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Land use change effects on surface and ground water quality in a Midwestern USA critical zone

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Land use changes in the USA Midwest have led to the conversion of ~99% of tallgrass prairies and, thereby, the structure and function of the critical zone including changes in water quality. This study focuses on how differing land use in the watershed affects water flow paths and quality in the Glacier Creek Preserve (GCP), a ~4km^2 preserve near Omaha, Nebraska. Previous work on shallow groundwater indicates shallower recharge flow paths exist under agricultural land compared to prairie because of compaction. Here, we integrate water quality findings from groundwater wells across agricultural and prairie hillslopes and the groundwater-fed stream system that runs through the property. The stream, Glacier Creek, flows ~ 0.5 km from two branches (north/agricultural and south/prairie) that converge and flow another ~0.5 km to Big Papillion Creek. Although GCP was impacted by row crop agriculture starting 150 years ago, the southern half of the property was restored to tallgrass prairie in 1970. Current farm practices on the northern half of the property include the addition of ammonium sulfate fertilizer, as well as various herbicides and pesticides. Unsurprisingly, nitrate concentrations in the groundwater under agricultural land use are greater (avg=57.0 ppm NO_3^-, n=30) than prairie land use (3 ppm, n=21) on the slopes. At the foot slope near the stream, these patterns differ: shallow agricultural groundwater contains less nitrate (1.8 ppm, n=7) than prairie shallow groundwater (14.8 ppm, n=7). Foot slope groundwater nitrate concentrations are consistent with nearby surface water exhibiting higher concentrations in the prairie-draining portion of the stream (9.4 ppm, n=6) compared to the agricultural fork (3.6 ppm, n=5). However, the headwaters of both forks contain negligible nitrate. The mismatch between upgradient and near-stream ground and surface waters may be explained by microbially mediated nitrate reduction coupled to ferrous iron oxidation, though more work is required to substantiate this. Qualitatively, sites of iron precipitation occur along the stream where nitrate is anomalously low given upgradient groundwater conditions. Future work includes characterizing iron content and speciation at these sites to better understand current nutrient cycling.