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Chalk aquifer is the main water resource for domestic water supply in many parts in northern France. In same basin, groundwater is frequently affected by quality problems concerning nitrates. Often close to or above the drinking water standards, nitrate concentration in groundwater is mainly due to historical agriculture practices, combined with leakage and aquifer recharge through the vadose zone. The complexity of processes occurring into such an environment leads to take into account a lot of knowledge on agronomy, geochemistry and hydrogeology in order to understand, model and predict the spatiotemporal evolution of nitrate content and provide a decision support tool for the water producers and stakeholders.

To succeed in this challenge, conceptual and numerical models representing accurately the Chalk aquifer specificity need to be developed. A multidisciplinary approach is developed to simulate storage and transport from the ground surface until groundwater. This involves a new agronomic module “NITRATE“ (NItrogen TRansfer for Arable soil to groundwaTEr), a soil-crop model allowing to calculate nitrogen mass balance in arable soil, and the “PHREEQC” numerical code for geochemical calculations, both coupled with the 3D transient groundwater numerical code “MARTHE”. Otherwise, new development achieved on MARTHE code allows the use of dual porosity and permeability calculations needed in the fissured Chalk aquifer context. This method concerning the integration of existing multi-disciplinary tools is a real challenge to reduce the number of parameters by selecting the relevant equations and simplifying the equations without altering the signal.

The robustness and the validity of these numerical developments are tested step by step with several simulations constrained by climate forcing, land use and nitrogen inputs over several decades. In the first time, simulations are performed in a 1D vertical unsaturated soil column for representing experimental nitrates vertical soil profiles (0-30m depth experimental measurements in Somme region). In the second time, this approach is used to simulate with a 3D model a drinking water catchment area in order to compared nitrate contents time series calculated and measured in the domestic water pumping well since 1995 (field in northern France – Avre Basin region).

This numerical tool will help the decision-making in all activities in relation with water uses.