Westerplatte in Katowice {Fig. 2), what can be an effect of water run away from the riverbed or irregular sewages delivery. The most probable is coexistence of both factors.

Long lasting human activity in Upper Silesian Industrial Region caused transformations of water relations. Modifications forced by anthropopression contributed directly and indirectly to transformations of river outflow. To direct factors forming outflow there shall be included the water – sewage management of industrial factories, municipal management (water intake and delivery) underground water delivery, water overflow and building of the area connected with canalisation nets (Jankowski, 1987). Indirect factors influencing outflow are hydrotechnical works mainly river engineering and depression engineering (Jankowski, 1987).

LITERATURE:

1. Czaja S., 1988: Zmiany stosunków wodnych w zlewni Brynicy w wyniku gospodarczej działalności człowieka. Geographia Studia et dissertationes, t. 11. UŚ. Katowice
2. Ćmiel R., 1996: Degradacja powierzchni górniczych na przykładzie zlewni Rawy, [w:] Problemy środowiska i jego ochrony, Centrum Studiów nad Człowiekiem i Środowiskiem UŚ, Katowice
3. Jankowski A. T., 1987: Wpływ urbanizacji i uprzemysłowienia na zmianę stosunków wodnych w regionie śląskim w świetle dotychczasowych badań. [w:] Geographia Studia et dissertationes, t. 10, UŚ Katowice
4. Jankowski A. T., 1988: Wpływ przemysłu i urbanizacji na zmiany odpływu Rawy (próba oceny), [w:] Dokumentacja Geograficzna IGiPZ PAN, z. 4
5. Jankowski A. T., 1995: Tendencje zmian odpływu rzeki Rawy w warunkach antropopresji górniczej i urbanizacji terenu, [w:] Zagrożenia i szanse gospodarki wodnej, III Konferencja Gospodarki Wodnej, 17-19.10.1995, Ustroń
6. Leś-Rogoż A., 1962: Charakterystyka hydrograficzna GOP, Biul. Komitetu ds. GOP PAN, 64, Warszawa
7. Obroślak Ł., 1999: Wpływ czynników antropogenicznych na kształtowanie warunków hydrologicznych zlewni Rawy, (maszynopis), Katedra Geografii Fizycznej WNoZ UŚ, Sosnowiec
8. Raport o zlewni rzeki Rawy i zagrożeniach wynikających z deformacji górniczych (maszynopis), 1993, RPWiK, Katowice.

Anna Madeksza, Agnieszka Rakowska
Faculty of Earth Sciences, University of Silesia, Sosnowiec, Poland

УДК 504.5 (438)

Reasons for qualitative and quantitative changes in outflows in the catchment area of the river Ruda

Зроблений широкий і глибокий опис гідрологічної системи річки Руди, яка є найбільшим правобережним притоком річки Одри. Проводиться аналіз змін системи, зміни напрямків водних потоків, сезонних зрушень внаслідок трансформації навколишнього середовища. Автори розкривають найвагоміші причини негативного впливу дренажних робіт на рух і якість водних ресурсів Руди.

The river Ruda is the biggest right-bank tributary of the upper part of Oder (Odra) (Jankowski A. T., 1994). Borders of its catchment area are marked by watersheds of 1^{st} or 2^{nd} order, which are merely clear and run through heights of the terrain. Catchment areas of its tributaries are bordered by watersheds of 3^{rd} order *(Mapa hydrograficzna 1:50 000...;* 1987, 1988). The characteristic feature of the right-bank part of the catchment area of Ruda is big afforestation amounting to over 50% of total area in some regions (e.g. Kuźnia Raciborska) (Dulias R., Hibszer A., 1996). The left-bank part of the catchment area has been subject to transformations resulting from anthropogenic factors since 19^{th} century. These transformations, however, have been particularly noticeable since 70s of the previous century, which results from more intense development of the Rybnik Coal Basin (Rybnicki Okręg Węglowy), an industrial centre covering mainly southern and eastern regions of the catchment area, during that time (Madeksza A., 1999). Transformations of particular components of the environment, that occurred, have led to noticeable changes in:

- sculpture of the earth’s surface (waste-dumps, collapse synclines),

- hydrographic conditions (deformations of streams, debasement of class of purity),
- pollution of atmospheric air (excess concentrations of substances in air, e.g. dust, sulphur, carbon dioxide) (Jankowski A. T., 1986),
- transformation of flora (growth of halophilic and ruderal flora) (Absalon D., 1998),
- deterioration of natural resources,
- reduced environmental productivity,
- elements of environment lacking regenerative abilities,
- degradation of aesthetic qualities (Żmuda S., 1973),

However, the essential impact on transformation of elements shaping quantitative and qualitative changes in outflows in the catchment area of the river Ruda comes from:

- transformations of earth's surface,
- transformations of riverbeds,
- anthropogenic water reservoirs,
- water shifts,
- coal-mine waters (Absalon D., 1998).

Excavations and dumps are main examples of anthropogenic transformations of the surface of the terrain in the catchment area of Ruda. The biggest excavations in this region are: an excavation in Żory-Rój, which is used for storing mining wastes (recultivated) and an excavation in a sand-pit in Szczejkowice. Dumps are located within the areas of Chwałowice, Boguszowice and Popielowo (southern districts of Rybnik) and Rydułtowy. Their localisation results in contamination of underground waters and disturbances in water conditions (*Mapa sozologiczna..., 1995a & b).*

In the southern part of the catchment area, there are continuous and discontinuous deformations of the terrain caused by exploitation activities of coal-mines in the ROW region. The processes related to the exploitation result in collapsing of the terrain and, subsequently, in:

- creating collapse synclines,
- flooding the terrain,
- deterioration of elements of the hydrographic network. (Żmuda S., 1973; Jankowski A. T., 1986).

The outside-industry factor contributing to the transformations of the earth's surface is agricultural activities. Hillsides that are composed of poorly penetrable formations are subject to the process of intense mechanical denudation (Absalon D., 1998).

Another important element which is essential for the quality and quantity of outflows from the catchment area of the river Ruda is transformations of riverbeds resulting from flood-control and putting up hydrotechnical structures upon them. Artificial channels, which influence on the course of fluvial processes, have been built on a significant part of Ruda and its tributaries. On the other hand, collapses of the terrain within the riverbeds result in specific overflows, which increases the danger of anthropogenic-type flood within the catchment area of tributaries of the river Ruda.

An integral part of the catchment area of Ruda, which determines the quality and quantity of outflows, is water reservoirs that are mainly of anthropogenic origin. They are connected with human economic activities that have been carried out it that region since old times (13^{th}-14^{th} century). They initially served as fishponds (fishpond agglomerates in the catchment area of Potok Woszczycki and Sumina). With the industrial development in this region (until the early part of 19^{th} century), they were used as sources of energy (Paruszowiec). The importance of the fishponds as sources of energy, however, diminished in the course of time, as coal was used (Kocel K., 1997). They are used in the industry now, for fish-cultures, and, additionally, they also serve the purpose of recreation.

Running towards the south-west, in the middle part of its stream, Ruda flows into Rybnik Reservoir (Zbiornik Rybnicki), which plays an important role in shaping the outflow of the river. Its waters are used in technological processes of Rybnik Power Plant (Elektrownia Rybnik) (chilling the machines). It was created in 1971 by damming up waters of the river. Apart from the purposes mentioned above, it also serves the purposes of fire-prevention and recreation (Jankowski A. T., Kuczera A., 1992).

Apart from Ruda, two streams flow into the reservoir: right-side Grabownia and left-side Gzel. These are tributaries of two side bays (Jankowski A. T., Kuczera A., 1992).

In order to prevent contamination of the reservoir with waters of the river Nacyna, which is the biggest left-bank tributary of Ruda, a pipeline was built which carries its waters behind the front dam in Stodoły (Jankowski A. T., 1986). That river initially flowed into Ruda in Orzepowice. Building a closed piping system was supposed to protect the chilling machines of the Power Plant from its impurities (Jankowski A. T., 1994) (i.e. salinised mining waters and municipal sewage coming from the part of the catchment area that underwent the biggest anthropogenic transformations (Absalon D., 1998)). Unfortunately, the capacity of the pumps is too low and, therefore, they are not able to prevent periodical overflows of impurities from Nacyna to the reservoir, when flows are higher than average (Jankowski A. T., Kuczera A., 1992).

Another element that has an impact on quantitative and qualitative transformation of the outflow of the river Ruda is water shifts. Insufficient local water reserves for municipal and industrial purposes are supported by shifts of potable water from the water-main of Upper-Silesian Water Supplier (Górnośląskie Przedsiębiorstwo Wodne) as well as from the retarding reservoirs in Mikołów (swelled by waters from Goczałkowice Lake (Jezioro Goczałkowickie), Czaniec Lake (Jezioro Czaniec) on the river Soła and Dziećkowice Reservoir (Zbiornik Dziećkowice) swelled by waters shifted from Soła and Skawa). Shifts from the catchment area of the river Vistula (Wisła) amount to 0.90 $m^3 \cdot s^{-1}$ (Absalon D. 1998).

Apart from the shifts from the catchment area of the river Vistula (Wisła), local water-supply systems are operated: in the city of Kuźnia Raciborska, in the commune of Kuźnia Raciborska, Gaszowice and Nędza. Additionally, Łąka Reservoir (Zbiornik Łąka) plays an important role; it is situated on the river Pszczynka and supplies water for industrial companies of ROW (31,000 m^3 x day^{-1}). In spite of measures that have been taken and plans concerning building a surface reservoir in Lyski on the river Sumina and in Gotartowice, an increasing shortage of water is forecast in the catchment area of Ruda.

After use, these waters come directly to Ruda and its tributaries through the 'system' of drainage, reservoirs and sometimes through uncontrolled throws. (Absalon D., 1998).

One more element, which is an important determiner of quality of the outflows from the catchment area of Ruda, is throws of mining waters. The area overlaps 10 mining fields of coal-mines, like Chwałowice, Rymer, Jankowice, Krupiński, Rydułtowy or Żory. Pit waters are carried away to Ruda mainly through the river Nacyna which flows across the oldest and thus the most urbanised regions of the ROW (Absalon D., 1998).

Carrying enormous amounts of highly salinised pit waters directly to the surface river system results in:

- increasing actual river outflow,
- changes in chemical qualities of waters (increase in e.g. chloride and sulphate concentration) and, consequently, deterioration of their purity. (Jankowski A. T., 1986).

Inflow of pit waters into the river Ruda was 0.129 $m^3 \cdot s^{-1}$ in 1994, which was 6.7% of the average flow rate of Ruda in the profile of Ruda Kozielska, and as much as 19.3% in case of the river Nacyna in the profile of Rybnik. The most important role in that case is played by contamination with chloride and sulphate solutions, with waters thrown directly into Ruda including much less chlorides in relation to sulphates. It is contrary in case of waters carried away through the collecting pipes. Mining waters which carry big load of impurities are partly carried away outside the regions that are subject to local protection (e.g. Olza Collector (Kolektor Olza) dating in 1976 carries away 9 mln m^3 saline waters every year). Salinisation of waters may be decreased in the course of time through expulsion from buried saline waters by meteoric waters and mixing of both types of waters (Absalon D., 1998).

In his thesis „Anthropogenic transformations of river outflows in the catchment area of the river Ruda", Absalon claimed that the total outflow from the catchment area of Ruda must have been modified by anthropogenic factors in 70s and 80s of the previous century. Rapid economic development that took place at that time resulted indirectly in changes in stream conditions of Ruda, i.e. disturbances in seasonal course. The influence was equally important yet less intense in 90s because of the economic transformations in Poland, which was related to restrictions in production and exploitation in big, unprofitable industrial plants, including coal-mines. However, restrictions in exploitation are not enough to decrease the pollution level of Ruda and its tributaries. Waters flowing along the length of Ruda are out-class waters, which is caused by mineral substances (chlorides and sulphates), heavy metals (e.g. lead) as well as bacteriologic impurities and biological substances (nitrates and phosphates).

LITERATURE:

1. Absalon D., 1998: *Antropogeniczne zmiany odpływu rzecznego w zlewni Rudy*, Prace Naukowe UŚ, nr 1732, Katowice.
2. Dulias R., Hibszer A., 1996: *Geografia województwa katowickiego*, Wyd. Rożak, Gdańsk.
3. Jankowski A. T., 1986: *Antropogeniczne zmiany stosunków wodnych na obszarze uprzemysławianym i urbanizowanym (na przykładzie Rybnickiego Okręgu Węglowego)*, Prace Naukowe UŚ, nr 868, Katowice.
4. Jankowski A. T., Kuczera A., 1992: *Wpływ zrzutu wód podgrzanych na warunki termiczne, tlenowe i przezroczystość wody w Zbiorniku Rybnickim*, Prace Naukowe UŚ, nr 1300, Katowice.
5. Kocel K, 1997: *Osady denne stawów jako wskaźnik zmian zaistniałych w środowisku przyrodniczym doliny Rudy*, [w:] *Scripta Rudensia*, 7. PK CKKRW, Rudy Wielkie, s. 75-84.
6. Madeksza A., 1999: *Charakterystyka wezbrania powodziowego w zlewni rudy w lipcu 1997 roku*, UŚ, WNoZ, Katedra Geografii Fizycznej, (rękopis pracy mgr).
7. *Mapa hydrograficzna w skali 1: 50 000, ark. 531.3 Rybnik*, 1987, GUGiK, Warszawa, OPGK, Poznań.

8. *Mapa hydrograficzna w skali 1: 50 000, ark. 530.2 Kędzierzyn-Koźle, 530.4 Racibórz, Gliwice 531.1*, 1988, GUGiK, Warszawa, OPGK, Poznań.
9. *Mapa sozologiczna Polski w skali 1: 50 000, ark. M- 34-62-A Gliwice*, 1995a, Główny Geodeta Kraju, GEOPOL, Poznań.
10. *Mapa sozologiczna Polski w skali 1: 50 000, ark. M- 34-62-C Rybnik*, 1995a, Główny Geodeta Kraju, GEOPOL, Poznań.
11. Żmuda S., 1973: *Antropogeniczne przeobrażenia środowiska przyrodniczego konurbacji górnośląskiej*, PWN, Warszawa-Krakyw.

Edyta Banicka, Grzegorz Hrymak
Faculty of Earth Science, University of Silesia, Sosnowiec, Poland

УДК 556.55 (438)

Anthropogenic Water Reservoirs and their protection in the Upper-Silesian region

Introduction

The region of Upper Silesia (Górny Śląsk) is situated in the south of Poland and covers Silesian Upland (Wyżyna Śląska) and parts of Racibórz and Oświęcim Basins (Kotlina Raciborska and Kotlina Oświęcimska) (Kondracki, 1998). An extreme concentration of water reservoirs, almost entirely of anthropogenic origin, makes it comparable to areas of the highest agglomeration of lakes, i.e. lake districts. Density of lake distribution in Pomeranian Lake District (Pojezierze Pomorskie), for example, is 0.83 statistical lake per square kilometre (Choiński, 1996), while it is as much as 1.13 statistical lake per km^2 in Upper-Silesian Industrial Region (Górnośląski Okręg Przemysłowy) (GOP) – the economically best-developed part of the province (Rzętała, 1998). The reservoirs resemble lakes characteristic for late-glacial areas, what differentiates them from the latter, however is their great variability of occurrence in place and time. (Jankowski, 1995; Rzętała, 1998). It might seem that such a concentration of 'lakes' results in big environmental differentiation of the region and possibilities of rest and recreation for the inhabitants of the agglomeration. Actually, it is quite contrary. Water concentrating in collapse ponds is usually highly contaminated by a number of chemical substances coming from industrial wastes, municipal sewage, groundwater flows or dry and wet precipitation of atmospheric contamination (Kosterski, 1974). Nevertheless, there are some man-made reservoirs of high landscape or environmental quality in the Upper-Silesian (Górny Śląsk) region. While valorising only Dąbrowa Górnicza, Celiński et al. (1996) listed over 50 species of protected plants (there are 47 in Białowieża National Park (Białowieski Park Narodowy)), many of which grow in water-marsh, water-land and water environment. Some of these reservoirs are protected by law, many of them are subject to recultivation, others have special qualities but are endangered by man. The aim of this paper is to present a unique character as well as a need to protect some of the anthropogenic water reservoirs.


Edyta Banicka


Grzegorz Hrymak

Genesis of water reservoirs

In 1993, there were 1482 water reservoirs in the GOP area; their total area was 1659.9 ha and capacity 35.58 million m^3. Small reservoirs of areas less than 1 ha each prevailed among them (81.2% of total number). They constituted 19.5% of total area of the reservoirs and held 9.7% of water retained in that region (Rzętała, 1998). Number of those reservoirs changes constantly, which results from their different origins and destinations.

A. T. Jankowski carried out a genesis-based classification of the reservoirs in 1986. He differentiated four types of them. First type is dam reservoirs (I), which were used for economic purposes in mills, sawmills and fishponds – they are now deteriorating to the large extend or being liquidated. Another type (II) is reservoirs in excavations which were created as a result of sand exploitation. Reservoirs in depressions and collapse synclines (III) result from ore exploitations and post-exploitation underground hollows that are created. In that case the surface of the area is deformed as the ground caves in and sinks. This process currently covers as much as 15.3% of the area of the former Katowice Province (wojewydztwo katowickie) (Dwucet, Krajewski, Wach; 1992).

Excavations that have been created in that way are filled with water coming from underground flows or near-surface waters. The remaining reservoirs (IV), which are related to man's intentional activities and involved in production cycle of industrial plants, are classified as