discusses in this paper, since the
scope of the study is limited to the theoretical analysis of the potential improvements in water usage.

4.5 Possible water savings by households

Domestic water usage contribute to the 8% of the global water consumption, while comparing it with water used by irrigation (69%) and industry (23%), it might appear that its participation in worldwide consumption is insignificant (Niemczynowicz 1997).

On the other hand, the scarcity of freshwater resources requires the change in water consumption patterns in order to increase the efficiency of its usage. It should be stressed that highest water quality is needed exclusively for consumptive purposes. However, all delivered water in urban areas has the same quality since there is usually only one water supply network (Ibid.). As the result, considerable amount of treated water is wasted for non-consumptive purposes as sanitation, gardening or car washing (Hermanson 2001).

From this point of view, the change in water consumption should be directed on minimisation of potable water use for other than consumptive purposes. Another reason for domestic water savings can be related to the economical incentives, since the costs of distributed water are increasing worldwide (Niemczynowicz 2000). In Poland for example, water prices are regulated by the enterprises responsible for water provision and sewerage off take respectively for different voivodships (Milewska 2000). Currently the prices for distributed water and sewerage off take (counted together) amount to 0.8 USD\(^*\) per cubic meter, with the annual tendency to increase. Hence, the change of habits related to water usage and investment into water efficient technologies are desired to implement.

While the average water usage by household in the Western European countries amounts to 200 litres per capita daily (Niemczynowicz 1997), most of this water is being used for water born sanitation, washing and bathing (Hermanson 2001). Thus, the instalment of water saving devices would reduce the quantity of water used for those purposes. According to the guidelines provided by the US Environmental Protection Agency (U.S. Environmental Protection Agency 2001) and the Centre of Ecological Technologies (Centrum Ekologicznych Technologii 2001), changing or fixing the following devices can increase household’s water savings:

- Faucets and showers – by adding a flow reducer
- Toilets – sorting toilets, instead of using 12 litres of water while flushing, 0,1 to max.3,5 litres can be used
- Pressure reducing valves – maintenance of adequate water supply pressure, lowering high flow rates
- Hot water pipe insulation – reduction of energy and water waste, caused by the hot water faucet running to carry hot water to the tap
- Dishwashers and washing machines – water efficient models can substantially reduce water consumption.

In order to visualize and compare the possible water savings resulting from the application of water efficient technologies, the following table made by R. Hermanson, can serve as a theoretical example.

\* The information about current prices is based on the monthly bills received to the households for water usage and sewerage off take.
Another important factor influencing the improvement in water use efficiency is the change of personal habits. Simple but meaningful solutions can be introduced, what would also contribute in more efficient household water economy.

The following options can serve as an example of individual water use optimisation (Walczak 2001):

- The dishes should not be washed under the running water.
- The tap water should be switched off while brushing teeth and shaving.
- Shower can be taken instead of bathing in the bathtub (about 50 litres less per day can be used).
- Dual flushing handles can be installed in order to reduce the amount of water used for flushing the toilet (35 litres of water per person daily can be saved).
- Installation of water meters that would enable consumers to calculate their costs according to real rate of water consumption and at the same time would provide an economical incentive to chose individual water usage habits* (UNEP*).

Alternative solution for additional water savings by households can be achieved by the collection of rainwater. The following example illustrates the potential benefits in terms of saved water, due to rainwater harvesting.

On the basis of conducted research by R. Bucklin for the University of Florida (Bucklin 2001) the following calculations on possible water savings due to rainwater collection have been made. If taking into consideration the catchment area of 100 m² and monthly precipitation of 50 mm the amount of collected rainwater can be estimated at about 3561.25 litres (the calculation includes 1/3 loss due to the evaporation, leakage or spillage of collected water) (Ibid).

---

* During 1994 the installation of water meters resulted in 50% decline in household water consumption in Poland (UNEP)

* UNEP – United Nations Environment Programme
Thus, if the month of July (the wettest month in Katowice) with average precipitation of 100 mm (IMIGW 2001) would be taken into consideration, the possible savings from the catchment area (such roof) of 100m² could be estimated at 6700 litres.

Hence, the potential of rainwater collection should be taken into consideration as additional supply of water for domestic, non-consumptive purposes.

5. Case study – the province of Katowice (Upper Silesian region)

Upper Silesia with its capital city Katowice constitutes a part of Silesian voivodship, which is located in the middle - south part of Poland. Katowice city is located in the industrial heartland of Upper Silesia. Two thirds of the four million inhabitants live in the urban agglomeration (Katowice Agglomeration Project 2001). Despite the industrial character, Katowice with its 340 700 inhabitants, is the cultural centre of the region with educational and scientific institutions, as well as political capital of this traditionally self-confident region* (Urzad Miasta Katowice 2001).

Formerly notorious and highly polluted air has diminished due to the reduced industrial activity and implementation of environmental protection measurements, especially at power plants (National Environmental Policy 1991). Nowadays, pollution of water and soil pose the most severe environmental hazards. The shortage of water resources in the Silesian region require detailed planning of further management of those resources.

5.1 Hydrological conditions of the Upper Silesian region

In the hydrological meaning nearly the whole province belongs to the Baltic Sea catchments, being a part of the two biggest Polish river basins Vistula and Odra (Rychlowski 1967).

The main hydrographical knot in the area is Mount Ochędzita (895 m), which lies in Beskidy Mountains in the southern part of the voivodship (Baranski 1995). Streams, which fall down from the slopes of the mountain, flow to the basins of Odra, Vistula and Dunaj (Danube) (See Appendix 2).

With the length of 127 km Vistula river is the longest water run in the Upper Silesian province (Rychlowski 1967). In its upstream, Vistula has the typical features of the mountain river, such as high drop of its bottom that is estimated at about few promilles at Vistula’s stream segment (Ibid.). After leaving the mountainous area, the river loses its drop and fast current, flowing instead as a river typical for the lowlands or plains with its vertical drop fluctuating between 0.4 and 0.2 promilles (Rychlowski 1967).

The Vistula’s basin covers 1/3 of the Upper Silesian region, while the basin of the second biggest Polish river – Odra, covers 2/3 of the area. As the result the total length of the rivers in this region is estimated at about 1100 – 1200 km, which gives the average river network density of 11 – 13 km/km² (Rychlowski 1967).

Although, the density of the river networks in Silesia in higher than the average one in the rest of the country, the local rivers in their natural conditions are insufficient source of needed water. This

* Due to the significant amount of the mineral resources and relative wealth of Silesia comparing to the rest of the country, the province was economically independent and self-reliant.
unfavourable feature comes from the hydrological location of the Upper Silesian province that lies on the main watershed of Vistula and Odra rivers.

It should be mentioned that, although Odra is an international river, shared also by Germany and the Czech Republic, there is no international conflict regarding usage of its waters. However, to secure international relations with the neighbouring countries, Poland has signed good – neighbourly treaties with the bordering countries (Gorka, Poskrobko, Radecki 1998). Both Germany and the Czech Republic have signed the treaties with Poland (Polish – German treaty signed in Bonn in 1991 and the treaty between the Czech Republic and Poland signed in Krakow in 1991), regarding mutual cooperation and help in the environmental field, especially in creating the strategy for environmental protection, putting an emphasis on combating transboundary pollution (Ibid.).

The local rivers are carrying small amounts of water – 2.3 mld m3 / year, that makes water supplies three times smaller than in Poland on average (Rostanski 1997). Hence, the rest of water needed to cover the existing demand is cached from the rivers in neighbouring provinces, pumped and further transmitted by the pipeline to the water reservoirs in Silesian province (Smogorzewski 2001).

The average annual runoff attains 96.5 m3/s (77,6m3/s for the Vistula river and 18,9m3/s for the Odra drainage basin) (Tomiczek 2000). Groundwater resources in the area reach up to 761,4mm3/year (renewable resources) and 640,1mm3/year (available resources). The aquifer water balance is disturbed due to mining activities as well as it results from increasing infiltration of the rain and river water into the ground. Hence, the groundwater quality is poor, especially in the urban and industrial centres (Ibid.).

Those supplies are insufficient both for the municipal and industrial needs of the region, so in order to fulfil the water deficit, the desired water supplies are brought from outside of the Voivodship area (Ibid.). Imported waters are gathered in two reservoirs (Goczalkowice and Dzieckowice) from where they are further distributed by the pipeline to the unremunerative areas. The amount of water distributed daily from the reservoirs amounts to 550 thousands m3 / daily (Ibid.).

The industrialisation and extensive urbanisation of the Upper Silesian region influence the water shortage in the province. The mining activity is one of the factors, which additionally hinders the conditions of the surface water flow from the catchments to the river (Rychlowski 1967). The exploitation of coal under the riverbeds causes the deterioration of the water runs’ beds, what makes the water flow difficult, as well as creates the danger of floods in the coal-mines (Rychlowski 1967).

The extensive mining and other industrial activities have degraded more than 15% of the area, since the urban centres are dominated by heavy industries (among them coal mines and extractive industries) with 40 000 plants, factories and commercial enterprises (Tomiczek 2000).

Furthermore, about 10% of the industrial sector is a major source of local pollution, which mainly results from the fact that Silesian region is the major source of raw materials for the Polish economy, the centre of heavy industry and electric power (Ibid.).

Another problem connected to the industrialisation of Upper Silesia is the pollution of the surface water. About 68% of water carried by local rivers is heavily polluted exceeding the existing norms.
and environmental regulations (Rostanski 1997). According to the investigation conducted by the Centre of Researches and Control of the Environment in Katowice (Osrodek Badan i Kontroli Srodowiska), the excessive pollution of the surface water by heavy metals, was caused mainly by lead and zinc from mining companies, steelworks industry and municipal sewages (Wojewoda Katowicki 1998).

Furthermore, not only surface water runs are affected by pollution. The quality of the water in underground reservoirs is also threatened by anthropogenic pollution such as industrial and municipal waste coupled with mining activity and polluted ground waters (Rostanski 1997).

5.2 Condition of groundwater resources and their impact on the Silesian environment.

Pollution from industrial sites is particularly serious problem where the enforcement of environmental emissions standards has not been effective. Regions of Eastern and Central Europe have experienced high levels of groundwater contamination, and Silesian Voivodship is not an exception.

Intensification of mining together with the activities of chemical plants and inappropriate disposal of industrial and communal wastes in the past years resulted in high level of groundwater contamination in Upper Silesia. Furthermore, mine waters pumped out from the coal mines to the surface settling ponds, contained coal dust, radioactive substances (radium and barium) and were of high salinity (Wozniak 1992). Such water content posed a negative impact on the local environment. The presence of Na and Cl ions in the mine water that has been distributed to the settling ponds by the leaky pipes, caused deterioration of the plants on significant areas, especially trees since the salty water damaged their roots (Ibid.).

Moreover, salinity of water is also correlated with radium concentrations in mine waters (Chalupnik et al. 2000). Saline waters from underground coal mines of Upper Silesia Coal Basin often contain natural radioactive isotopes such as $^{226}$Ra from the uranium decay series and $^{228}$Ra from the thorium series (Ibid.).

Currently there are 50 mines still operating in the Silesian region discharging to the surface rivers around 10000 tonnes of salt per day. Saline waters containing high radium concentrations, reaching 390kBq/m$^3$ (Chalupnik et al. 2000,) cause severe damage to the natural environment and health hazards, not only for mine workers but also for the people living in the area (Wozniak 1992). In the mining industry in Poland, monitoring of the radioactivity of mine waters and precipitates has been obligatory since 1989 (Chalupnik et al.2000), what provides an opportunity to investigate the impact of an individual mine on the surrounding environment.

In Upper Silesia the annual release of radium in mine waters to the natural environment is estimated at around 75GBq of $^{226}$Ra and approximately 145GBq of $^{228}$Ra (Ibid.). A significant amount of radium discharged with mine waters to the settling ponds is further transported to the rivers, especially threatened is the area of Vistula river catchment (Ibid.).

Until now some regulations issued for the mining industry have been applied to such reservoirs and the dose equivalent limit for the miners is much higher than for the general public. However, the problems might increase when the unprofitable mines will be closed down. In such case the local authorities would have to undertake the necessary activities connected to the ground reclamation and removal of the deposits with enhanced natural radioactivity.
Despite the fact that significant amount of groundwater resources in Upper Silesia are contaminated, it should be pointed out that there are still available groundwater reserves that are used as the sources of drinking water. The exploitation of Jurassic waters in eastern part of the Silesian Voivodship could serve as such example. Those waters, classified by the Ministry of Health and Social Care as mineral waters are bottled and sale on a countrywide scale. Another example is connected to the usage of Triassic water pumped out from the underground catchments of the closed coal mine “Saturn” in Czeladz. The Sanitary Epidemiological Station investigated the quality of that water source and recognised its quality as suitable for drinking and economic purposes, meeting the requirements of bacteriological and physical purity (Gulinski 2001). Hydraulic installations that were designed for the use of the closed coal mine, serve as transmission pipes, distributing water to the inhabitants of Czeladz city (Ibid).

The usage of underground water resources implies high investment outlays, especially if the groundwater pollution occurs. Hence, the abstraction of such water resources in Silesia is limited due to the high costs of water treatment process resulted from significant contamination. The protection and management of groundwater reserves should be focused on reduction of further dispersion of contaminants by insulation (sealing). For the rehabilitation of priority sites, a remediation strategy is required (Dobris Assessment 1995).

Such strategy for Katowice region of Silesia is currently being prepared with the help of UNEP IETC* (Whitelaw 1998). The project’s target is to provide guidance and information on environmentally sound technologies for groundwater remediation at the municipal or city level (Ibid.).

The scientists from the Institute for the Ecology in Industrial Areas (IETU) in Katowice, have undertaken another initiative aiming at groundwater remediation in the region. The project focused on phytoremediation of the contaminated groundwater and soil. The implementation of this strategy has been possible due to the sponsorship and technical help provided by DOE’s* Office of Environmental Management U.S (Florida State University 1997). The process of phytoremediation is based on the ability of certain species of plants to clean up soils and groundwater polluted by low levels of metals or radionuclides (Miller 2000). Plants, as hybrid willow or sunflowers, are used to break down or degrade organic pollutants, as well as for stabilizing metal contaminants by acting as filter taps (Florida State University 1997).

According to the conducted researches the method has shown positive results for remediation of lead, copper, zinc, cesium, arsenic, cadmium, zinc, nickel and uranium (Ibid.). The application of phytoremediation project in Katowice region is a part of management strategy for environmental reclamation in the region. Furthermore, it’s cost effectiveness enables to save around 40% of the financial outlays, which would be necessary for traditional excavation and treatment approaches (Ibid.). Although, phytoremediation is an alternative to labour treatment approaches, this technology can be only applied to the sites that have relatively low concentrations of both metals and radionuclide pollutants of the groundwater and soil. The reason for that limitation results from the reduced limit of plant’s uptake, limited by the plan’s rate of growth and the size of their roots (Florida State University 1997.).

* IETC – International Environmental Technology Centre
* DOE – United States Department of Energy
The improvement of groundwater condition in Upper Silesia is a necessary step for the environmental reclamation of the area, as well as for securing the water reserves in the region, that due to industrial past become scarce in freshwater supplies.

5.3 Municipal water distribution

In each city in Poland there is one enterprise responsible for water provision to all inhabitants in the area. As often such enterprise consists of several institutions that provide water from more than one catchment. It works similarly with the sewerages, because the enterprises that deal with water provision usually are also responsible for sewerages off take.

In majority of Polish cities including the city of Katowice, the prices for cubic meter of supplied water and sewerages that are carried away, are different for households and other consumers (such as production plants, industry). Those prices include both water provision and sewerage off take and depend on the quality of supplied water coupled with the costs of getting sufficient water supplies for the area (Milewska 2000).

The municipalities mostly own the water supply enterprises, which usually operate as legal entities based on the regulations of the trade law (Ibid.).

Main source of potable water for the Silesian agglomeration is Goczalkowice reservoir, that uses the surface catchment of Vistula river (80% of supplied water for Silesia comes from surface catchment) (Matyasik 1991). Additionally, about 17% of water supplies come from groundwater sources and remaining 3% from mine waters (Czapla 2000). However, the contribution of main waters as potable water supplies is decreasing as the result of their high contamination that significantly increases the costs of their treatment (Famielec 1999). Moreover from the epidemiological point of view, usage of mine waters for potable purposes poses also health hazards on the consumers related to the presence of the carcinogenic substances in such water sources (Chalupnik et al. 2000).

Most – 95% of needed drinkable water for the province of Katowice is distributed by municipal (organized) water supply system, managed by Voivodship Enterprise of Water Mains and Sewers and in the small percentage (about 4% of the consumers) by the Voivodship Institution of Water Services in Katowice (Matyasik 1991, Smogorzewski 2001).
Figure 4 The length of municipal water supply and sewerage network in km. (the province of Katowice)

Source: Central Statistical Office 1999

Resulting from the growth of residential area around the city of Katowice, the length of the municipal water supply system increased from 438 km in 1995 to 483 km in 1999, as it can be observed from the presented chart (Central Statistical Office 1999). Another influencing factor was the implementation of the regional strategy for municipal water supplies in the area (Matyasik 1991).

However, at the same period of time (1995 -1999) the length of sewerage system for the municipality increased just of 14 km, since the greatest delays are related to the implementation of suitable sewerage system and water treatment plants in large agglomerations countrywide (Ministry of Environmental Protection, Water Resources and Forestry 2000). Such delays are related to the lack of sufficient financial resources in municipality’s budget to cover all necessary investments in urban water management. The financial outlays in the past years were focused more on water supply issues than on the sewerage offtake (Najwyzsza Izba Kontroli 2001). As the result the municipality experiences the lack of sufficient sewerage network, although the financial outlays in the recent years have been directed on sewerage system modernisation (Ibid.).

It should be pointed out that, wastewater discharges paid by commercial enterprises are high enough to provide strong incentive to treat sewage (Budnikowski 1998). In contrast the fee applied to the municipalities and water utilities are only one fifth of those paid by the enterprises, and therefore provide no such incentive (Ibid.) Hence, it can be assume that if the same fee rate would be applied to households and industries it would be an incentive to treat water even in small municipalities, where unit treatment costs are at the high rate (Najwyzsza Izba Kontroli 2001).

5.4 Municipal water consumption by individual households and industry

Some progress has been made in the last decade to reduce water consumption. Total water withdrawal in Poland declined by 21% between 1990 and 1998, due to sharp reductions in water needs for irrigation and for communal purposes (Central Statistical Office 1999).
Decrease in water consumption by individual households resulted from the increase in prices of water provision and sewerage off take. In the region of Katowice those prices are among the highest in the country, due to the significant costs of water treatment and maintenance of hydraulic installations govern by the Voivodship Enterprise of Mains and Sewers (Najwyzsza Izba Kontroli 2001). Moreover, as a monopolist regarding water provision and sewerage off take, the enterprise fixes high prices for the services provided (Ibid.).

Another factor influencing the water consumption rate in by the households in Katowice is decrease in the city’s population. While the statistical predictions in the beginning of 1990’s estimated that the city population will reach more than 370 000 (Matyasik 1991), the current number of the inhabitants in the area doesn’t exceed 341 000 and it is still declining (Central Statistical Office 1999).

![Figure 5 Daily water consumption per capita in litres (Katowice province)](image)

**Figure 5 Daily water consumption per capita in litres (Katowice province)**

Water consumption per capita in Katowice was equal to 149 litres daily (UNCHS* 1998) with the tendency to stabilise at this value. Further decline in individual water consumption shouldn’t be recommended in order to keep the living, health and hygienic standards on the appropriate level.

Moreover, numerous damages of the transmission pipe increase the percentage of water loses, that occurred due to the leakages within transmission pipes network (Rzymelka 1997). Additionally, water losses within municipal water provision system resulted from the technological exploitation of water mains by the water distributing enterprises, as well as due to the washing of the hydraulic infrastructure after occurred damages or interruptions in the water provision for the municipalities (Najwyzsza Izba Kontroli 2001).

According to the investigation conducted by the Supreme Chamber of Control, the main reasons for the increase in water loses in the province were related to the poor condition of the pipes network, inappropriate exploitation of the pipelines by the water distributors and insufficient assistance of the technical services during occurred failures of the network (Ibid).

---

* UNCHS – United Nations Centre for Human Settlements
As it can be observed from the graph, the percentage of water losses has significantly increased in the period of seven years (13.53%). Such situation can be related to the bad condition of the network, resulted from land subsidence (originated from the mining activity in the region) and additionally due to the earth tremors caused by tramways and excessive traffic (Matyasik 1991, Czapla 2000).

Table 5 Municipal water usage for the needs of the national economy by sectors in cubic in millions cubic meters annually in the Silesian Voivodship in 1997.

<table>
<thead>
<tr>
<th>Sectors of national economy</th>
<th>Amount of used water for production purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and excvation industry</td>
<td>7.7 mln m³</td>
</tr>
<tr>
<td>Grocery industry + beverages prod.</td>
<td></td>
</tr>
<tr>
<td>Incl. Beer production</td>
<td></td>
</tr>
<tr>
<td>Meat processing</td>
<td>0.2 mln m³</td>
</tr>
<tr>
<td>Paper production</td>
<td>0.1 mln m³</td>
</tr>
<tr>
<td>Coal related products, oil refining and nuclear fuels</td>
<td>0.5 mln m³</td>
</tr>
<tr>
<td>Chemical production and fibres</td>
<td>0.7 mln m³</td>
</tr>
<tr>
<td>Non-ferrous metal production</td>
<td>0.1 mln m³</td>
</tr>
<tr>
<td>Metals production + machinery</td>
<td>5.3 mln m³</td>
</tr>
<tr>
<td>Hot water, natural gas, steam and electricity provision</td>
<td>9.6 mln m³</td>
</tr>
</tbody>
</table>

As the result of the reduction in the amount of operating industrial sites and coal mines in the Katowice province, their contribution in water withdrawal from communal network has decreased (Wojewoda Katowicki 1998). Furthermore, due to the current policy of reducing water usage by industrial sites it can be assumed that the industrial contribution in usage of urban water supplies would keep the tendency to decline (Ibid.). It should be stressed that currently there is no gap between the amount of supplied water by municipal supply system and actual demand. Provided water meets the requirements of existing industrial and communal needs, mainly due to the reduction of industrial contribution in municipal water usage (Smogorzewski 2001).
In order to visualise possibilities and constraints of water supply system for the province of Katowice the following specification has been made. Its basis was drawn from the collected data published by Statistical Office in Katowice, The Centre of Research and Environmental Control and The Voivodship Enterprise of Water Mains and Sewers (Wojewoda Katowicki 1998, Matyasik 1991).

The analysis takes two kinds of factors into consideration – "internal" and "external" ones. First group of investigated factors ("internal") presents the possibilities and limitations inside the existing system, while the "external" factors consider the opportunities and dangers that influence the water supply system from the outside.

<table>
<thead>
<tr>
<th>Table 6 Analysis of water provision in the province of Katowice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal factors / Possibilities</strong></td>
</tr>
<tr>
<td>Technical improvement of waterworks network.</td>
</tr>
<tr>
<td>Efficient usage of the existing regional water resources</td>
</tr>
<tr>
<td>Water treatment plants for re-use of wastewater for industrial purposes</td>
</tr>
<tr>
<td>The extension of collective water mains.</td>
</tr>
<tr>
<td>Development of alternative methods of water management (rainwater, stormwater management)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>External factors / Opportunities</strong></td>
</tr>
<tr>
<td>Use of &quot;imported&quot; water resources</td>
</tr>
<tr>
<td>Reduction of water pollution, which would increase the chance to use local water sources for the municipal purposes</td>
</tr>
<tr>
<td>Restructuring of functioning water – absorptive industry and the implementation of the prohibition that would limit further erection of such sites</td>
</tr>
<tr>
<td>Well formulated and feasible to implement water management policy</td>
</tr>
<tr>
<td>Financial outlays for modernization of municipal water related infrastructure (preferential credits)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Source: Author's own computation based on: Wojewoda katowicki, Ochrona Srodowiska, Poland, Katowice 1998, Matyasik 1991

Presented specification of the different factors influencing one another is a suitable tool to analyse the dependencies between listed variables. While considering the effects of "internal" and "external" factors on the water supply system, it can be observed that existing water distribution subsystem such as water mains, which has both certain possibilities (i.e. efficient usage of existing water resources) and limitations (i.e. intensive exploitation of the underground water sources and
high levels of contamination) is mainly threatened by the “external” dangers that increase the limitations.

One of the threats that affect the possibilities and opportunities of the system is the lack of financial resources and necessary technical equipment to implement desired changes. Moreover, the negative impact of the mining activity significantly hinders the possibilities of expanding collective water mains network as well as it affects the efficiency of local water resources usage, due to their poor quality.

On the other hand, the use of water “imported” from neighbouring provinces together with the decline in industrial contribution into urban water use might result in increasing sufficiency of water provision for the municipal needs. Natural disasters as floods or droughts can pose negative effects on water resources and their quality and at the same time stress the dangers and limitations of “external” and “internal” factors.

5.5 Regional potential for mine water exploitation

In an industrial region such as Silesia is, the possible source of water supplies might be the water pumped out from the closed mines. As the example can be used the coal- mine situated around 20 km from Katowice, that due to exhausted coal resources in the area, was assigned to be closed down (Gulinski 2001).

In the late 1970’s the authorities from the Voivodship Sanitary – Epidemiological Inspection classified the underground water resources as “suitable for drinking and economical purposes”(Ibid.). As the result the main water reservoir was built with the capacity of 11 800 m3 and the ability to pump 5 m3 of water/ minute. The construction of second retention reservoir (4300m3 capacity) enabled to seize water from both tanks, as well as to store up the water resources outside the time of the highest water collection (Gulinski 2001).

Closure of the coal mine and the cessation of further coal excavation in the area enabled to expand and modernise the hydraulic connections between the closed coal mine (currently served as water provision point) and the reservoirs. Currently it is planned to establish an enterprise responsible for drainage and pumping out the water from the drafts remained from the closed mine (Ibid.). As far as it has been investigated the quality and the amount of the water used from the described source are constant, since the mining activity has been stopped in the area (Gulinski 2001).

To protect the underground water resources within the former coal-mine location, local authorities issued the document that prohibited such activities as storage of industrial and communal waste in the proximity of water catchments area and underground reservoirs. Moreover, to protect from the uncontrolled accumulation of water in the drifts, the channels enabling unconstrained underground waters flow have been designed (Ibid).

However the possibility of using underground coal mine water, especially for economic purposes, seems to be a challenging opportunity for industrial Silesia, the seize of those water resources meets significant constraints in majority of cases.
According to the researches conducted by the Upper Silesian Enterprise of Water Mains, the main problems with exploration of coal mine water resources are connected to the lack of stability in quality and the amount of accessible water (Wozniak 1992). Furthermore, high contents of minerals, iron and manganese hinder the possibilities of underground water usage. Negative impact of mining activity results in tectonic movements, which cause considerable damages of the hydraulic equipment (Ibid.).

Another limitation is linked to high salinity of waters in Silesia. Due to significant concentrations of salt, much of the mine waters are too contaminated to be used, even for industrial purposes. The possibility to recycle the salty water has been investigated in order to minimise the environmental and economical effects of water salinity (Ibid.)

The Institute of Inorganic Chemistry from Gliwice proposed its own technology for producing mineral fertilizers from the substances dissolved in the coal mine waters (Green Brigades 1994). The technology is original and does not produce any waste, but it is expensive and has not been properly examined yet. The Institute of Mining has patented a method of recycling the salty water underground, with only a small part of it being discharged into the rivers (Ibid.).

5.6 Pollution sources and sewerage treatment

In Silesian Voivodship the shortage of water resources resulted from the hydrological condition of the region is additionally fostered by poor quality of accessible water. In such situation, the scarcity of freshwater is one of the main threats for the area.

Human economic activity is one of the factors forming the environment, especially water conditions. Hence, in highly industrialised and urbanised regions such as Upper Silesia, the water system is significantly exploited, to meet the requirements of domestic water consumption as well as to fulfil the needs of industry and national economy.

The data on water pollution gives reason to concern. According to the assessment made by the Centre of Research and Environmental Control in Katowice only 3.3% of the rivers in the region meet the requirements of the First class purity (that can be used for consumptive purposes) (Wojewoda katowicki 1998). At the same time 73.4% of the rivers are excessively polluted (beyond the classification) being unusable even for industrial purposes (Ibid.). However, sources of water contamination originated not only from the industry. Inappropriate treatment of communal sewerages coupled with insufficient capacity and amount of treatment plants, significantly contributed in water contamination.

As the result of discharges of untreated or insufficiently treated communal sewerages, excessive concentrations of the parameters as BOD*, ChOD*, suspended matter and biogens, occurred in the rivers flowing through Silesia (Wojewoda katowicki 1998). The presence of biogens is related to the lack of sufficient methods of their removal in sewerage treatment plants (Ibid.) The negative impact of industrial activities on water quality is mirrored by the concentrations of the chlorines, sulphates and water-soluble pollutants mainly originated from saline water discharges from the operating coal mines (Czapla 2000).

* BOD – Biological Oxygen Demand
* ChOD – Chemical Oxygen Demand
It should be stressed, that the concentrations of salt in the discharged mine waters vary dependably on the weather conditions (Myslinski 2001). The highest concentrations of saline effluents were observed in the periods of dry summers and frosty winters in Vistula river (Ibid.). Concentrations of heavy metals are mainly related to the presence of zinc, cadmium and lead that come from coal mines, steel mills, communal sewerages and motorisation (Wojewoda katowicki 1998).

Since, the pollution of water resources has persistent character and implies costly investments, it is difficult to be reduced. Although, the factories dumping poisons to the rivers, such as cadmium, have been closed or cleared up, the problems with lower level polluters, as coal mines are more difficult to solve. Authorities cannot concentrate on fighting pollution and neglect social tensions caused by the possible closures of operating coal mines and subsequent lay-offs.

On the other hand the necessity for sufficient and good quality of water supplies implies radical changes in water economy of the region.

It should be pointed out that due to the current regional policy, the percentage of discharged untreated industrial sewerages was reduced from 18.71% (1992) to 6,1% (1998) (Wojewoda katowicki 1998). It resulted mainly from the subsequent investments into sewerage treatment in industrial sector that was perceived as the main factor contributing to water pollution. However at the same time, untreated communal discharges still account to 25.3% (Ibid.). Although, the improvement in this field cannot be neglected (e.g. the decrease in untreated communal sewages of 10% from 1995-1999), there is still an urge to expand the connections to the sewers and to erect sewerage treatment plants especially in the small municipalities in the region (NIK 2001). It should be stressed, that even though Katowice city itself has nine municipal mechanical – biological sewerage treatment plants, only 85% of sewerage are being purified. Such situation is mainly caused by increased costs of treatment as well as by the insufficient development of the necessary equipment (Urzad Miasta Katowice 2001).

Such disparities between the contribution of industry and municipalities in water pollution, resulted from the fact that the introduction of sewerage treatment in industrial sector was prioritised by the local authorities and thus the investments were first directed there (Peszko, Lenain 2001). On the other hand, complicated hydraulic infrastructure of the urban areas and lack of necessary funds in municipal budget hindered the development of communal sewer network and treatment plants (Ibid.).

Although the current trends show the increase of the investments within urban sewerage treatment sector (NIK 2001), the improvement within the province is uneven. Large municipalities as Katowice finance the erection of new water treatment plants from their own budgets and granted loans (Wojewoda Katowicki 1998). At the same time smaller communes, often not connected to the sewer system, are facing problems with getting necessary financial and technological outlays to improve the existing situation (Ibid.).

The costs of sewerage treatment can be also seen as factors influencing the quality of discharged wastewater. According to the Supreme Chamber of Control, as the result of decrease in water consumption and sewerage offtake, the treatment capacity of the existing treatment plants was not
fully used (NIK 2001). As the result the unit cost of sewerage treatment and water provision have increased, that lead to the decrease in quality of discharged sewerages (Ibid.)

Another factor influencing the urban sewerage network is the stormwater that affects municipal sewer system. Katowice as most of the Polish cities has combined sewer system, constructed before World War II (Matyasik 1991).

During intensive rainfalls the stormwater from the sewer system overflows, flooding the streets of relatively high surface slope (Niemczynowicz 2001). Such situations are visible in Katowice especially in the months of highest precipitation (June and July) when streets are flooded by immediate runoff. On the basis of conducted researches it can be also stated that the additional factor influencing described situation, is connected to the surface material, in this case asphalt (Niemczynowicz 2001).

Significant number of impermeable areas in the city hinders the infiltration of water into the soil, causing the risk for river contamination by the urban runoff. Additional constraint for groundwater recharge by stormwater in the province is connected to low water absorption capacity of the soil in the area (Hauke 1997). Hence, continuous rainfall increases the danger of possible flooding and resulting pollution of available water resources.

A "green light" towards improvement in current urban water management in the region can be related to the participation of Katowice city in the Sustainable Cities Programme, coordinated by the UNCHS (UNCHS). Sustainable water management plan, directed mainly on purification of urban river basins and modernisation of sewerage network, which are currently being under realisation process (Urzad Miasta Katowice 2001).

As the result of the participation in the programme, the projects on regeneration of the local rivers have been elaborated (Danski 2001). Small but meaningful example of these activities is the restoration of small Slepiotka brook in Katowice, whose bed was once deepened, straightened and covered with concrete. Due to the cooperation of the Central Mining Institute and the naturalists from the Silesian University, the natural state of the brook will be restored, as far as it is biologically and technically possible (Ibid.).

5.7 Potable water treatment

The water collected in the Goczalkowice reservoir, which seize the water from Vistula river, mainly supplies the province of Katowice.

Water taken from Goczalkowice reservoir is treated biologically at the Goczalkowice treatment plant, to meet the quality requirements in respect of organoleptic (aesthetic) parameters, among them colour, odour, turbidity and suspended matter (Barzycki 2000, Dziennik Ustaw 2000). The basis for the treatment against organic pollution is the use of chlorine, which is added in extended dose, due to high rate of occurred damages in the network (Barzycki 2001).

Furthermore, in order to avoid microbiological contamination, the additional doses of chlorine are added on several segments of 50 km long transmission pipe (from Goczalkowice to Katowice) (Czapla 2001).

Despite chlorination, the quality of provided water is questionable, since there are not sewerage treatment plants in the area surrounding the reservoir and thus reservoir's water contains significant number of Trihalomethanes, the byproducts of disinfection (U.S. Environmental Protection Agency 2000, Czapla 2001). The consumption of water containing trihalomethanes increases the risk of
getting cancer, as well as it may affect kidney and liver (U.S Environmental Protection Agency 2000).

Moreover, since the reservoir is supplied by Vistula river it should be stressed that its waters carry the contaminations from untreated industrial, communal and agricultural sewerages from the sites situated on the route of Vistula’s flow (Barzycki 2001).

According to the Polish legislation, only the water classified at first class purity can be used as potable water (Dziennik Ustaw 1974). Practically due to the limited amount of such water sources, water distributors are using accessible — poor quality sources to meet the demand for water consumption (Barzycki 2001). Hence, the treatment should be more advanced that the one currently applied.

Alternative solution for Goczalkowice can be the application of water ozonization instead of chlorination. Implementation of such technology would reduce more effectively bacteria and other microorganisms and therefore could be applied as a disinfection stage in the water treatment process (Bodzek, Konieczny 1998). The application of ozonization would prevent the formation of trihalomethanes and other organochlorine compounds by decomposing human acids (Hirotsuji 1998). Furthermore, while combined with activated carbon filtration, it serves to remove agricultural chemicals and industrial wastes (Ibid.).

Although, the costs of applying ozonization technology are higher than traditional use of chlorination, such investment would bring relatively higher environmental benefits as well as it would reduce the health hazards connected to excessive use of chlorine.

The ozonization has been introduced to Dzieckowice reservoir that serves as an additional water reservoir for the city of Katowice. Due to the high costs of water treatment, the plant operates only on the small scale (Somogorzewski 2001). Hence, in order to upgrade the quality of water distributed from Goczalkowice reservoir, water from both reservoirs are mixed on the transmission pipes and further distributed for the consumers (Ibid.). This method is however insufficient to provide the whole Silesian region with water of better quality, since it is mainly applied for the city of Katowice and neighbouring areas.

6. Discussion

The consumption of water increases proportionally to the expansion of the urban and industrial areas. Hence, in highly industrialised and urbanised regions such as Upper Silesia, the water system is especially exploited, to meet the requirements of municipal and industrial water consumption. As it can be observed in most of the post communist countries, excessive industrialisation had led to significant contamination of water resources (Carter, Turnock 1993).

Unlike as mentioned in the other former countries, the region of Upper Silesia (Poland) faces a deficit of suitable water resources, not only in respect of their quality but also regarding its quantity. Thus, the management of urban water, which is the subject of the study, should encourage a multidimensional approach towards alleviation of existing problems and further improvements to secure desirable standards of provided water. Undertaken activities should be based on the principle of sustainable development. In such an approach both legislation and economy should consider social aspects of the undertaken decisions. The environmental benefits would mirror not only in the remediation of the surrounding ecosystems, but also in improved living conditions and reduced risk of water born health hazards.
While the legislative basis for the sustainable management of urban water is basically coherent to the requirements posed by the European Union and meets international environmental standards, the practical application of the issued regulation can be questioned. In many respects the institutions responsible for the urban related water issues (e.g. Sanitary- Epidemiological Stations or water distributors) are not prepared to fulfill the obligations. In some cases, as in the presented one of Polish Mains Economical Chamber, the difficulties in implementation of the issued resolutions can be related to the lack of necessary adjustment time to prepare suitable means to meet the legislative obligations. On the other hand, for the legislative bodies an important inventive is to modify the existing Polish law towards the EU requirements, and hence the adjustment time is being reduced. Therefore, the practical application of the amended laws meets significant constraints.

One of the main factors influencing such situation is related to the under investment of budgetary units, which mirrors in inadequacy of the available technological base and human resource sector. Although, according to collected data the financial outlays for the water protection present considerable value, the existing problems give the reason to assume that the subsidies in this domain were misallocated. One of the causes might be related to the fact that the subventions are shared by different administrative units responsible for water protection what results in the dilution of the financial means and their uneven distribution.

The responsibilities for water resources protection are dispersed between different agencies with overlapping powers on the central and local level. Hence, each agency focuses on its own prerogatives, but no institution is interested in the formulation of specific targets related to the quality of water and clearly responsible for the actual improvement. For example, locally elected voivodship authorities formulate regional environmental policies but have few instruments to implement them. On the other hand, the centrally appointed provincial Governors, who have no responsibility for the formulation and implementation of regional policy objectives and strategies, issue emission permits for the most hazardous polluters.

Therefore, in order to increase the enforcement of the issued regulations, integration of the policy goals between different actors should be perceived as the first step towards practicable application of existing law that would secure the sustainable management of urban water resources. The main target should be directed into horizontal approach towards integration of the water protection issues and the realisation of the policy goals.

While taking into consideration the importance of high quality water needed for consumptive purposes, the case study of Katowice province can serve as an example of how urgent are the improvements in urban water quality. In addition to the significant levels of water contamination originated from the industrial effluents, local water resources are also threatened by the communal discharges.

Moreover, mine water, pumped out from the coal mines, due to its high salinity contains radionuclides posing severe danger on human health and local ecosystems. Despite such contamination, the predominant method of water treatment is chlorination, which is not efficient in reducing the presence of carcinogenic substances. Furthermore, the excessive usage of chlorine is disadvantageous due to the formation of chloro-organic compounds, mainly trihalomethanes. These compounds are heavily toxic and thus their presence in potable water is not recommendable (Bodzek, Konieczny 1998).

Although, the world’s tendency is to reduce the usage of chlorine, from the economical point of view its use is reasonably inexpensive, serving also a variety of other purposes including controlling
of aesthetic parameters of treated water (Potapenko 1999). Hence, it can be predicted that chlorine would still be used by the enterprises responsible for water treatment. However, the methods to upgrade the quality of potable water by ozonization were introduced in one of the water treatment plants providing water for the region of Katowice, the scale of this undertaking is relatively small. Ozonized water is distributed mainly for the city itself and not for the province, since the capacity of the plant and high costs of the treatment are of the main constraints for operating on the larger scale (Smogorzewski 2001).

One of the possible options for the households to improve the quality of potable water could be the instalment of active carbon or reverse osmosis filters. However, such investment poses a significant financial burden on a single household, since the cost of the installation exceeds financial possibilities of an average earning family (AMII 2001, Central Statistical Office 2001). It should be also pointed out that good quality of water shouldn’t be perceived as a luxury, and thus a society regardless of the economical status should be equally provided with safe water.

On the other hand, considerable part of the Polish society is not aware about the quality of the potable water. Although, the boards of the communes are obliged by law to inform inhabitants about the quality of used water (Dziennik Ustaw 2001), such publications are not accessible for the individual households. The improvement in this domain would increase social pressure on the local authorities to prioritise the undertakings related to water quality and its treatment.

There is also a need to extend and modernise municipal sewerage system, since communal discharges still significantly contribute in the contamination of the water resources in the region (Wojewoda Katowicki 1998). Although, current activities are directed on modernisation of the sewerage network and some progress has been already achieved, the inaction of the past years created considerable backlog in this field. Thus, the improvement in sewerage treatment and the extension of the urban sewers require significant financial and technological outlays that often exceed economical possibilities of the communes. On the other hand, even if the sewerage treatment plants have been erected in the municipalities, the sewerages are not being fully treated, as presented in the case of Katowice. Such situation is mainly caused by increased costs of treatment as well as by the insufficient development of the necessary equipment (Urzad Miasta Katowice 2001).

Relatively high investments in wastewater treatment plants in the area, have not led to proportional improvements in water quality in the region. Hence, it might be assumed that investment resources have not always been targeted at projects that bring highest environmental benefits.

The economical (financial) limitations are one of the main constraints for effective application of the reforms related to the sustainable management of water resources in the province of Katowice. Thus, a feasible and cost – effective option, that to some extend could alleviate the levels of water contamination, might be the introduction of phytoremediation project introduced in Katowice. Although, phytoremediation is an alternative to labour treatment approaches, this technology can be only applied to the sites that have relatively low concentrations of both metals and radionuclide pollutants of the groundwater and soil. Despite mentioned limitation, phytoremediation could be implemented in on the larger scale in the province as an auxiliary method of water rehabilitation.

While taking into consideration the protection of urban water quality in the Silesian region, it should be underlined that the reduction of industrial contribution into water contamination has been achieved due to the participation of enterprises’ own financial and technological means in introducing environmentally sound methods of water usage and treatment (Budnikowski 1998).
Moreover, as the result of the restructuring of the industry sector and resulting decline of the water withdrawal (including municipal water supply network), the water provided to municipalities meets their current demand (Smogorzewski 2001).

Although, the sufficiency of the water reserves for the province is estimated to meet municipal demands for the next 20 years, the optimisation of water consumption should be taken into consideration (Ibid.).

The incentives for sustainable water usage could be rooted in different approaches. One of them can be related to the economical value of water, costs of treatment and provision that would provide stimulus to save water to decrease the cost of its utilization.

The other one can originate from the holistic view that emphasises the scarcity of freshwater and thus underline the necessity to optimise its usage (Miller 2000).

The practical introduction of water saving methods can be applied on the individual household level by installing water saving household appliances, metering the water usage and changing water consumption patterns. There is also a potential to collect rainwater for non-consumptive purposes. However, it can be assumed that since the costs of instalment of elaborated hydraulic systems for rainwater harvesting are high, the collection of water would be limited to simple methods applied for gardening or car washing.

Finally, the contribution of Katowice city in the Sustainable Cities Programme provides additional incentives for the local authorities to improve the situation related to the urban water issues. Participation within this programme fostered both the cooperation between local authorities and competition between the cities taking part in the project. The projects elaborated during the programme target on practical application of sustainable development of urban areas that would eventually lead to optimisation of the communal water usage and harmonised coexistence of the city within the surrounding environment.
7. Conclusions

The major findings of this study are as follows:

- Urban water deficit in the province of Katowice is mainly related to the high levels of water contamination, originated from the industrial effluents and communal discharges. Additionally this situation is aggregated by the unfavourable hydrological condition of the Silesia region. In order to alleviate the existing problems the government and local authorities should prioritise the investments connected to the safe water provision.

- Considerable costs of water seizure, distribution and treatments, which are managed by the Enterprise of Water Mains and Sewers, mirrors in high water prices for the consumers. The elevated prices are however incoherent to the quality of distributed water, which is treated inappropriately due to the usage of insufficient purification methods. The improvement in the quality of provided water could be feasible if to apply on the large scale the advanced water treatment methods as ozonization.

- Current legislation regarding the water quality and the protection although coherent to the EU directives and WHO requirements is practically hardly enforced. The units responsible for the water quality control, despite of severe water contamination do not check the presence of benzene in water designed for potable use, although the maximum admissible concentration of this parameter is denominated in the Polish water quality resolution.

- Despite the legislative obligations to inform society about the quality of provided water, local authorities neglect issuing such information and hence the society is unaware of actual quality of tapped water. Establishment of the water information system would mobilize society to put pressure on local authorities to undertake desirable activities towards upgrading the feature of distributed water.

- Urban water provision in the region is threatened by the increase in occurring failures of the water supply network, which results from the land subsidence related to the mining activity.

- Dispersed responsibilities for water protection issues cause uneven improvement and misallocation of the financial outlays in the field of the water management. The lack of sufficient subventions and resulted shortage of needed technological base mirrors in inappropriate water and sewerage treatment. Hence, there is an urge to harmonize the water management policy from the different levels of governance. The horizontal approach towards policy application is needed.

- In order to reduce water pollution in the region the financial outlays should be directed on modernisation of municipal sewerage system and erection of the sewerage treatment plants. Furthermore, the penalties for the untreated sewerage discharges should be arisen both for industry and municipalities, to provide incentives to invest in environmentally sound water management.
8. List of references

Bibliography:

2) Baranski, M., Pasma Klimczoka i Rownica, Poland (Mountain ranges of Klimczok and Rownica), Wydawnictwo PTKK „Kraj”, Warszawa 1995.
5) Carter, F., Turnock, D., Environmental Problems in Eastern Europe, UK, USA, Routlege, 1996
7) Chalupnik, S., Michalik, B., Wysocka, M., Skubacz, K., Mielnikow, A., Contamination of settling ponds and rivers as the result of discharge of radium –bearing waters from Polish coal mines, Journal of Environmental Radioactivity Vol. 54, 2001
8) Dobris Assessment, Environment in Europe, Danmark, European Environmental Agency, Copenhagen, 1995
10) Dziennik Ustaw Rzeczpospolitej Polskiej, nr 12, poz.49, (The Decree about National Sanitary Inspection), Poland, Warsaw, 1985
11) Dziennik Ustaw Przeczpospolitej Polskiej, nr 82, poz.937, (Ministry of Health and Social Care, Decree on potable water requirements), Poland, Warszawa 2000.
20) Hauke, B., The flood catastrophe in the Czech Republic and in Poland, Germany, ERC FRANKONA Ruckversicherung – AG Munich, 1997
23) Matyasik, J., Plan regionalny województwa katowickiego w zakresie systemow zaopatrzenia w wode, (Regional plan of Katowice voivodship water supply systems), Poland, Biuro Planowania Przestrzennego Katowic, Katowice 1991

27) Mwaiselage, A., Infrastructure and services in Tanzania, Course on Urban Systems and the Environment, Lumes: Master’s Programme in Environmental Sciences, Lund, 2001


29) Najwyzsza Izba Kontroli Delegatura w Katowicach (NIK), Wyniki Kontroli Kosztow Prowadzenia Publicznej Gospodarki Wodno – Sciekowej, (Results of Controlling the Costs of Operating in the Public Water Supply and Sewer Economy), Poland, Katowice 2001

30) Niemczynowicz, J., Integration of Urban Water Management With Other Sectors, Canada, IX World Water Congress, Montreal, 1999


35) Nowicki, M., Environment in Poland. Issues and Solutions, Poland, Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw, 1992


42) Wa1czak, L., Zmniejszenie zużycia wody i scieków w domu, (Reduction of water usage and sewerage discharges from the households), Poland, Murator No.9/2001, Wydawnictwo Murator Sp. z o.o, Warszawa, 2001

43) Wojewoda katowicki, Ochrona Środowiska Województwo Katowickie, (Environmental Protection in the Katowice Voivodship), Poland, Katowice, 1998.


Electronic references:

1. AMII Water Filters, Reverse osmosis filters, 2001

2. Baltic Sea Project (BSP), BSP Newsletter No. 99:1:p34ff, 1999,

3. Barzycki, A., Problematyka jakości wody poruszana w mediach a świadomość istnienia tej problematyki w społeczeństwie śląskim, (Water quality issues discussed in media and the awareness of the problems in Silesian society)
5. Centrum Ekologicznych Technologii, Toalety sortujace (Sorting toilets), 
6. City Farmer, Canada's Office of Urban Agriculture (COUA), Rain Barrels, 
7. Civil and Environmental Engineering, Urban Runoff, 
8. Colorado State University, Overland flow, 
10. Central Statistical Office, Water consumption, 1999, 
12. Central Statistical Office, Information on mean national wages, 2001, 
13. Czapla, B., Ogólna ocena jakości wody do picia w aglomeracji śląskiej (General assessment on potable water quality in Silesian agglomeration), 
14. Danski, M., Green determination of the Silesian Region, 
15. Environmental Protection Agency (EPA), Water Recycling and Reuse: Environmental Benefits, USA, 1998, 
16. Environmental Protection Agency (EPA), How much drinking water do we use in our homes?, USA, 2001, 
17. Environmental Protection Agency (EPA), Health Risk of the Trihalomethanes Found in Drinking Water: Carcinogenic Activity and Interactions, USA, 2000, 
18. Euro statistics (Eurostat), Poland lets polluters pay – progress in defusing environmental hot spots, 2000, 
19. Ferenc, G., Posiedzenie senatu, (Senate Session), 2000, 
21. Gerston, J., Rainwater harvesting a new water source, 
25. Hirotsumi, J., Advanced ozone water treatment technology, 
26. Instytut Meteorologii i Gospodarki Wodnej (IMGW), Biuletyn hydrologiczny (Hydrological Bulletin), 
27. Izba Gospodarcza Wodociagi Polskie, 2000, 
28. Milewska, K., Gospodarka wodna, (Water economy), Rzeczpospolita No. 178, 2000, 
29. Ministry of Environmental Protection, Natural Resources and Forestry; National Environmental Policy of Poland, 
30. Ministry of Environmental Protection, Water Resources and Forestry, Surface waters, 
31. Ministry of Environmental Protection, Water Resources and Forestry, Main types of pressure and 
    influence on Polish environment, 1998, 
    http://www.mos.gov.pl/publikac/Raporty_opracowania/guidelines/wojskoan1.html, assessed September 
32. Potapenko, S., Drinking water chlorination in Ukraine and possible alternatives, 1999 
33. Resource Renewal Institute (RRI), Poland International Aspects of Environmental Policy, 
34. Rocky Mountain Institute, Re-evaulating stormwater. The Nine Mile Run Model for Restorative 
35. Roughing Filter Technology, 2000 
36. Ryymelka, J, Przemysłowe i naturalne zrodła skazienia wod podziemnych i powierzchniowych w 
    aspekcie zaopatrzenia ludnoci w wode do pica (Industrial and natural sources of groundwater 
    contamination in the aspect of urban water provision) 1997, 
    assessed September 2001.
38. UNCHS (Habitat), Water Indicators for Selected Cities and Towns, 1998. 
39. United Nations, Habitat Special Session’s Thematic Committee Examines Environment 
40. United Nations Environmental Programme (UNEP), Sourcebook of Alternative Technologies for Freshwater 
    Augmentation in East and Central Europe, 
41. Walker, B., Preparing for the storm: Preserving water resources with stormwater utilities, Policy study No. 275, 
42. Whitelaw, J., Groundwater Remediation Project to Focus on Katowice, UNEP – IETC Newsletter, June 1998, 
43. Water Supply and Sanitation Collaborative Council, Water Demand Management and Conservation, 2000, 
9. Appendix 1

Comparison of the water quality standards set by the Polish legislation [NMAC – national maximum admissible concentration], the EU directives [MAC-maximum admissible concentration, G – guide] and WHO requirements [GV – guideline value].

A. Organoleptic (aesthetic parameters)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNIT OF MEASUREMENT</th>
<th>POLAND NMAC</th>
<th>THE EU DIRECTIVE</th>
<th>WHO GV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Colour</td>
<td>mg/l Pt - Co</td>
<td>15</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>2 Turbidity</td>
<td>mg/l SiO₂</td>
<td>&lt;1</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>3 Odour</td>
<td>Dilution number at 25°C</td>
<td>Acceptable by consumers</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4 Taste</td>
<td>Dilution number at 25°C</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

B. Physiochemical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit of measurement</th>
<th>Poland NMAC</th>
<th>EU directive</th>
<th>WHO G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Conductivity</td>
<td>µS/cm at 20°C</td>
<td>2500</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
<td>2 Hydrogen ion concentration</td>
<td>pH unit</td>
<td>Min. 6.5</td>
<td>Max. 9.5</td>
<td>Min. 6.5</td>
</tr>
<tr>
<td>3 Temperature</td>
<td>°C</td>
<td>-</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>4 Total hardness</td>
<td>mg CaCO₃/l</td>
<td>60 - 500</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>5 Aluminium</td>
<td>mg Al/l</td>
<td>0.2</td>
<td>0.2</td>
<td>0.05</td>
</tr>
<tr>
<td>6 Ammonium</td>
<td>mg NH₃/l</td>
<td>0.5</td>
<td>0.5</td>
<td>0.05</td>
</tr>
<tr>
<td>7 Arsenic</td>
<td>mg NH₃/l</td>
<td>0.5</td>
<td>0.5</td>
<td>0.05</td>
</tr>
<tr>
<td>8 Barium</td>
<td>µg Ba/l</td>
<td>700</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>9 Benzene</td>
<td>µg/l</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10 Benzo(a)pyrene</td>
<td>µg/l</td>
<td>0.01</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11 Boron</td>
<td>µg B/l</td>
<td>1000</td>
<td>-</td>
<td>1000</td>
</tr>
<tr>
<td>12 Cadmium</td>
<td>µg Cd/l</td>
<td>3</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>13 Chloride</td>
<td>µg Cl/l</td>
<td>250</td>
<td>200</td>
<td>25</td>
</tr>
<tr>
<td>14 Chromium</td>
<td>µg Cr/l</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>15 Copper</td>
<td>µg Cu/l</td>
<td>1000</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>16 Cyanides</td>
<td>µg CN/l</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>17 Fluoride</td>
<td>µg F/l</td>
<td>1500</td>
<td>1500</td>
<td>-</td>
</tr>
<tr>
<td>18 Iron</td>
<td>µg Fe/l</td>
<td>200</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>19 Lead</td>
<td>µg Pb/l</td>
<td>10</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>20 Magnesium</td>
<td>mg Mg/l</td>
<td>50</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>21 Mercury</td>
<td>µg Hg/l</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>22 Nickel</td>
<td>µg Ni/l</td>
<td>20</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>
### C. Microbiological parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit of measurement</th>
<th>Poland NMAC</th>
<th>EU directives</th>
<th>WHO GV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NMAC</td>
<td>MAC</td>
<td>G</td>
</tr>
<tr>
<td>1. Total coliforms</td>
<td>No. 100 ml</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2. Faecal coliforms</td>
<td>No.100 ml</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>3. Faecal streptococci</td>
<td>No. 100 ml</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>4. Sulphate reducing clostridia</td>
<td>No 100 ml</td>
<td>0</td>
<td>&lt;1 (No.20 ml)</td>
<td>-</td>
</tr>
<tr>
<td>5. Total bacteria colony counts</td>
<td>No./ml at 37°C</td>
<td>20</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>No./ml at 22°C</td>
<td>100</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

The EC normally sets two standards for parameters in the form of concentrations not to be exceeded. The G value is the guide value, which commission desires Member States to work towards in the long term. In the Drinking Water Directive, the "l value" is called maximum admissible concentration or MAC. National standards must conform to the MAC values, although it is permissible for member states to set stricter standards, which does happen occasionally.
10. Appendix 2

RZGW Katowice
Hydrographic Net

Source: Ministry of Environmental Protection, Natural Resources and Forestry