

Impact of groundwater table fluctuation on pollutant concentrations: how to adapt monitoring strategy to climate change?

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Point sources of contamination frequently impact groundwater quality; for instance, two thirds of industrial contaminated sites in France are concerned by such an impact. Groundwater quality is thus monitored to observe the evolution and degree of impact. Most monitoring protocols correspond to point sampling in conditions of low and high groundwater table (generally early spring and early autumn). Fluctuations of contaminant concentrations, which are sometimes large with unexplained peaks, are regularly observed. It is therefore challenging to assess whether the situation is deteriorating and whether temporary high concentrations have been considered. This leads BRGM to question the current monitoring strategy, as part of its role in supporting local and national authorities by providing methods and tools such as monitoring groundwater quality in the vicinity of contaminated sites. The representativeness of groundwater monitoring downgradient of contaminated sites is more particularly addressed, especially near groundwater catchments for drinking water.

A state of the art and examples of known sites helps address the question. Understanding the relationship between groundwater levels and the fluctuations of pollutant concentrations appears necessary to improve the monitoring strategy. We assume that important concentration fluctuations are associated with extreme climate periods such as heavy droughts, floods or rainy periods. In a context of climate change, these periods are getting more frequent in Europe and worldwide. We also question the representativeness of the sampling period. To achieve this, we compare the sampling dates with the evolution of the groundwater table, looking in particular at lowest and highest levels. We focus more particularly on two pilot sites influenced by groundwater hydrodynamics. The monitoring data, available for several years and including extreme periods, are interpreted in detail. The first pilot site is a former landfill located in Nantes (western France), where the underlying alluvial groundwater is polluted by leaching of waste due to rainwater infiltration. The second example is the catchment area of Lille in northern France: the chalk aquifer (Cretaceous) is strongly influenced by volatile organic compounds emissions from various industrial sites.

The state of the art shows that the evolution of pollutants concentration is mainly explained by physico-chemical changes in the vadose zone of intermittent saturation above the groundwater table. Unusual variations with a very high groundwater table lead to physico-chemical or bio-chemical changes, that in some cases enhance the liberation/mobility of pollutants through desorption or dissolution. Higher groundwater table is considered to occur in early spring. For the last 20 years, these high levels appear however at different times of the year (from December to June), depending on very heavy rainfall or even floods.

These advances should lead to more effective protocols to improve monitoring strategies: Towards warning systems based on piezometric and/or conductivity thresholds, based on continuous monitoring using multi-parameter sensors, particularly upstream of vulnerable receptors such as drinking water catchments. These alerts could also be used to trigger quality monitoring campaigns to facilitate the detection and management of temporary concentration peaks observed at many contaminated sites.