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Persistent pollution of Warta river catchment with chromium: case study from central Poland

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Upper reaches of the Warta river, the third largest river in Poland, are located in a densely populated and industrialized area, with presence of heavy industry going back to the second half of the XIX century. Industrial activities include iron smelters in towns of Częstochowa and Zawiercie, large chemical plants (Rudniki and Aniolow) producing predominantly chromium compounds, paper and textile industry, as well as large number of small enterprises specialized in metal coatings (nickel and chromium). Until the 1960s all the industrial and municipal effluents in the region were discharged into the Warta river and its tributaries. Solid wastes were dumped on the surface, mostly without appropriate cover and isolation. This resulted in progressive contamination of surface waters and groundwater with heavy metals, mostly chromium.

The upper reaches of the Warta river are located on top of upper Jurassic Major Groundwater Basin (MGWB 326 which is one of four most important groundwater reservoirs in Poland. Almost all potable water demands in the area (ca. 340,000 inhabitants, 800 factories and enterprises) are covered by MGWB 326 (50 deep wells with the average extraction rate of 57,000 m3/d). As the MGWB 326 is mostly phreatic, it has been recognized since long time that persistent pollution of the upper catchment of the Warta river with heavy metals may pose serious thread to quality of this important groundwater resource.

In this presentation we summarize the work carried out to date, focused on characterization of the extent and understanding of the mechanisms of pollution of surface water, sediments and groundwater in MGWB 326 with chromium. Historical monitoring data of the levels of chromium in the Warta river and its tributaries are presented, supplemented by the results of measurements of Cr loads in Warta over-bank deposits and Cr levels in groundwater production wells in the area.

Three conceptual models of spreading of chromium in the catchment of Warta river are considered: (i) leaching of Cr from waste dumps and its migration in local circulation systems with typical spatial scales of several hundred meters to single kilometers, (ii) migration of Cr on large distances (tens of kilometers) through regional, deep circulation systems, and (iii) hyporeic transport of Cr deposited in the past in over-bank sediments of the Warta river and its subsequent leaching to groundwater (spatial scales of several hundred meters to single kilometers). These conceptual models are evaluated on the basis of 3D regional flow and transport model, supplemented by environmental tracers data.

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