define regularities concerning courses of changes of its concentration in water.

Conclusions

Human activities are an important factor modifying magnitude, system and quality of river outflow in the catchment area of Kłodnica. Close correlation between the course of industrial processes within the catchment area and level of transformation of water conditions can be observed.

A clear aspect of anthropogenic changes in river outflow in the catchment area of the river Kłodnica is poor quality of surface waters. The river Kłodnica is highly contaminated. It carries waters that are out of any class of purity over its length. Main impurities that cause such poor quality of waters in this river are: biogenic substances, mineral substances (represented by chlorides and sulphates coming from coal-mine waters drained to Kłodnica and its tributaries) and heavy metal (like lead). The source of contamination of waters in Kłodnica are loads of municipal sewage and industrial wastes coming from industrialised and urbanised areas of western part of Katowice Upland (Wyżyna Katowicka) (e.g. Katowice, Zabrze, Bytom, Gliwice). Salted coal-mine waters are very dangerous for environment. The process of utilisation of such waters is complex and costly. Poor quality of waters in the catchment area of Kłodnica imposes considerations concerning chances of its improvement. Quality of waters in the catchment area of Kłodnica could be improved by reducing amount of loads of wastes drained to the river. Suggested operational rules of the salted water drainage system would be propitious. The system is based on catching particular loads with collectors and transporting them outside the most endangered area thus increasing efficiency of protecting local water intakes. The system of hydrotechnical protection would be based on (Absalon, 1993a): main collectors of salted waters, terminals for each coal-mine and retaining-dosing reservoirs. Other methods of salted water utilisation, i.e. deep or shallow pressing from the surface into the orogen, shallow pressing from exploitation flats or desalinisation are not used or used on small scale in Poland (Jankowski, 1997).

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Artificial water reservoirs in Rawa catchment - qualitative and quantitative changes

Аналізується довготерміновий вплив промислового використання компонентів географічного середовища, яке призвело до його деградації. Головна увага приділяється змінам гідрологічних систем на прикладі річки Равви, де відбулася значна зміна не тільки форми водних резервуарів, а й їх хімічного складу, що викликало формування антропогенного озерного регіону в басейні річки Равва.

Silesian Upland is a part of Silesian & Cracow's Upland (Kondracki, 1994). Within its precincts there is separated a number of mesoregions with the most transformed Katowice Upland. Long economic utilization of components of geographical environment led to its degradation. The most strongly transformed were surface relieves and water relations.

The river basin of Rawa is situated in central part of Katowice Upland in the depression of the erosion gutter cut into Carboniferous rocks stuffed with Pleistocene sediments coming from before Quaternary (Karaś-Brzozowska, 1960). The Rawa lies in the river basin of the Vistula and is a water-race of IV order. The Rawa flows at the heights of 285 m over sea level out of the Marcin pond in Ruda Śląska. The area of the whole river basin equals 89,8 km^2 (Podziai hydrologiczny Polski 1983). The length of watercourse is 19,4 km (Jankowski, 1987).


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The area of Upper Silesia is called an anthropogenic lake district. The name is caused by the fact that there are over 1000 water reservoirs of the joint surface of 4,310.4 ha and of capacities of 201,657,000 m^3 on the area of Upper Silesian Industrial Region (USIR) There fall 2.19 ha of water surface on each square kilometre of ground surface. (Jankowski, 1995).

Anthropogenic water reservoirs in the river basin of Rawa shall be divided on four main types (Jankowski, 1995; Czaja, 1995; Czaja, 1999):

I. Dam Reservoirs

Nowadays dam reservoirs do not perform significant role. At the beginning of 19th century there were about ten water mills (Topographisch militarischer..., 1809) and small factories basing on water wheels on the Rawa and its inflows. The greatest cascade on the Rawa was found near Bogucice, where existed the great ironworks called. Młot Bogucicki (Boguce's Hammer) (Czaja, 1995). Use of steam engines, worsening of sanitary state of watercourses and deterioration of hydrotechnical devices (dykes, weirs) in result of mining damage caused disappearance of dam reservoirs (Czaja, 1999).

II. Reservoirs in subsidence basins and sinks

Anthropogenic reservoirs formed in subsidence basins and sinks are highly labile (Jankowski, 1987). The genesis of these reservoirs is connected with exploitation of deposits of hard coal, in result of which rock mass was violated. Gradual lowering of ceiling of exploited layer leads to depression of ground. As a result of the process there occurred subsidence basins and sinks. Created depressions are filled with waters of underflow or of superficial origin (Czaja, 1995).

III. After Exploitation Reservoirs

Reservoirs in excavations were formed as a result of opencast exploitation of raw materials. In the river basin of Rawa there were exploited with opencast method mostly: hard coal, iron and sand ores, clays, limestones and dolomites (Czaja, 1995). Reservoirs described were formed in the beginning of 20th century and since fifties they are the most numerous group in number and surface (Czaja, 1995).


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IV. Industrial Reservoirs

Industrial reservoirs have small surfaces but are a numerous group. They have been performing significant role from the beginning 20th century (Jankowski, 1996), all connected with industrial plants reservoirs like pit water basins, stower basins, washery effluents, fire protection basins, basins at sewage treatment plants etc are called industrial reservoirs

Water reservoirs are subject of transformations in result of economic performance of human. This appears in the shape of forming and decaying of reservoirs and also in the change of their surface and shape. As the evidence it may be taken the fact that their number increased (from 7th to 12th) and also their surface increased (from 13.36 ha to 30.56 ha) in no longer period than 35 years in the valley of Leśny Potok (Obroślak, 1999). It was caused by sedimentation resulting from exploitation of hard coal deposits.

Together with transformations of surface and shape of reservoirs there changes quality of their of waters. Many of the reservoirs in the river basin of Rawa are receivers of industrial and communal liquid wastes and strongly polluted fall waters (Jankowski, 1995). Pollution of reservoir waters occurs when the content of basic ions exceeds standards (Mielniczuk, Obroślak, 1996).

Investigated waters of reservoirs shall be divided in three groups in respect of their hydrochemical composition:

- Waters of type magnesium – calcium – sulfate – bicarbonate (Dynowski, Gołdyń, 1973) characterized with small conductivity (482 - 641 µS / cm) having included sulfate or chlorine ions proving the anthropogenic influence on transformation of water relations;
- The second type is typical for chemical composition characteristic for natural waters (calcium – bicarbonate or calcium – magnesium bicarbonate) (Dynowski, Gołdyń, 1973);
- Chemical composition of the rest of waters gives proves for pollution from mining waters (high content of chlorine sulfate and sodium ions) electrolytic conductivity of waters in these reservoirs attains considerable values exceeding many times those given by J. Dojlido (1995) for natural waters, and many times greater than in natural waters content of chlorides, sulphates, sodium, calcium and magnet proofs pollution was caused by industrial sewages, mostly mining waters (Mielniczuk, Obroślak, 1996).

The area of Upper Silesia is called an anthropogenic lake district. The name is caused by the fact that there are over 1000 water reservoirs of the joint surface of 4,310.4

ha and of capacities of 201,657,000 m^3 on the area of USIR. There fall 2.19 ha of water surface on each square kilometre of ground surface. (Jankowski, 1995).

Water reservoirs in the river basin of Rawa are of very labile character. Surfaces and shapes of artificial water reservoirs surrender to changes very quickly. When in 18th and 19th centuries dam reservoirs performed the greatest role in the river basins; from the beginning of 20th century so that from the moment of intensifications of anthropogenic transformations of environment, resulting from development of coal mining and progressive industrializations in the region, there have begun to dominate after exploitation reservoirs, and later industrial reservoirs and formed in subsidence basins and sinks. Anthropogenization of natural environment led to transformation of water relations. The quantity and quality of reservoirs have been changed. Most of reservoirs have waters under standards. It has been caused by intensive utilization of geographical environment. Increase of industrial production increasing output of hard coal increased pollutions. There lacked closed technologies and insufficient sewage treatment brought up strong degradation of superficial waters, being a phenomenon in the scale of Europe and the world. Those reason caused the formation of anthropogenic lake district in the river basin of Rawa, where man influenced not only the genesis of reservoirs but also chemical composition of theirs.

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Influence of antropogenic transformation on runoff of Rawa river

Гостро ставиться питання впливу промислового розвитку, нераціонального муніципального використання водних ресурсів на стан річки Равви, яка претерпіла найбільшої трансформації гідрологічної системи в Польщі.

The Rawa is a river with one of the most transformed hydrological systems in Poland. In result of mining exploitation its sources near Chebzie disappeared. There was placed concrete in considerable parts of its riverbed and even covered (Jankowski, 1995). Sewages from numerous service and industrial plants are carried away to the river. Moreover the Rawa is being polluted with municipal sewages from water supply and sewarage plants from Katowice, Chorzyw, Świętochłowice and Ruda Śląska (Obroślak, 1999). The most urbanized area, the Rawa flows through - the downtown of Katowice – there is a subject of ground sedimentation (Ćmiel, 1996). All these factors decide about the transformation of river flow in degree not comparative to other regions of the country.

In 1962 Leś-Rogoż wrote: „... the Rawa on its whole length is a receiver of sewages from 12 mines, 6


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