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CIVILIZATION AND THE PROBLEM OF WATER MANAGEMENT

The march of civilization has already been assigned a number of indicators. But it may also be measured by the per cent of population making use of a central water supply and/or a central sewer system. These uses are generally associated with urban growth and the degree of industrialization experienced by a given region or country.

The increasing water demand, both in household and industry, makes local resources exhaust within a relatively short period of time. To cope with the problem of water shortage, local authorities usually make economies on supply or avail themselves of alimentation from regions having richer aquifers.

A uniform development of industry covering the whole area of a given country will preclude any water transfer. This should, on one hand, compel the authorities to change their present methods of water management both on the regional and on the national scale and, on the other hand, make them think in the future about the needs of the continent as a whole.

1. INTRODUCTION

It is a well-known fact that in the past decades human activity has dramatically altered the composition of available water resources. On the other hand, water consumption – i.e. the number of population making use of a central water supply and/or a central sewer system – is an important factor to indicate the quality of life. The value of water consumption increases with the increasing degree of industrialization and urban growth experienced by the given country. But even at the present stage of development, the available treatment methods are insufficient to remove all of the pollutants entering the recipient streams. This must lead to a degradation of natural waters, which may go faster or slower, but never stops going on.

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A single use of water for municipal needs brings about a rise in the concentrations of pollutants in the secondary effluent. Here are some measured data:

dry residue	–	100–300 mg/dm^3,
ammonia nitrogen	–	20–40 mg N/dm^3,
nitrates	–	to 20 mg N/dm^3,
chlorides	–	20–50 mg Cl^-/dm^3,
sulphates	–	15–30 mg $SO_4^=$/dm^3,
phosphates	–	to 40 mg P/dm^3,
calcium	–	6–16 mg Ca/dm^3,
magnesium	–	7–19 mg Mg/dm^3,
sodium	–	40–70 mg Na/dm^3.

It is also BOD_5 that persists in the secondary effluent at a concentration of about 30 mg O_2/dm^3. In the remaining BOD_5 the organic pollutants are resistant to a further biochemical degradation. Analytical results show that secondary effluents contain approximately 50% of pollutants (determined as dichromate COD) as nonbiodegradable substances. Secondary effluents discharged into a water-course also include some amounts of surfactants, bacteria and viruses.

What raises serious concern of environmental scientists is the continuous increase of mineral matter and refraction substances in surface waters. In Poland water intakes for municipal supply should meet the requirements of first-class purity. In fact, waters carried by the Vistula upstream of Cracow are classified as unfit for any uses. Average annual concentrations of chlorides measured in the Vistula within the city of Cracow increased from about 46 mg Cl^-/dm^3 in 1934 to 562 mg Cl^-/dm^3 in 1982. The maximum concentration measured for this river was as high as 940 mg Cl^-/dm^3. There is also evidence that chlorides concentration has increased continually in the Odra river since 1908. Thus, the annual concentrations of chlorides recorded in the period of 1908 to 1911 upstream of the city of Wrocław averaged between 30 and 40 mg Cl^-/dm^3 to reach the level of 120 to 180 mg Cl^-/dm^3 (and occasionally far above 800 mg Cl^-/dm^3) in 1979–1982.

The rise in mineral substance content became obvious with the increase of ammonia nitrogen concentration, which varied from 0.5 to 5.0 mg N/dm^3 in the Odra river water a few years ago. The presence of ammonia nitrogen in surface waters should be attributed to the mineralization of organic pollutants entering the recipient together with wastewater discharges and agricultural runoff.

The pollution level found in natural waters depends not only on the purpose for which they are used, but also on the degree of industrialization of the entire catchment area.

2. WATER AND WASTEWATER MANAGEMENT IN INDUSTRIALIZED URBAN AGGLOMERATIONS

Urban growth brought about a concurrent development of central systems for water supply. As a result, water demand for municipal uses increased substantially, and so did the quantity of sewage produced. Urban communities either discharged their sewage into the waterways without any treatment whatever or applied primary treatment only. Figure shows water management practice as it has developed with urban growth since the establishment of municipal water supply systems.

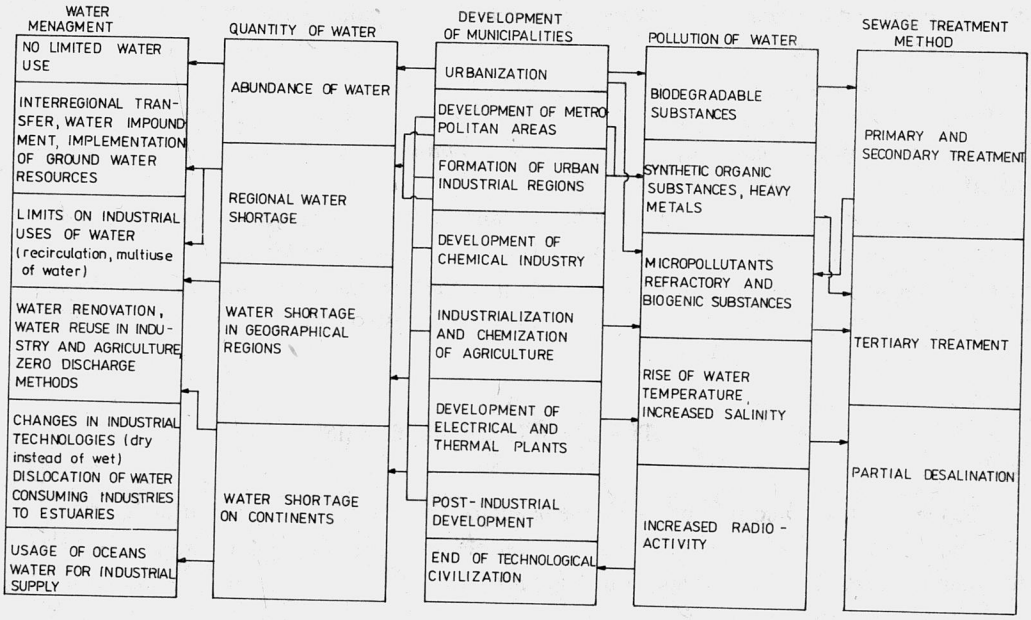

Fig. 1. Implications of urban and industrial development on water pollution and management
Rys. 1. Wpływ rozwoju aglomeracji miejsko-przemysłowych na stan czystości wód i gospodarowanie wodą

As in the initial stage of urban growth water was available in abundance, it was squandered by liberal uses and uncontrolled discharge. Sewage entering the recipient stream accounted primarily for the concentration of biodegradable organic substances. Thus the degree of removal, as well as the admissible pollution load, were determined from the oxygen balance in the river.

At a further stage of urban growth and industrialization, water pollution loads entering the receptors began to carry synthetic compounds and heavy metals in addition to the degradation products coming from the secondary effluents. Those radical changes in the composition of

natural water made the water managers take up the application of advanced treatment methods (III^{o}) in order to remove biogenic substances and prevent algae blooms.

In water management attention should also be given to the ever increasing salinity level. There is an urgent need to desalt brackish waters, especially those discharged into rivers or river sections which are no longer able to absorb salts.

Excess pollution from mineral matter, micropollutants (including refractory substances) and heavy metals raises serious treatment problems and in some instances makes the water unfit for municipal uses. Heated water, discharged principally by the thermal power plants, threatents aquatic life by changing the biocenosis and disturbing the biological balance in the recipient stream to stimulate long-lasting excess blooming.

A major potential hazard to rivers and lakes creates the expanding use of nuclear energy to generate electric power. Thus, the sitting of nuclear power plants (radiation sources) has become an increasing focus of environmental concern.

The growing pollution load experienced by rivers and streams owes its origin to wastewater discharges, agricultural runoff and atmospheric precipitation. These all pose high demands on the efficiency of wastewater treatment plants.

Surface runoff is responsible for water-borne concentrations of biogenic substances, pesticides and herbicides. To reduce the possible side effects of such chemicals entering the environment, it is necessary that fertilizing and spraying processes be modified. This can be achieved by making use of low-solubility fertilizers and biodegradable pesticides or herbicides.

3. WATER SHORTAGE PROBLEMS

The increased water consumption on one hand and the ever increasing pollution level on the other hand account for the abatement of available water resource and, consequently, bring about an increase of water shortage. But the remedy for water deficit seems to lie in the adequacy of the management system.

Regional-scale defficiency can be made up by interregional water transfer regardless of some inherrent disadvantages. To prevent a further shortage it is advisable to make economies on water supply by implementing recirculation systems in industry, by practicing multi-reuses of water or by substituting low-water-demand technologies for obsolete high-water-demand techniques. Storage in lakes or underground reservoires has an important part in water management. That is why attempts should be made to achieve water reserves amounting to about $30^{o}/o$ of the annual discharge in a dry year (in Poland this makes a total of 1×10^{10} m^3).

Despite these efforts, water shortage will continue to increase in the future. The abatement of water deficit can be achieved by several means. Managerial practice of current significance may include one (or a combination) of the following:

1) recirculation of water for reuse in the municipally-industry-agriculture system,

2) water renovation from municipal sewage as a water source for industrial and agricultural needs,

3) application of zero-discharge technologies in those regions where water shortage i particularly severe.

4) sitting of high-water-demand industries at estuaries of rivers or large streams and in coastal regions to enable supply of sea or ocean water in the future.

4. SUMMARY

Urban growth and industrial development are characterized by a concurrent increase of water consumption, a systematic degradation of available water resources and a continuous increase of water shortage.

The methods by which water management has long been practiced should be reconsidered to make appropriate modifications. There is an urgent need of implementing low-water-demand technologies. High-water-demand industries should be located or relocated at estuaries of rivers and in coastal areas to enable water supply from seas and oceans in the future.

The composition of natural waters has changed in the past decades. Undegradable refractory substances, biogenic compounds and heavy metals are becoming increasingly frequent in the recipient streams. The possibility of occasional hot water discharges or radiation exposure (coming from an inappropriate sitting of nuclear facilities) cannot be dismissed, either, even though safety measures are usually taken.

CYWILIZACJA A GOSPODAROWANIE WODĄ

Poziom cywilizacji może być określany na podstawie różnych wskaźników. Jednym z nich jest procent ludności korzystającej z centralnego zaopatrzenia w wodę i z centralnego systemu kanalizacji. Wartości tych wskaźników wiążą się z urbanizacją i uprzemysłowieniem regionu lub kraju. Zwiększone zapotrzebowanie na wodę może być początkowo zaspokajane alimentacją z regionów zasobniejszych, później jednak są konieczne zmiany w systemie gospodarowania wodą.

Zanieczyszczenia wód zmieniają swój charakter przechodząc od związków podatnych na rozkład biochemiczny do związków mineralnych i refrakcyjnych. Powoduje to zmiany w metodach oczyszczania ścieków. Przemysły oparte na technologiach wymagających dużych ilości wody będą musiały być zlokalizowane przy ujściach dużych rzek. W dalszych etapach uprzemysłowienia należy liczyć się z koniecznością wykorzystania do celów przemysłowych wody morskiej.

ZIVILISATION UND WASSERWIRTSCHAFT

Die Zivilisation als Gesamtheit der technisch-kulturellen Einrichtungen lässt sich durch verschiedene Kenngrössen beschreiben. Ein wichtiger Kennwert ist das Prozentverhältnis der Einwohner, die von der Zentral-

wasserversorgung und von dem Zentralkanalisationssystem Gebrauch machen, zu der Gesamtzahl der Bevölkerung. Diese Kenngrössen hängen mit der Entwicklungsstufe der Industrie sowie mit jener des Städtebaus zusammen. Der steigende Wasserverbrauch soll mit Hilfe von Alimentierung aus wasserreichen Gegenden gedeckt werden, solange dieses Reichtum nicht ausgeschöpft ist.

Die Verschmutzung der Gewässer nimmt laufend zu. Man beobachtet seit Jahren eine anwachsende Zufuhr von Mineralstoffen, die sich als biochemisch schwer oder gar unzersetzbar erwiesen haben. Dies führt zu bedenklichen Änderungen in den Reinigungsverfahren. Dazu bedarf es sicherlich einer neuen Lokalisierung jener Industrie, die sich durch grossen Wasserverbrauch auszeichnet (dazu scheinen Flussmündungen vor allem geeignet zu sein). In der Zukunft soll die Industriewasserwirtschaft vom Meereswasser Gebrauch machen.

ЦИВИЛИЗАЦИЯ И ПРОБЛЕМЫ ВЕДЕНИЯ ВОДНОГО ХОЗЯЙСТВА

Уровень цивилизации может определяться на основе разных показателей. Одним из них является процент населения, пользующегося центральным водоснабжением и центральной канализационной системой. Значения этих показателей связаны с урбанизацией и индустриализацией района или страны. Повышенная потребность в воде первоначально может удовлетворяться питанием за счёт более богатых районов, в будущем, однако, необходимы изменения в системе ведения водного хозяйства.

Загрязнения вод меняют свой характер, переходя от восприимчивых к биологическому разложению соединений к минеральным и рефракционным соединениям. Это вызывает изменения в методах очистки сточных вод. Виды промышленности, которые основаны на технологиях требующих большого количества воды, нужно локализировать в устьях больших рек. В дальнейших этапах индустриализации следует учитывать необходимость использования морской воды для проиышленных целей.