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Analysis of the impact of industrial activity on the pollution of groundwater environment of the Kamienna River Catchment

Abstract:

The Kamienna River Valley area is situated in the Old Polish Industrial District - the oldest industrial district in Poland. In the older days, it had been characterized by human activity in the field of metallurgy, thanks to the presence of easily accessible iron ore deposits. The first industrial plants were established here in the Middle Ages. Over the years, mining and metallurgy, as well as metal processing, including arms production, were being developed here. Brickyards and sawmills, which provided direct materials and construction support for local factories, were established. Ore mining was gradually abandoned; however, rock mining, including the mining of limestone deposits, and the cement industry continued to develop. The mining industry was responsible for the creation of spoil heaps. Waste generated by large industrial plants was deposited in landfills located in their vicinity. The mechanical, electro-machinery and chemical industries were also strongly developed in this area. The industrial plants, which had existed here for many years, mostly either went bankrupt or were restructured. At present, large post-industrial areas are located in city centres, adversely affecting the environment.

It should be emphasized that the Kamienna River Basin is also a valuable natural area. Nearly 70% of this area is under nature protection within the boundaries of reserves, landscape parks and the National Park. Additionally, about 40% of the catchment area is located within the range of a major groundwater basin requiring special protection. These reservoirs are generally non-isolated and the estimated time of vertical migration of possible contaminants from the ground surface to the aquifer is often shorter than 5 years.

This dissertation attempts to assess the geochemical status of soils, water sediments and waters in the Kamienna Catchment and the changes that have taken place in the soil environment of this area over the last 20 years. This analysis was based on a comparison of study results carried out in the early 1990s for the "Geochemical Atlas of Poland" (Lis, Pasieczna, 1995), with the study results conducted during the development of the topic "Analysis of the impact of waste disposal on the pollution of the groundwater environment of the Kamienna River Basin" in 2009-11.

Awareness about the content of potentially harmful compounds leaching into the groundwater environment in this region should be helpful for the future development of local and regional spatial planning aimed at environmental protection and landscaping. The chemical composition of water and soils depends on a number of both natural and anthropogenic factors. Elevated concentrations of some elements or chemical compounds may be a result of human activity (industry, municipal economy, agriculture), however some may have a natural origin - geogenic, connected to the erosion of outcrops of crumbling rocks, shallow mineral deposits and rock formations characterised by natural, elevated concentrations of some elements.

As part of the work conducted, objects located in the analysis area that constitute potential contamination foci were inventoried. For laboratory studies, 300 soil samples, 50 surface water samples and 49 water sediment samples were taken. The locations from where the soil samples were

taken were chosen so that the results obtained could be compared with the studies carried out in the 1990s. The sampling locations for water sediments and surface water were placed along the banks of the Kamienna River and its tributaries.

The results were statistically analysed using STATISTICA software. Arithmetic and geometric mean, median, minimum and maximum values, and standard deviation were calculated.

Based on the conducted studies, it was found that the contents of most of the elements studied in the soils did not differ when compared to the geochemical background for Poland. Slightly higher values were observed for barium, chromium, titanium and manganese.

In 40% of the soil samples, which underwent a wider range of analyses, increased contents of polycyclic aromatic hydrocarbons were found. Higher contents of mineral oils were present in as many as 83% of the samples.

The average content of individual elements in the studied water sediments were generally lower when compared to the geochemical background for Poland. Higher concentrations were observed for titanium and zinc.

Similarly, the mean concentrations of most compounds and elements were lower than the Polish geochemical background observed in surface water samples. Only in 86% of the samples, the concentration of manganese was higher than the average content of this element observed in the surface waters of Poland.

The spatial distribution of the concentration of particular elements and compounds in the groundwater environment in the studied area is highly complex, resulting from the geological structure of the area, its management and industrial activities. The zones containing elevated concentrations of particular elements are usually concentrated near industrial areas of larger agglomerations: Skarżysko-Kamienna, Starachowice and Ostrowiec Świętokrzyski. Higher iron, lead, mercury, copper and zinc contents are characteristic for areas connected with the mining and processing of iron ore. Increased values of the studied elements were also observed in soil samples taken from the vicinity of waste landfills. Locally, elevated contents of chromium, copper, barium, arsenic, cobalt, nickel, manganese, iron, calcium, magnesium, titanium and vanadium should be related to the metallurgical, mining, chemical and mineral industries and metallurgy, all which had been developed in the discussed area over a long period of time. Intensively developed agriculture, especially in the southern part of the Kamienna Catchment, causes higher concentrations of arsenic, chromium, copper, phosphorus, calcium, magnesium, iron and manganese in soils and chlorides, nitrates, sulphates, boron, calcium, magnesium, potassium and sodium in surface waters. Elevated amounts of chromium, copper, barium, nickel and chlorides are injected into the environment as a result of surface runoffs from urbanized areas and roads.