Anthropogenic Impacts on Environment and Quality of Water Supply

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Summary

Water in the nature is not distributed in sufficient quality and quantity in time and space to meet water demands in line with the requirements for safe drinking water. In the past, water was free for all and one could use it without any restrictions for his needs. Drinking water consumption increases due to the impact of demographic trends and the level of water supply as well as technological and industrial development. Meeting the demands is more difficult because of limited possibilities of increasing food production due to pollution and increasing demands for use of natural resources.

Keywords: anthropogenic activity, drinking water quality, drinking water supply, decrease in water consumption, environment

Introduction

Extensive deforestation associated with the development of agriculture, industry as well as the impact of anthropogenic activity have affected the natural ecosystem and disrupted ecological balance in large areas of the earth. Water and wind erosion become more intensive leading to the increase of land devastation. The impact of human activity on the surrounding environment has not only a local impact, but it is of global character. Intensity of exploitation and utilization of natural resources has also increased. The use of chemicals (fertilizers, pesticides, etc.) in agriculture disrupts biological cycles and may pose a risk to surface and ground water quality.

Water is an indispensable substance for the development of communities. Due to constantly increasing number of world's population the standards of living are higher and thus the demands for drinking water supply increase. The upward trend of water supply requires the operators of public water supply systems to assure sufficient amounts of safe drinking water for public use and to ensure reliable drinking water supply.

Anthropogenic pressures and impacts

World population growth, economic development, intense industrialization as well as development of international trade and human society have taken place to the extent that serious environmental damage and unsustainable exploitation of natural resources have already taken a global scale.

The main anthropogenic sources of pollution include in particular the burning of fossil fuels, transport, industry, agriculture and waste management. Pollutants coming from human activity can damage natural ecosystems in direct or indirect way. The impact on the aquatic environment leads to contamination of surface and ground water resources.

In many cases, surface and groundwater resources are deteriorated to the extent that they cannot be used for supplying the population with drinking water. The figure 1 shows the categories of surface water quality and the figure 2 groundwater quality. There are the following categories regarding pollution:

- Point sources of pollution – pollution from industry, landfills, wastewater discharge, tank leaking, contaminated localities, etc.
- Diffuse sources of pollution – pollution from agglomerations, households, septic tanks, drains, gardens, small farming, sewer system failures, agriculture – animal farming, plant farming (pesticides, fertilizers,...) [20].

Surface water and groundwater resources are classified according to particular quality categories. The quality categories define the purpose for which a given water resource can be used.

Water quality categories:

category 1 – usually suitable for universal purposes, water supply, food industry, recreational use, fish farming, has a valuable landscaping function,

category 2 – usually suitable for the most of purposes, water supply, food industry, recreational use, has a landscaping function,

category 3 – is usually suitable only for industry, conditionally can be used for water supply in the

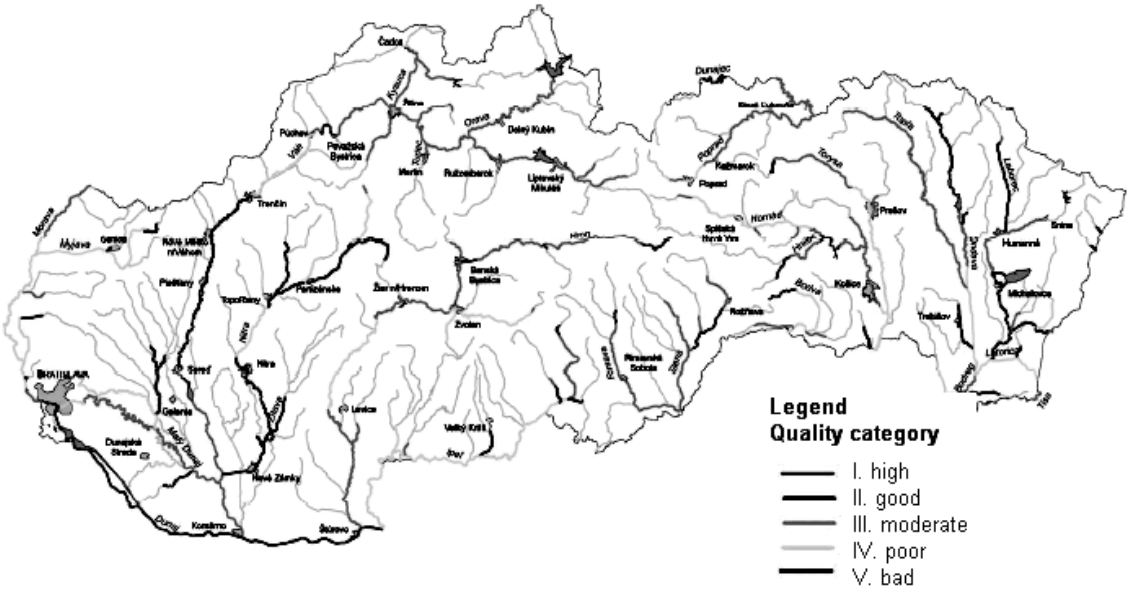

Fig. 1. Map of surface water quality categories [18]

Rys. 1. Mapa wód powierzchniowych z uwzględnieniem klas jakości [18]

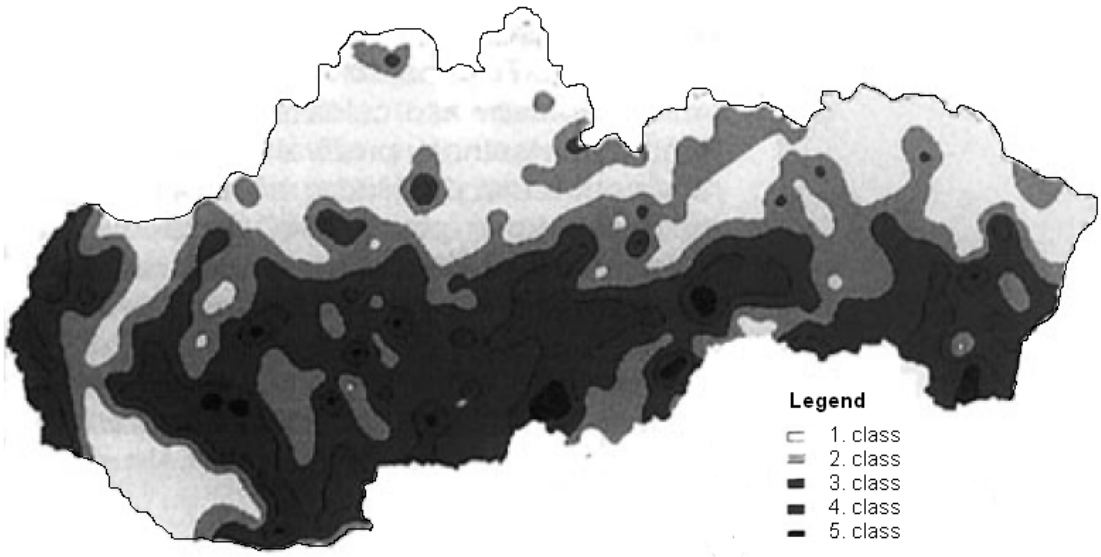

Fig. 2. Map of groundwater quality categories [19]

Rys. 2. Mapa wód gruntowych z uwzględnieniem klas jakości [19]

absence of a source with better water quality (multi-stage treatment required), has a small landscaping function,

category 4 – usually suitable only for some limited purposes,

category 5 – usually unsuitable for any of purposes.

Water demand is determined by the number of population supplied and the specific drinking water demand. Water consumption can be divided according to four main sectors: population, industry, agriculture and civic amenities. Besides historical anthropogenic loads an increasing number of the EU member states suffer from more frequent occurrence of long-term droughts. The figure 3 shows the EU states affected by water scarcity due to climate change. Climate change negatively affecting hydrological cycle and precipitation (drought) will result in increasingly worsening drought periods. The number of areas affected by droughts has increased in the European Union by almost 20%. Reduced availability of safe water has a direct adverse effect on the development of communities and may result in increased water demand and going hand in hand with a growing popu-

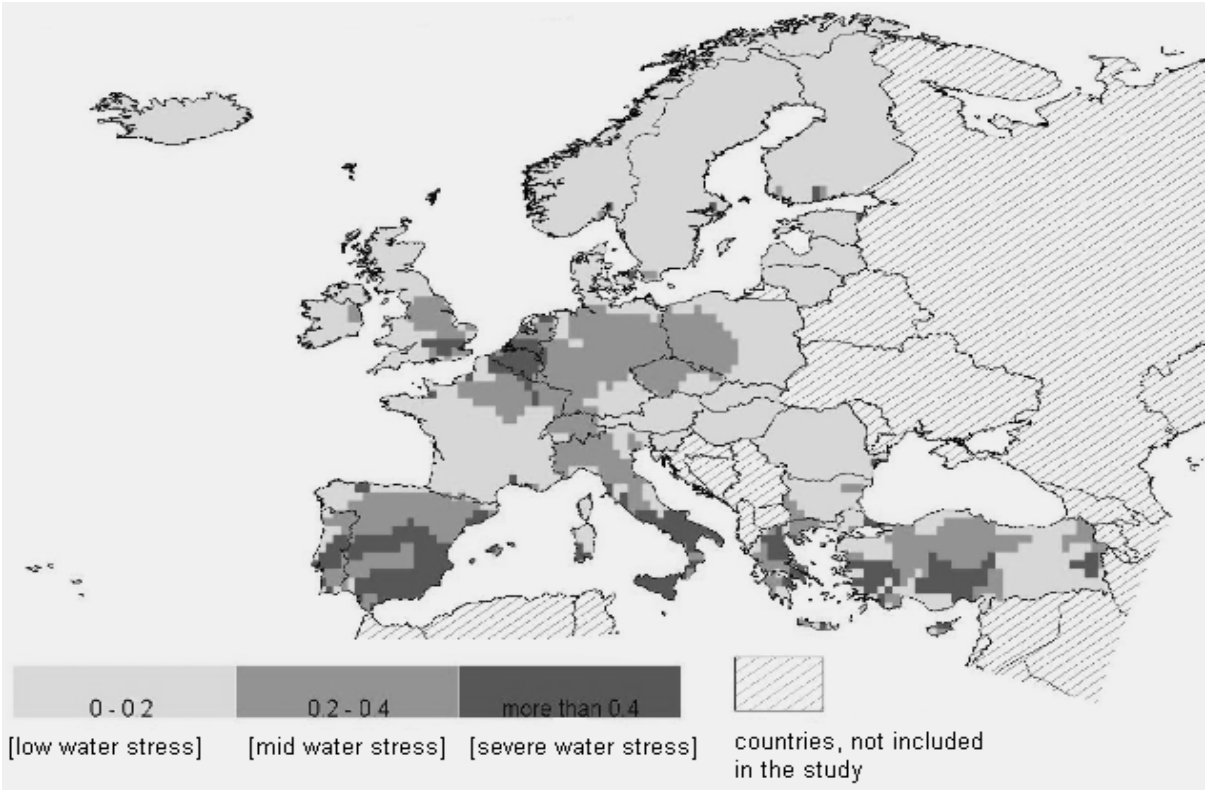

Fig. 3. Water stress areas [1]

Rys. 3. Tereny stresu wodnego [1]

lation it may lead to increased specific consumption. On the contrary, gradual reduction in average water consumption per capita in several regions of Europe has resulted in increasing water tariffs and also growing concern about the events such as droughts and water shortages. In many areas, water consumption decreased to the lower limit of hygienic minimum (80 l per inhabitant a day).

Reducing leaks from drinking water supply systems

Water leaks often called water losses in public water supply are not only technical, but also economic problem. Water supply system may become ineffective and unreliable due to various technical problems which often result in interruptions of water supply and leakage of large volumes of water. Water losses are divided into two groups: apparent losses and leaks (actual losses).

Apparent losses include all types of unauthorized water consumption, including thefts, inaccuracies of water metering devices as well as unethical manipulation of water meters. Water leaks are real losses, consisting of water leaks due to cracks in the pipeline, failures, defects of fitting joints, overflow of storage reservoirs and water tanks [7].

The effort of water supply operators should focus on reducing water leaks up to the limit of unavoidable losses under optimal economic conditions. The real losses (actual leaks) represent the largest share

Table 1. Standard IWA terminology of water balance [6]

Tabela 1. Standardowa terminologia IWA balansu wodnego [6]

System input volume	Authorized consumption	Billed authorized consumption	Billed metered consumption	Revenue water
			Billed unmetered consumption	
		Unbilled authorized consumption	Unbilled metered consumption	Non-revenue water
			Unbilled unmetered consumption	
	Water losses	Apparent losses	Unauthorized consumption	
			Customer metering inaccuracies	
		Real losses	Leakage on distribution system	
			Leakage on service connections	

of water losses in the network. Apparent losses – metering inaccuracies and unauthorized water – consumption represent 8-10% of water intended for consumption. Therefore, the greatest attention is paid to the real losses - leaks. Water loss management is focused mainly on water loss reduction to optimum level. Its activities include the four main areas:

- Pipe material management: Water supply systems are often in operation for many years and in most cases they are not reconstructed / upgraded in the required time frame due to high costs Preventive maintenance and reconstruction of water supply networks are the major factors affecting water leaks in the system. An international survey of IWA (International Water Association) recommends replacing 0.6% of pipes in the network pre year. Practical findings show that leaks occur frequently also at household connections, bringing further problems.
- Pressure management: This relates to the effective management of pressures in the network and is an essential tool for effective water loss management strategy. High pressure conditions in water supply network are probably the most important aspect of pressure control in relation to the management of leakage. Frequent changes in pressure conditions occur in pipeline. The changes lead to higher frequency of failures and water leaks, resulting in a shorter life of pipes.
- Time and quality of failure repairs is the main element of water loss management. The longer water leak lasts the larger volume of water is lost. Three key time factors are the following: time of leak detection, time of leak localization and failure description and time of leak repair.
- Active and passive control of leaks: Passive control includes only detection of failures found by operator during a routine inspection or reported by customers and the public. Active control is the management of water supply where the operator actively searches for leaks and unauthorized consumption. Localization of leakage is precise identification of leak in the section of pipeline network which can be carried out during a routine network inspection or in parts of the network every six months or at least once a year. Monitoring of night discharges is used to obtain information on leaks, allowing operators to prioritize leaks. There are several techniques to detect leaks in the distribution network:
  - District metered area (DMA) – network is divided into smaller areas by installing stop valves as well as discharge and pressure meters (reading sensors) continually recording water flow into a district with defined boundaries.
  - The use of acoustic methods based on listening for and measuring noise level of characteristic frequency occurring due to pipe leaks.
  - Identification of leaks by detecting ballast water in a sewer system.

Reduction in household water consumption

The decrease in water consumption directly in households also plays an important role in the overall water savings. The best known and most effective methods include the following:

Technical modifications in buildings help reduce water consumption more effective use. However, it is important to mention that a large drop in flow rates can cause significant problems and failures of water supply networks. For large pipe diameters (larger volume), the result would be a low discharge leading to the stagnation of zone in sedimentation area and long residence time of water in drinking water supply system. This tends to increase the risk of bacterial growth. In addition, the corrosion and encrustation of metal pipes and equipment occurs more frequently. There can be taken several measures in terms of technological aspects and costs.

Rainwater harvesting process can meet water demand during three fourths of the calendar year. An example might be the United Kingdom, where the savings are between 30–50% of the water used in households. The period for achieving the return on investments in construction of a rainwater collection system is rather long taking into account the price of water for the household in Europe. This causes slow development of systems for using rainwater in households. Far better situation seems for civic amenities, industry or agriculture. The cost of equipment and storage tanks depends on the location of installations (surface and underground) and on the equipment (pumps, etc.) in different categories [13].

Wastewater recycling requires a specific programme for households, which should be defined already during construction and it is quite difficult to apply it to older buildings. Local treatment system will treat “gray water” for further use in gardens and perhaps for toilets or washing. Grey water is the term for wastewater from bathrooms, showers, sinks, washing machines, etc. Water from toilets and kitchens is called “black water” and shall be treated at the wastewater treatment plants. Various studies dealing with water recycling in buildings have shown that the reuse of wastewater requires high investments which may discourage direct use in households. It seems good method for the industry, where water of different quality is used.

Water savings in household equipment – improvement of the technological performance of household

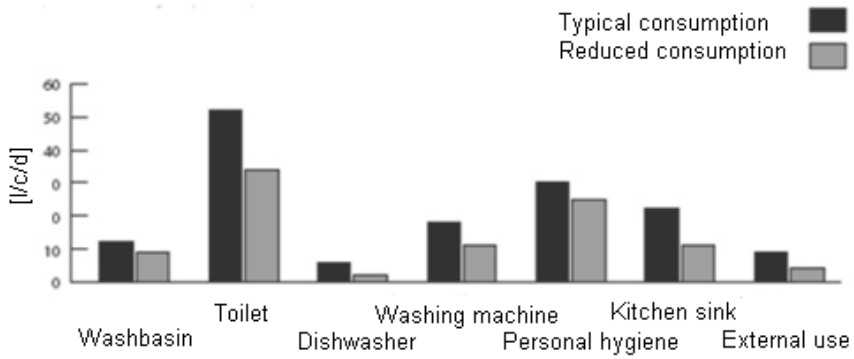

Fig. 4. Potential savings by effective water use (l/household/day) for separate household installations [8]

Rys. 4. Potencjalne oszczędności dzięki zastosowaniu efektywnego użytkowania wody (l/gospodarstwo domowe/dzień) dla poszczególnych instalacji [8]

appliances may reach savings up to 25% of water. A shower can be used as an example of the reduction in water consumption. Replacement of older shower head by a modern one may result in water savings up to 25%. A shower time can be an important factor – when reducing shower time by 1 minute on average, the water consumption decreases by about 17%. Significant water savings could be achieved by replacing older models of toilets which typically use 9–10 liters of water per flush. Modern ultra-low flush toilet can reduce water consumption to 3–6 liters, representing up to 70% of water saving. The figure 4 shows the potential savings that can be achieved at households by efficient use of water.

Measures for tourism are similar to those for households. The potential to increase the efficiency of water consumption can be as follows: installing modern equipment in coffee shops, kitchen facilities and hotel rooms. The period for return on investments in more efficient appliances in accommodation facilities will be 3 years or shorter. More efficient technology or using rainwater for irrigation of golf courses and sports grounds is expected to save up to 70%.

Reduction of water consumption in agriculture and industry

In agriculture, water savings can be achieved by improving irrigation infrastructure and technology. Efficiency of irrigation systems is between 10 and 25% of water abstraction. Water savings resulting from increased efficiency are estimated at 15–60% of the water used. Further savings can be expected by planting plants more resistant to drought and by applying wastewater recycling. The largest water consumers in the industrial sector are paper mills, leather processing and chemical plants as well as food and pharmaceutical industry. More efficient use and recycling of rainwater and treated wastewater are the processes leading to a reduction in water consumption in industrial sectors. We can significantly reduce water consumption in agriculture by introducing new sophisticated technology and active monitoring of water supply system. In case of reducing consumption in the buildings for staff the measures are the same as for households.

Conclusion

Water is one of the basic prerequisites for the health of humans, animals, and plants. Events such as droughts and water scarcity become more frequent. It is therefore an urgent need for action to address these issues and to ensure sustainable future for water resources and water management. The studies on the potential water savings in Europe describe measures to reduce the pressure on water resources without major changes to the standard of living. The measures for reducing water consumption are focused on priority areas, namely households, industry and agriculture. By adopting these rational principles, water savings can reach 40% on average in these areas.

Predicting the future is always a difficult task, especially under the current conditions associated with climate changes and adverse anthropogenic impacts. Overexploitation and pressure on water resources are not sustainable and can have adverse effects on water quality and ecosystems dependent on water. Therefore, it is necessary to reduce demand and increase the efficiency of water use as well as minimize the adverse effect of anthropogenic activity on water resources.

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Wpływ czynników antropogenicznych na środowisko i jakość wody

Woda w przyrodzie nie jest rozprowadzania w odpowiedniej jakości i ilości w czasie i przestrzeni, aby sprostać wymogom bezpieczeństwa wobec niej. W przeszłości woda była darmowa dla wszystkich i każdy mógł używać jej bez jakichkolwiek ograniczeń. Konsumpcja wody pitnej wzrosła ze względu na wpływ tendencji demograficznych oraz poziomu jej zaopatrzenia jak również ze względu na rozwój przemysłu. Sprostanie wymaganiom jest trudniejsze, ponieważ ograniczone są możliwości zwiększenia produkcji jedzenia przez zanieczyszczenia oraz zwiększenia wymagań wobec użycia źródeł naturalnych.

Słowa kluczowe: działalność ludzka, jakość wody pitnej, zaopatrzenie w wodę pitną, spadek spożycia wody, środowisko