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A combined hydrochemical - isotopic approach for assessing the regional pollution of an alluvial aquifer in a urbanized environment

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The alluvial aquifer of the Meuse River is contaminated at regional scale in the urbanized and industrialized area of Liège in Belgium with different types of contaminants, in particular inorganics such as sulfate, nitrate and ammonium. The sources of those contaminants are numerous: brownfields, urban waste water, subsurface acid mine drainage from former coal mines, atmospheric deposits related to pollutants emissions in the atmosphere... Sulfate, nitrate and ammonium are both typical pollutants of the aquifer and tracers of the possible pollution sources.

According to the European legislation on water, groundwater resources should reach a good quality status before 2015. However, an exemption can be obtained if it may be unfeasible or unreasonably expensive to achieve good status. In this case, groundwater quality objectives and management plans can be adapted to these specific conditions. To obtain such an exemption for the Meuse alluvial aquifer, it is required to demonstrate that the poor qualitative status is caused by acid mine drainage, or by widespread historical atmospheric deposition from industries, and not by recent anthropogenic contamination from the urban and industrial context.

In this context, a detailed hydrogeochemical characterization of groundwater has been performed, with the aim of determining the origin of the inorganic contaminations and the main processes contributing to poor groundwater quality. A large hydrochemical sampling campaign was performed, based on 71 selected representative sampling locations, to better characterize the different vectors (end-members) of contamination of the alluvial aquifer and their respective contribution to groundwater contamination in the area. Groundwater samples were collected and analyzed for major and minor compounds and metallic trace elements. The analyses also include stable isotopes in water, sulfate, nitrate, ammonium, boron and strontium.

Different hydrogeochemical approaches are combined to obtain a global understanding of the hydrogeochemical processes at regional scale. Hydrochemical interpretations are based on classical diagrams (e.g. Piper), spatial distribution maps, geochemical equations, multivariate statistics and isotopic analyses. With this combined approach, the location of the contaminant sources and most contaminated sectors of the alluvial aquifer together with a better understanding of geochemical processes involved are obtained.