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Upscaling of lysimeter measurements to regional groundwater nitrate distribution

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For many European countries nitrate leaching from the soil zone into the aquifer due to surplus application of mineral fertilizer and animal manure by farmers constitutes the most important threat to groundwater quality. This is a diffuse pollution situation and measures to change agricultural production have to be investigated at the aquifer scale to safeguard drinking water supply from shallow groundwater resources

Lysimeters are state-of-the-art measurements for water and solute fluxes through the unsaturated zone towards groundwater at the point scale, but due to regional heterogeneities (especially concerning soil conditions) lysimeters cannot provide aquifer-wide groundwater recharge and solute leaching. Thus, in this work the numerical simulation model SIMWASER/STOTRASIM (Stenitzer, 1988; Feichtinger, 1998) for quantifying groundwater recharge and nitrate leaching at aquifer scale is applied. Nevertheless, according to Groenendijk et al. (2014) a model calibration by means of lysimeter measurements is essential, since uncalibrated models are generally far from acceptable. Thus, a lysimeter provides the basis for the parameterization of numerical simulation models.

To quantify also the impact on regional nitrate distribution in the groundwater, we couple the unsaturated zone model SIMWASER/STOTRASIM with the saturated groundwater flow and solute transport model FELOW (Diersch, 2009) sequentially. In principal, the problem could be solved by the 3 dimensional equation describing variable saturated groundwater flow and solute transport. However, this is computationally prohibitive due to the temporal and spatial scope of the task, particularly in the framework of running numerous simulations to compromise between conflicting interests (i.e. good groundwater status and high agricultural yield). To account for the unknown regional distribution of crops grown and amount, timing and kind of fertilizers used a stochastic tool (Klammler et al, 2011) is developed that generates sequences of crop rotations derived from municipal statistical data. Required retention and unsaturated hydraulic conductivity curves are derived from information out of the Austrian Soil Mapping (BMLF, 1974) by pedotransferfunctions.

In summary, we present a method to quantify the temporal and spatial nitrate distribution at the aquifer scale with focus on the importance of lysimeter measurements also for modelling issues.

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