Geophysical Research Abstracts
Vol. 20, EGU2018-9139, 2018
EGU General Assembly 2018

Assessment of high-frequency in situ nitrate and specific conductance data to estimate nitrate loading to streams from three end-member pathways

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The myriad hydrologic and biogeochemical processes taking place in watersheds occurring across space and time are integrated and reflected in the quantity and quality of water in streams and rivers. Collection of high-frequency water quality data with sensors in surface waters provides new opportunities to disentangle these processes and quantify sources and transport of water and solutes in the coupled groundwater-surface water system. A new approach for separating the streamflow hydrograph into three components was developed and coupled with high-frequency specific conductance and nitrate data to estimate time-variable watershed-scale nitrate loading from three end-member pathways - dilute quickflow, concentrated quickflow, and slowflow groundwater - to two streams in central Wisconsin. Time-variable nitrate loads from the three pathways were estimated for periods of up to two years in a groundwater-dominated and a quickflow-dominated stream, using only streamflow and in-stream water quality data. The dilute and concentrated quickflow end-members were distinguished using high-frequency specific conductance data. Results indicate that dilute quickflow contributed less than 5% of the nitrate load at both sites, whereas 89±5% of the nitrate load at the groundwater-dominated stream was from slowflow groundwater, and 84±13% of the nitrate load at the quickflow-dominated stream was from concentrated quickflow. Concentrated quickflow nitrate concentrations varied seasonally at both sites, with peak concentrations in the winter that were 2-3 times greater than minimum concentrations during the growing season. Application of this approach provides an opportunity to assess stream vulnerability to non-point source nitrate loading and expected stream responses to current or changing conditions and practices in watersheds.