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Title : **Modelling of recharge areas and travel time for phreatic groundwater piezometers in Flanders in view of nitrate pollution**.

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Abstract :

Despite strong efforts by both policy makers and farmers to reduce the nitrate concentrations in phreatic groundwater in Flanders, the water quality in many sampling locations of the phreatic groundwater network does not meet the EU standard for nitrate. In 2010 still 35% of the sampling points had a nitrate concentration higher than the limit of 50 mg nitrate per liter, set in the 1991 nitrates directive (91/676/EEG).

A network of circa 2100 sampling locations in Flanders, managed by the Flemish Environmental Agency (VMM), provides up to date information of the chemical quality of the phreatic groundwater. In each location, 3 separate piezometers with filter lengths of 50 cm or 1 m, are installed at three different depths. The first 2 filters were placed to sample the oxic zone of the aquifer and provide information on the amount of nitrate entering the groundwater, whereas the third filter is placed in the reduced zone and provides information on the background concentration of the nitrate. Knowledge on the origin and the travel time of the sampled water can greatly improve the use of this network to model effects of policy measures.

In this study, the recharge area and travel time of the groundwater and the transported nitrate sampled in the first filter of this groundwater sampling network, is determined by means of a simple transport model. This model takes into account the depth of the aquifer, the location of the filter in the aquifer, and distance to the water divide. A map of the groundwater table was obtained through the Bayesian Data Fusion (BDF) framework presented by Bogaert and Fasbender (2007), using a combination of a kriging interpolation and a simple groundwater model.

By means of backward particle tracking, programmed in Matlab, the flow line through each piezometer was calculated, allowing us to determine the location of the infiltration area using a simple equation after Cook and Böhlke (1999).

Deriving the standard deviation of the infiltration point in both longitudinal and lateral direction along the flow line and solving the equation for a bivariate probability distribution, we can delineate an elliptic area with a certain statistical probability around the calculated infiltration point, in which the actual infiltration point is located.

Furthermore the travel time for each of the first filters was calculated. The median travel time was 3.6 years whereas 20% of the piezometers had a travel time longer than 10 years. This result clearly demonstrated that it takes several years to observe the full improvement of groundwater quality resulting from an improved groundwater management policy.