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title: **Impact of urbanization and industry on groundwater resources. Case study of the Silesian-Cracow Triassic aquifer systems (Southern Poland)**

author(s): **Andrzej Kowalczyk**
University of Silesia, Poland, andrzej.kowalczyk@us.edu.pl

Andrzej J. Witkowski
University of Silesia, Poland, andrzej.witkowski@us.edu.pl

Krystyn Rubin
University of Silesia, Poland, krystyn.rubin@us.edu.pl

Janusz Kropka
University of Silesia, Poland, janusz.kropka@us.edu.pl

Hanna Rubin
University of Silesia, Poland, hanna.rubin@us.edu.pl

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The Upper Silesia urban industrial region (southern Poland) constitutes one of the most industrialised areas in Europe. It results from a huge concentration of mineral deposits, including hard coal, zinc and lead ore and other raw materials. The population is about 3.9 million inhabitants within the area of ca 6600 km^2.

Triassic carbonate formation covering the area of about 4000 km^2 is divided into five major aquifer systems (Fig. 1). It is the most important and valuable source of potable water for the Upper-Silesian region.

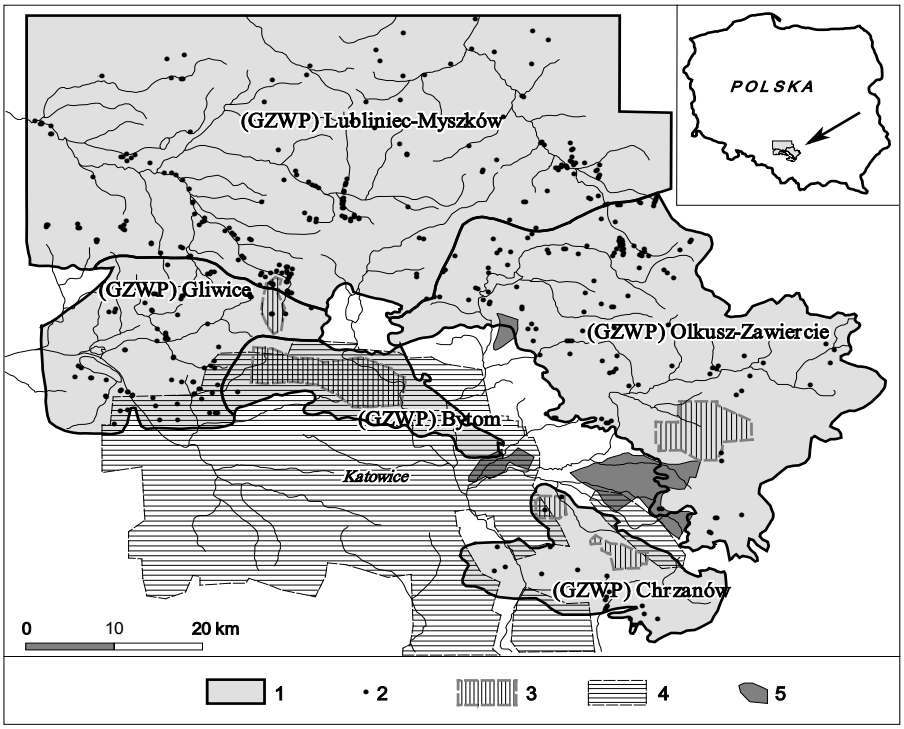

Figure 1. Location of wells and mining areas within the Triassic major aquifers in the Upper Silesia region (Southern Poland). 1 — extend and boundary of the Triassic major aquifer (MA) systems; 2 — wells; 3 — Zn-Pb ore mining areas; 4 — hard coal mining areas; 5 — sand open pits.

Within the Triassic formation there are four regions with Zn-Pb ore mining activity in the Middle Triassic beds, and within two of them there is the system of two-level exploitation of Zn-Pb ores and hard coal deposits in Carboniferous.

There are four major elements of human impact in the area of the Silesian-Cracow Triassic aquifers: long-lasting metal ore mining (underground and surface), intensive groundwater abstraction by mining and well fields, numerous urban-industrial centres, agriculture.

Mining and intensive groundwater abstraction.by well fields have predominated impact on transformation of hydrogeological conditions of the considered area. Urban and industrial areas with compact settlement influenced groundwater are dispersed throughout the whole area.

Through the long industrial history of the region the aquifer systems have been subjected to a significant abstraction by numerous wells and zinc-lead ore mines, still active or abandoned. At the end of the 1990s total abstraction of groundwater ranged from about 9 to 10.6 m^3/s (773 000–893 000 m^3 per day). Consequently, major changes to the groundwater flow systems have occurred. The water table has declined by 40–70 m in well fields and by 100–260 m in mining areas (Kowalczyk, 2003) (Fig. 1).

According to the assessment by means of the mathematical modelling performed for the regional groundwater flow systems the recharge for the whole systems of the main aquifers amounts to 13% and 21% of precipitation. These are areal average recharge rates of the studied areas. For zones of very intensive water drainage by wells and mining where recharge intensification or activation of new sources of recharge takes place the rates of recharge obtained by analytical estimations vary from 20% to 55% of the average annual precipitation (Kowalczyk, Witkowski, 2008). The paper summarizes the changes of groundwater resources due to urban and industrial impact on Triassic carbonate formation taking into account quantity and quality of the groundwater.

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