Development of hydrologic processes in the DNDC model to explore beneficial management for reducing nutrient losses from cropping systems

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Abstract

Promoting sustainable agricultural practices that maintain or increase crop yields while limiting negative anthropogenic influences on the environment is an important global research initiative. Biophysical agricultural models are effective science-based management tools for assessing sustainability provided they are frequently updated with our current understanding of the many interlinked environmental processes. In this thesis the widely used DeNitrification DeComposition (DNDC) model was compared to the more hydrologically complex Root Zone Water Quality Model (RZWQM2) to determine which processes were sufficient for simulating water and nitrogen dynamics. Based on these findings a new quasi-2D sub-model for tile drainage, improved water flux, root growth dynamics, and a deeper and heterogeneous soil profile were implemented in DNDC. Simulation of soil water storage, daily water flow and nitrogen loading to tile drains was greatly improved post-development. The revised model was then used to investigate fertilizer management options for reducing N losses over a multi-decadal horizon at locations in eastern Canada and the U.S. Midwest. The assessment helped to distinguish which fertilizer practices are effective in reducing N losses over a long-term time horizon. In addition, modelling methodologies were assessed for simulating the impacts of climate change on cropping systems. The DNDC model proved to be a useful tool for characterizing the feedbacks between climate, soil, crop and management that are critical for accurately assessing crop system behavior.

About the Candidate

Ward graduated with a MSc in Agricultural Engineering from McGill under the supervision of Professor Shiv Prasher. He is currently employed as a Physical Scientist at the Ottawa Research and Development Centre and has continued to expand his understanding of soil hydrology, nutrient cycling and drainage through a PhD under the supervision of Associate Professor Zhiming Qi.