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Regional modelling of nitrate leaching from Swiss organic and conventional cropping systems under climate change

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Organic cropping systems have been promoted as a sustainable alternative to minimize the environmental impacts of conventional practices. Relatively little is known about the potential to reduce NO_3-N leaching through the large-scale adoption of organic practices. Moreover, the potential to mitigate NO_3-N leaching and thus the N pollution under future climate change through organic farming remain unknown and highly uncertain. Here, we compared regional NO_3-N leaching from organic and conventional cropping systems in Switzerland using a terrestrial biogeochemical process-based model DayCent. The objectives of this study are 1) to calibrate and evaluate the model for NO_3-N leaching measured under various management practices from three experiments at two sites in Switzerland; 2) to estimate regional NO_3-N leaching patterns and their spatial uncertainty in conventional and organic cropping systems (with and without cover crops) for future climate change scenario A1B; 3) to explore the sensitivity of NO_3-N leaching to changes in soil and climate variables; and 4) to assess the nitrogen use efficiency for conventional and organic cropping systems with and without cover crops under climate change. The data for model calibration/evaluation were derived from field experiments conducted in Liebefeld (canton Bern) and Eschikon (canton Zürich). These experiments evaluated effects of various cover crops and N fertilizer inputs on NO_3-N leaching. The preliminary results suggest that the model was able to explain 50 to 83% of the inter-annual variability in the measured soil drainage (RMSE from 12.32 to 16.89 cm y-1). The annual NO_3-N leaching was also simulated satisfactory (RMSE = 3.94 to 6.38 g N m-2 y-1), although the model had difficulty to reproduce the inter-annual variability in the NO_3-N leaching losses correctly (R2 = 0.11 to 0.35). Future climate datasets (2010–2099) from the 10 regional climate models (RCM) were used in the simulations. Regional NO_3-N leaching predictions for conventional cropping system with a three years rotation (silage maize, potatoes and winter wheat) in Zurich and Bern cantons varied from 6.30 to 16.89 g N m-2 y-1 over a 30-years period. Further simulations and analyses will follow to provide insights into understanding of driving variables and patterns of N losses by leaching in response to changes from conventional to organic cropping systems, and climate change.