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Large discrepancies on nitrate loading estimates from sparse measurements by SWAT and statistical models at catchment scale

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Nitrogen (N) is one of the major pollutants to aquatic ecosystems. One of the key steps for efficient N reduction management at watershed scale is accurate quantification of N load. High frequency monitoring of stream water N concentration has not been common, and this has largely been the limiting factor for accurate estimation of N loading worldwide. N loads have often been estimated from sparse measurements. The objective of this study was to investigate the performance of the physical-based SWAT (Soil and Water Assessment Tool) model and three commonly used regression methods, namely LI (linear interpolation), WRTDS (Weighted Regression on Time, Discharge, and Season), and the LOADEST (LOAD ESTimator) on estimating nitrate load from sparse measurements through a case study in an agricultural watershed in eastern Canada. The range of daily nitrate load of SWAT and LOADEST was 0.05-1.29 and 0.14 - 1.35 t day^{-1}, compared with 0.13 - 13.08 t day^{-1} and 0.15 - 16.75 t day^{-1} for LI and WRTDS, respectively. Mean daily nitrate load estimated by the four methods followed the order: WRTDS > LI > LOADEST > SWAT. The large discrepancies were mainly occurred during the non-growing season during which there was observation data available. As regression methods use concentration data from dry seasons to estimate the concentrations of wet seasons, there is a strong likelihood of overestimation of nitrate load for wet seasons. The results of this study shed new light on nitrate load estimation under conditions of different data availability. Under situations of limited water quality measurement, policy makers or researchers are likely to benefit from using hydrological models such as SWAT for constituent load estimation. However, the selection of the most appropriate method for load estimation should be seen as a dynamic process, and case by case evaluation is required especially when only sparsely measured data is available. As agri-environmental water quality issues become more pressing, it is critical that data collection strategies that encompass seasonal variation in streamflow and nitrate concentration be employed in regions like Atlantic Canada in the future.