# Geostatistical Characteristic of Space -Time Variation in Underground Water Selected Quality Parameters in Klodzko Water Intake Area (SW Part of Poland)

Barbara Namysłowska-Wilczyńska

Faculty of Civil Engineering, Wroclaw University of Technology, Poland

This paper presents selected results of research connected with the development of a (3D) geostatistical hydro-geochemical model of the Klodzko Drainage Basin, dedicated to the spatial and time variation in the selected quality parameters of underground water in the Klodzko water intake area (SW part of Poland). The research covers the period 2011÷2012. Spatial analyses of the variation in various quality parameters, i.e, contents of: ammonium ion [gNH4+/m3], $NO_3$- (nitrate ion) [g$NO_3$/m3], PO4-3 (phosphate ion) [gPO4-3/m3], total organic carbon C (TOC) [gC/m3], pH redox potential and temperature C [degrees], were carried out on the basis of the chemical determinations of the quality parameters of underground water samples taken from the wells in the water intake area. Spatial and time variation in the quality parameters was analyzed on the basis of archival data (period 1977÷1999) for 22 (pump and siphon) wells with a depth ranging from 9.5 to 38.0 m b.g.l., later data obtained (November 2011) from tests of water taken from 14 existing wells. The wells were built in the years 1954÷1998. The water abstraction depth (difference between the terrain elevation and the dynamic water table level) is ranged from 276÷286 m a.s.l., with an average of 282.05 m a.s.l. Dynamic water table level is contained between 6.22 m÷16.44 m b.g.l., with a mean value of 9.64 m b.g.l. The latest data (January 2012) acquired from 3 new piezometers, with a depth of 9÷10m, which were made in other locations in the relevant area.

Thematic databases, containing original data on coordinates X, Y (latitude, longitude) and Z (terrain elevation and time – years) and on regionalized variables, i.e. the underground water quality parameters in the Klodzko water intake area determined for different analytical configurations (22 wells, 14 wells, 14 wells + 3 piezometers), were created. Both archival data (acquired in the years 1977÷1999) and the latest data (collected in 2011÷2012) were analyzed. These data were subjected to spatial analyses using statistical and geostatistical methods. The evaluation of basic statistics of the investigated quality parameters, including their histograms of distributions, scatter diagrams between these parameters and also correlation coefficients r were presented in this article. The directional semivariogram function and the ordinary (block) kriging procedure were used to build the 3D geostatistical model. The geostatistical parameters of the theoretical models of directional semivariograms of the studied water quality parameters, calculated along the time interval and along the wells depth (taking into account the terrain elevation), were used in the ordinary (block) kriging estimation. The obtained results of estimation, i.e. block diagrams allowed to determine the levels of increased values Z* of studied underground water quality parameters.

Analysis of the variability in the selected quality parameters of underground water for an analyzed area in Klodzko water intake was enriched by referring to the results of geostatistical studies carried out for underground water quality parameters and also for a treated water and in Klodzko water supply system (iron Fe, manganese Mn, ammonium ion NH4+ contents), discussed in earlier works. Spatial and time variation in the latter-mentioned parameters was analysed on the basis of the data (2007÷2011, 2008÷2011).

Generally, the behaviour of the underground water quality parameters has been found to vary in space and time. Thanks to the spatial analyses of the variation in the quality parameters in the Kłodzko underground water intake area some regularities (trends) in the variation in water quality have been identified.