HOW MUCH DOES AIR POLLUTION AFFECT GROUNDWATER QUALITY?

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It is renowned that rainfalls reduce air pollution in the troposphere, since contaminants are captured and dissolved by rain drops or involved in the formation of particulate matter. Consequently, a fraction of rainfalls, enriched in dissolved ions derived from air pollutants, infiltrates through ground surface and migrates through the vadose zone, contributing to groundwater contamination. This means that pollution moves away from air to surface water and, lastly, to groundwater. However, the quantification of the impact of atmospheric pollution on groundwater quality is still uncertain.

The path air–rainfall–infiltration water–groundwater is observed and analyzed in Milan and its surroundings, covering an area of 3000 km², where both urban areas and agricultural activities are extensively present. The reconstruction of the path is carried out following the procedure:

1) Collection of rainfall samples related to the same rainfall event at 12 monitoring points covering the entire study area. Rainfall collection is repeated several times during the year, covering at least the two main rainfall periods in spring and autumn.
2) Chemical analyses of rainfall samples to determine major anion concentrations through ion chromatography (e.g., NO^{3-}, SO_4^{2-}, Cl^{-}).
3) Comparison of rainfall chemistry and air pollution, to evaluate the influence of air pollution on rainfall quality.
4) Implementation of a numerical model to evaluate the amount of contaminant infiltrating through the vadose zone. The numerical model considers different hydrogeological and environmental contexts (i.e., urban and agricultural environments), according to the specific land use and land cover of the various sectors of the study area.

Preliminary results of the first rainfall collections have shown a direct relationship between high levels of air pollutants (NO_2 and SO_2) in the atmosphere and relatively high contaminant concentrations (NO^{3-} and SO_4^{2-}) in rainfall samples. Rainfalls sampled at the beginning of the precipitation, especially after a long dry period, show higher contaminant concentrations respect to those sampled at the end of the precipitation window. Further investigations are necessary to understand the spatial distribution of contaminant concentrations in the study area: a) urban against rural areas; b) proximity to emission sources (e.g., traffic roads, airports); c) evolution of the rainfall event during the sampling period (intensity and wind direction).

The numerical model uses contaminant concentrations obtained through the chemical analyses of rainfall samples to estimate the contaminant concentrations not related to direct sources of contamination (e.g., industrial wastes, leakages from the sewage systems and fertilizers). This allows identifying anthropogenic background values of pollutants in groundwater.