Sean Tolle

2. Contact Information

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4. Proposed Research

About 15% of U.S citizens use private drinking water sources.[1] These wells draw water from various groundwater aquifers based on their depths that may be subjected to different levels of nitrate contamination. About 5% of Texas wells exceeded EPA drinking water standard for nitrate (10 mg/L) tested between 1990 and 2007 by Texas Water Development Board (TWDB).[2] Elevated levels of nitrate can cause blue-baby syndrome in infants and long term exposure can cause hemorrhaging of the spleen.[3] The focus on my research is on nitrate contamination of groundwater in the state of Texas as part of a larger NIH project examining the interaction of nitrates, nitrites and nitrosatable drugs on neural tube defects. Nitrate concentration in Texan aquifers can be estimated by combining a solute transport equation such as convection dispersion equation coupled with saturated flow (Darcy based) and unsaturated flow (Richards based) governing equations.

The objective of my proposed research is to model the transport of nitrogen from its sources including agricultural fertilizers applied on the land surface, underground septic tanks, disposal of waste from animal operations, fixation of atmospheric nitrogen, and seepage of nitrate from storage reservoirs and/or rivers, through the vadose zone, and through the aquifer system with advanced modeling and data assimilation systems. I plan to incorporate recent updates in data assimilation and multi-scaling approach to improve the capability of currently available modeling tools for surface and groundwater contaminant transport.

Data assimilation is a technique in modeling which incorporates a process based model results and field measured data to produce an updated model output at each time step which is introduced as input in the next time step for model simulation. This assimilation process improves model predictability by incorporating new observations. My research will use examine the use of several variations of the ensemble Kalman filter (EnKf) for data assimilation. EnKf creates an ensemble of model inputs derived from a distribution function of the parameters, which are modeled in parallel. The ensemble model outputs are updated with measured values with an EnKf filter and the updated values are utilized for inputs for the next time step. Several variations of implicating the EnKf technique were developed in recent years.[4,5,6] Part of my research is determining the EnKf variations that are best suited for vadose zone and groundwater contaminant transport studies.

My research will also examine the use of scaling techniques in modeling. Often, values for a parameter are dependent on the scale the values were measured or modeled. Changing the scale of the model requires that parameters to be up- or down-scaled. Measured data availability can range from point scale measurements like nitrate measurements at a well, to large scale measurements of several kilometers like satellite soil moisture. Using the measured values in

data assimilation requires the observed data be scaled to the modeled scale. My research requires examination of the potential scaling techniques to best predict the subsurface water contamination. My proposed research could be adapted to other contaminants transport with proper adjustments for biogeochemical processes.

6. Funding Purpose

Funding will be used for tuition at the Texas A&M University.

7. Intended Career Path

I intended to pursue a career in research for water and environmental design. I should complete my Ph.D. around 2010. Afterwards, I plan to complete one or two postdoctorates before beginning a career in research as a professor or for a governmental agency.

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[1] EPA. 2002. Drinking Water from Household Wells. EPA 816-K-02-003.

[2] TWDB. 2008. Groundwater Database. Access on 7 Jan 2008. Available at http://www.twdb.state.tx.us/publications/reports/GroundWaterReports/GWDatabaseReports/GWdatabaserpt.htm

[3] EPA. 2006. Consumer Factsheet on: NITRATES/NITRITES. Update last 26 Nov 2006. Available at http://www.epa.gov/OGWDW/contaminants/dw_contamfs/nitrates.html

[4] Evensen, G. 1994. Sequential data assimilation with a nonlinear quasi-geostrophic model using Monte Carlo methods to forecast error statistics. *Journal of Geophysical Research*. 99(C5):10,143-10,162.

[5] Whitaker, J.S. and T.M. Hamill. 2002. Ensemble Data Assimilation without Perturbed Observations. *Monthly Weather Review*. 130:1,913-1,924.

[6] Houtekamer,P.L. and H.L. Mitchell. 2001. A sequential kalman filter for atmospheric data assimilation. *American Meteorological Society.* 129:123-137.