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Decadal stream water quality trends under varying climate, land use, and hydrogeochemical setting in, Iowa, USA

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Understanding how nitrogen fluxes respond to changes in agricultural practices and climatic variations is important for improving water quality in agricultural settings. In the central United States, intensification of corn cropping in support of ethanol production led to increases in N application rates in the 2000s during a period including both extreme dry and wet conditions. To examine the effect of these recent changes, a study was conducted on surface water quality in 10 major Iowa Rivers. Long term (∼20 to 30 years) water quality and flow data were analyzed with Weighted Regression on Time, Discharge and Season (WRTDS), a statistical method that provides internally consistent estimates of the concentration history and reveals decadal trends that are independent of random variations of stream flow from seasonal averages. Trends of surface water quality showed constant or decreasing flow-normalized concentrations of nitrate+nitrite-N from 2000 to 2012 in all basins. To evaluate effects of annual discharge and N loading on these trends, multiple conceptual models were developed and calibrated to annual concentrations. The recent declining concentration trends can be attributed to both very high and very low streamflow discharge in the 2000's and to the long (e.g. 8-year) subsurface residence times in some basins. Dilution of surface water nitrate and depletion of stored nitrate may occur in years with very high discharge. Limited transport of N to streams and accumulation of stored N may occur in years with very low discharge. Central Iowa basins showed the greatest reduction in concentrations, likely because extensive tile-drains limit the effective volumes for storage of N and reduce residence times, and because the glacial sediments in these basins promote denitrification. Changes in nitrogen fluxes resulting from ethanol production and other factors will likely be delayed for years or decades in peripheral basins of Iowa, and may be obscured in the central basins where extreme flows strongly affect annual concentration trends.