Hydrology and Earth System Sciences
An Interactive Open Access Journal of the European Geosciences Union

Hydrol. Earth Syst. Sci., 13, 423-439, 2009
www.hydrol-earth-syst-sci.net/13/423/2009/

Spatial and temporal dynamics of stream chemistry in a forested watershed

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Abstract. Spatial dynamics of solute chemistry and natural abundance isotopes of nitrate (^{15}N and ^{18}O) were examined in seven locations and at the watershed outlet in 2001 and 2002 in a forest watershed in the Adirondack Mountains of New York State, USA. Temporal dynamics were examined during five discharge periods: winter, snowmelt, spring, summer, and fall, based on discharge levels at the watershed outlet. Solute concentrations were variable across space and time with significant ($p \leqslant 0.05$) interaction effects. Year*period was significant for pH, NH_4^+, NO_3^-, total N, DOC, and total Al suggesting that inter-annual variability in discharge levels was more important for these solutes than intra-annual variability. Period*sampling point was significant for pH, Mg^{2+}, Ca^{2+}, sum of base cations, Si, and total Al suggesting that the differences in concentration of these solutes among sampling points were moderated by discharge levels. In general, groundwater sources located in upper watershed controlled stream chemistry at higher elevations with highest pH, Ca^{2+}, sum of base cations, Si, and SO_4^{2-} concentrations, with higher values in summer, and dilution effects during snowmelt. Two low elevation wetlands had a substantial influence over stream chemistry at those locations contributing lowest NO_3^- and highest DOC. Snowmelt exhibited among the lowest pH, sum of base cations, and SO_4^{2-}, and highest NO_3^-, total N, and total Al; snowmelt appeared to dilute groundwater, and flush stored soil-derived solutes. Summer discharge, composed mainly of groundwater, exhibited the lowest flow, among the highest Mg^{2+}, Ca^{2+}, and lowest DON, DOC, and total Al concentrations. Isotopic analysis indicated that NO_3^- was microbial with primary source in upper watershed soil, from where it was flushed to stream under high discharge-conditions, or drained to groundwater which became its secondary source when discharge was low. Watershed outlet did not exhibit specific solute levels found at source-areas, but represented solute dynamics in the rest of the watershed well.

Final Revised Paper (PDF, 1091 KB) Discussion Paper (HESSD)

Citation: Piatek, K. B., Christopher, S. F., and Mitchell, M. J.: Spatial and temporal dynamics of stream chemistry in a forested watershed, Hydrol. Earth Syst. Sci., 13, 423-439, 2009. Bibtex EndNote Reference Manager