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Multidisciplinary approach in order to study terbuthylazine groundwater contamination in the Lucca aquifer (Italy).

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Since 1998 the herbicide terbuthylazine, an s-triazine, was found in concentration values exceeding the 0.1 µg/L EU drinking limit in pumping wells in the Lucca aquifer (Tuscany, Italy). The Lucca aquifer provides the water resource to the municipalities of Lucca, Pisa, and Livorno (around 300,000 people), by means of 5 well fields located along the Serchio River reach flowing across the aquifer. Initially, it was believed that the application of terbuthylazine for agricultural purposes in the countryside nearby the abstraction areas might be the substantial cause for contamination, posing a threat to the use of the groundwater resource. Hence, an EU LIFE project (LIFE04 ENV/IT/000503) aimed at studying and solving the problem of terbuthylazine contamination at basin scale (Di Bugno et al., 2007).
A multidisciplinary approach was followed involving several activities in order to solve the contamination problem. A set of piezometers were installed in the aquifer and qualitative and quantitative monitoring of groundwater and surface water were performed on monthly bases. Soil analysis, hydrological and hydrogeological investigations were carried out as well as remote sensing land cover survey in order to define catchment characteristics and land use in the study area. A participative approach helped in collecting data from farmers, and an effective communication campaign spread information on the project activities among the public and the private sector. Chemical data were analysed by means of multivariate statistical analysis and groundwater and solute transport numerical modelling (involving advection, dispersion and retardation processes) using GIS tools completed the study (Rossetto & Bockelmann-Evans, 2007).
Intermediate activities focused on the S. Alessio well field and demonstrated that alternative potential diffuse and point sources of groundwater contamination existed, since agriculture (mainly maize crops) and industry (the paper mill sector) used the herbicide in the catchment. Occasional groundwater contamination point source caused by incorrect farming practices were noticed in the area nearby the well field. However, a one-order magnitude larger terbuthylazine contamination was monitored in the Serchio River. Although searched, discharge contaminated outlets along the Serchio River reach were not located. The latter focused the point on the interchange of herbicide mass flux between the river and the aquifer. The numerical model results and hydrological monitoring showed that the bulk of groundwater contamination did not come by means of direct seepage through the unsaturated soil to the aquifer, but was supplied via river leakage. Transit time from surface water to the abstraction wells were estimated in 5 to10 days. The same result was achieved by defining average herbicide mass used for agricultural purposes in the study area. Cluster analysis performed on concentration at the pumping wells highlighted a gradient in the clusterisation according to well distance from the river. Understanding, the source of contamination of the Serchio River surface water was not possible, because at some point of the project all the collected samples (both surface water and groundwater) showed very low values of terbuthylazine concentration (closed to detection limit), preventing any further analysis.
Project results demonstrated the importance of having a complete set of continuous monitoring points for groundwater and surface water in sensitive areas (i.e. abstraction areas) both for chemical and hydrological variables in order to prevent water pollution. Moreover, in mixed urban and agricultural environment it is crucial the investigation of land use in order to compute mass balances and detect possible alternative sources of contamination. Finally, mass flux analysis and numerical modelling may help in defining contamination processes and estimating the extent of contamination.

References

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