Title – Influence of tile-drainage on groundwater flow and nitrate transport in heterogeneous geological materials

G. De Schepper & R. Therrien

Department of Geology and Geological Engineering – Université Laval, Quebec City, QC, Canada
guillaume.de-schepper.1@ulaval.ca

JC. Refsgaard
Department of Hydrology – Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark

KEY WORDS               Tile-drainage, HydroGeoSphere, Numerical modeling, Nitrate transport, Heterogeneities

ABSTRACT

Subsurface drainage is a common agricultural practice in poorly drained production fields to guarantee the productivity of crops and to reduce flooding risks. The impact of shallow tile-drainage networks on groundwater flow patterns and associated nitrate transport from the surface needs to be quantified for adequate agricultural management. A challenge is to represent tile-drain networks in numerical models, at the field scale, while accounting for the influence of subsurface heterogeneities on flow and transport.

A numerical model of a tile-drainage system has been developed with the fully integrated HydroGeoSphere model for the Lillebaek catchment, Denmark, where agriculture is widespread. The main modelling objective is to assess the influence of tile drains on the nitrate reduction zone depth, also known as the redox-interface, while accounting for local geological heterogeneities. The Lillebaek catchment is an experimental study area where hydraulic heads, stream and drain discharges, as well as groundwater and surface water nitrate concentrations are regularly measured. Using the national-scale geological model for Denmark combined with available local data, a hydrogeological model at field scale has been generated. A proper representation of the tile-drains geometry is essential in order to calibrate and validate the nitrate transport model. HydroGeoSphere can represent drains directly into a model as one-dimensional features, which however requires a very fine discretization that limits the size of the simulation domain. Because of this limitation, we have tested an alternate approach where the tile-drain network and surrounding porous medium are represented by a dual-continuum formulation, similar to that used to represent fractured porous media, for example. Equivalent properties for the tile-drain network are defined from their geometry and spacing and the dual formulation allows for water and solute exchange between the drains and surrounding soil matrix. This presentation will focus on some preliminary simulations designed to validate the dual-continuum approach to represent tile-drained networks. These simulations are also designed to demonstrate the applicability of the approach for 3D variably-saturated flow and transport modelling at the field scale, accounting for local geological heterogeneities.