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From groundwater baselines to numerical groundwater flow modelling for the Milan metropolitan area

Giovanni B. Crosta (1), Paolo Frattini (1), Lidia Peretti (1), Federica Villa (1), and Maurizio Gorla (2)

(1) Universita' degli Studi di Milano - Bicocca, Earth and Environmental Sciences, Milano, Italy (paolo.frattini@unimib.it), (2) Ufficio Bilancio Idrico e Geologia , Cap Holding, Gruppo Cap, Assago (MI), Italy

Contamination of major aquifers in highly densely populated areas is a major concern for stakeholders involved in the use and protection of groundwater resources. Sustainable groundwater withdrawal and management, and the identification of trends in groundwater contamination require a careful hydrochemical baseline characterization. This characterization is fundamental to investigate the presence and evolutionary trend of contaminants. In fact, it allows recovering and understanding: the spatial-temporal trend of contamination; the relative age of the contamination episodes; the reasons for anomalous behavior of some compounds during migration to and in the groundwater; the associations with which some contaminants can be found; the different behaviors in phreatic and semi-confined and confined aquifers. To attain such a characterization for the Milan metropolitan area (about 2,500 km2, ca 4.000.000 inhabitants, Lombardy, Italy), we carried out three main activities.
(1) Collection of complete and reliable datasets concerning the geological, hydrogeological and hydrochemical (over 60,000 chemical analysis since 2003 to 2013) characteristics of the area and of the involved aquifers. This activity was very demanding because the available data are provided by different authorities (Lombardy Region, Provinces, Lombardy Environmental Agency – ARPA Lombardia, public own companies in charge of water system managements) in raw format and with different database standard, which required a large effort of manual verification and harmonization.
(2) Completion of a hydrochemical characterization of the metropolitan area aquifers by classical statistical and multivariate statistical analyses, in order to define a baseline both for some major physical chemical characteristics and for the most relevant contaminants.
(3) Development of a three dimensional hydrogeological model for the metropolitan area starting from the above listed datasets and existing models. This model will allow for the groundwater flow and transport modeling at the large scale and could be successively linked to some more site-specific transport multi-reactive models focused on the modeling of some specific contaminants.