Nitrate Attenuation Pathways and Capacity in Urban Wetlands of Phoenix, Arizona

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Background

Unmanaged, accidental wetlands have developed in the Salt River channel near downtown Phoenix, Arizona. The ecosystem is fed by nitrogen (N)-rich water supplied by stormwater drains (Fig. 1). We asked, what is the capacity of the wetlands to reduce N concentration?

We examined surface-water (SW) and subsurface porewater (PW) chemistry, incubated soil from dominant wetland vegetation patch types in laboratory microcosms, and conducted field studies using a push-pull method. Our objective was to evaluate potential pathways for nitrate (NO_3^-) transformation and removal.

Figure 2. Sites included in the study had standing water most of the year and supported abundant vegetation, including *L. peoploides* and *T. domingensis*.

Surface-Subsurface Chemistry

We collected samples of SW and PW across two wetland sites and three different patch types (Fig. 2) to determine if conditions for microbial nitrate reduction exist.

Fig. 3: NO_3^- and nitrite (NO_2^-) concentrations were higher in SW water than PW (a, c) while ammonium (NH_4^+) was the opposite (b), suggesting that NO_3^- consumption rate in the PW exceeds rates of both NO_3^- diffusion from SW and nitrification. Dissolved organic carbon (DOC), a microbial C source, was significantly higher in vegetated compared to open patches (d).

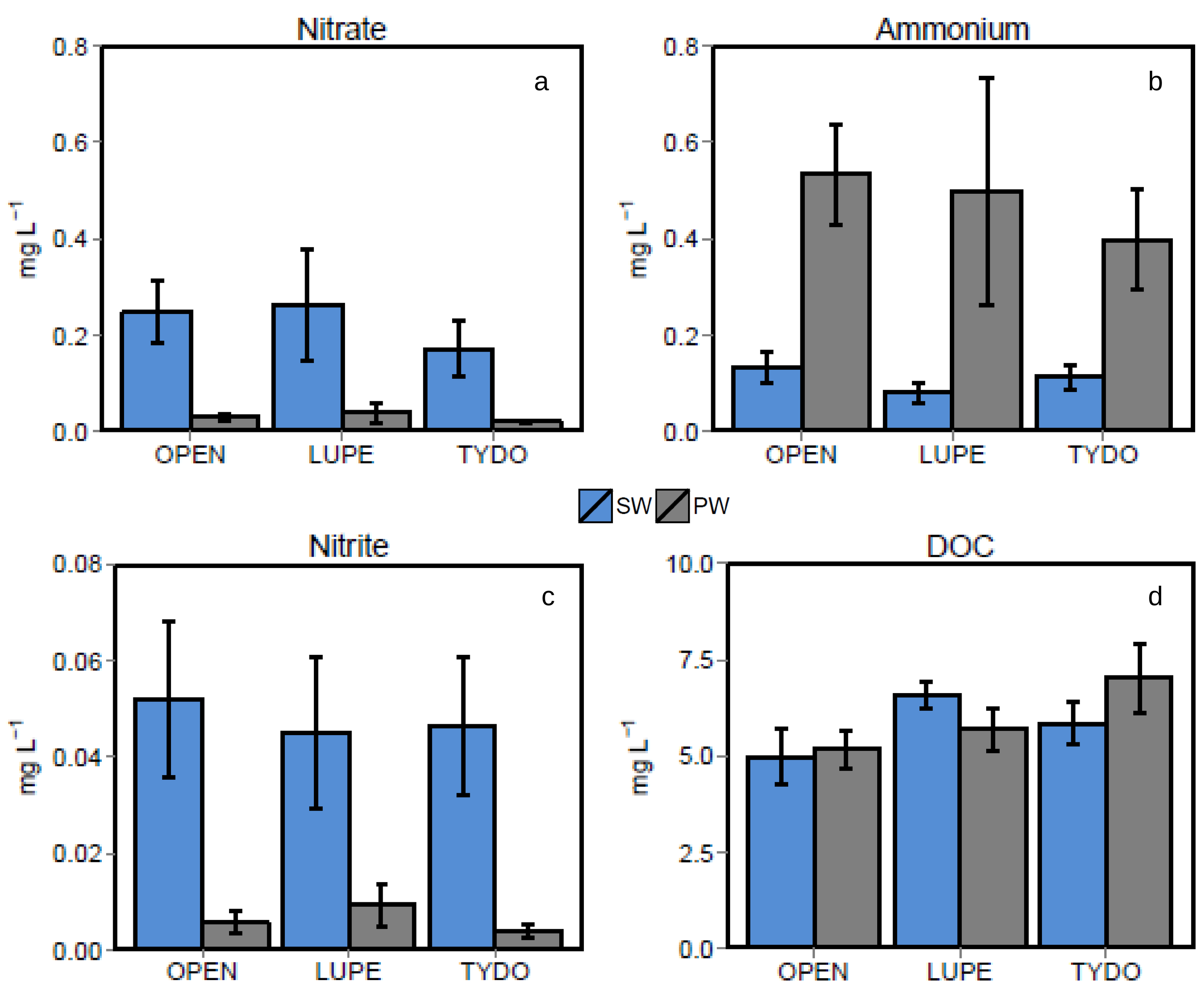

Figure 3.

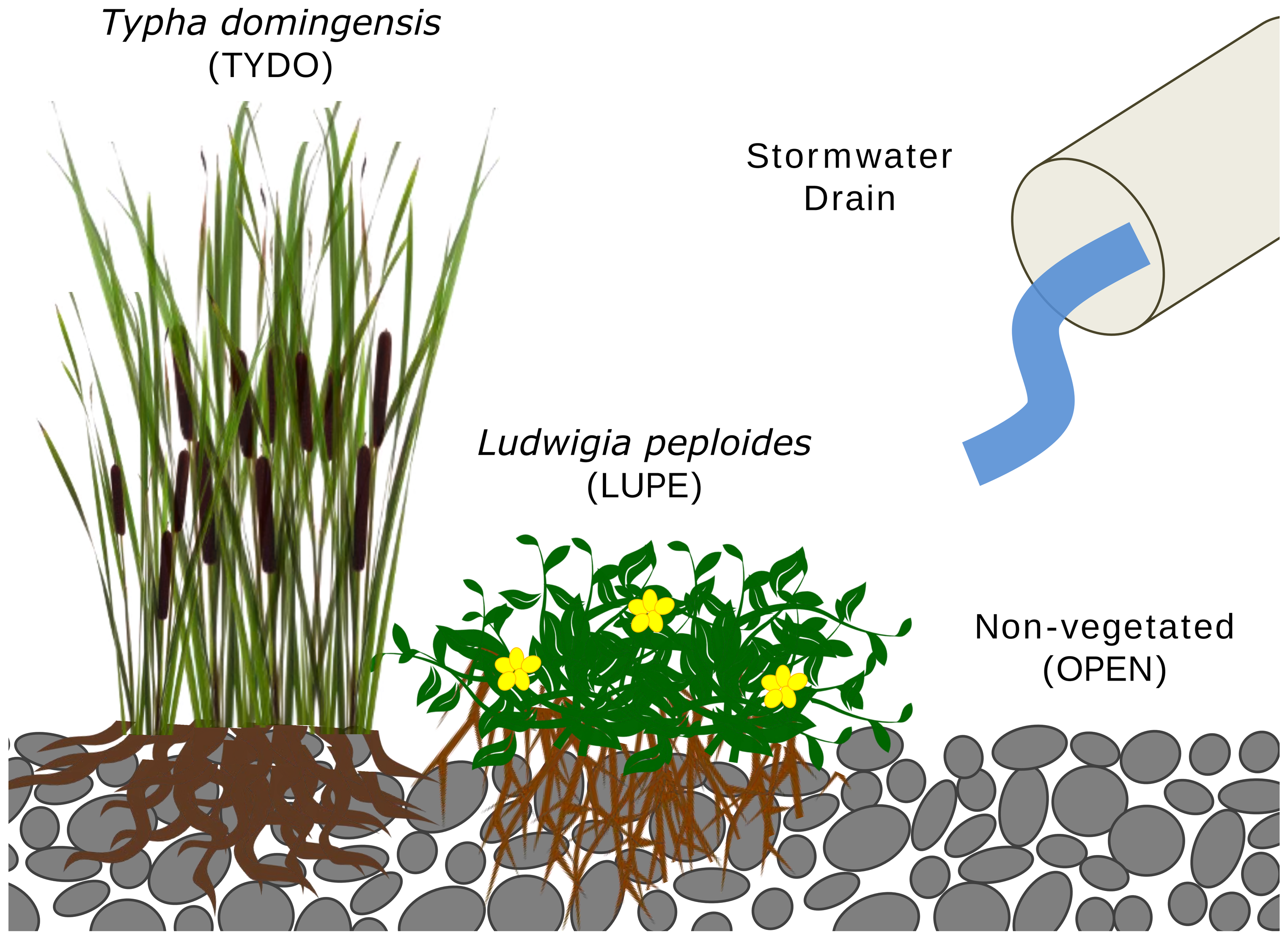

Figure 1. Schematic of the Salt River Wetlands including the major patch types.

Sediment Microcosm Experiment

We conducted 8-hour laboratory microcosm incubations of sediment from the three dominant patch types in the wetlands. We treated microcosms with either a 7 mg L^{-1} (high) or 1 mg L^{-1} (low) ^{15}N-labeled NO_3^- solution to test how different microbial nitrate reduction pathways might be favored under different NO_3^- concentrations (Fig. 4).

Higher NO_3^- loss rates occurred in high-concentration microcosms and in microcosms with sediment from vegetated patches (a). NH_4^+ concentration increased in the high-concentration microcosms in all patch types (b). The $\delta^{15}N$ of the NH_4^+ pool increased more in high-concentration than in low-concentration microcosms, as well as in microcosms with sediment from OPEN patches compared to vegetated patch types (c). DOC concentration varied across patch types and treatment (d).

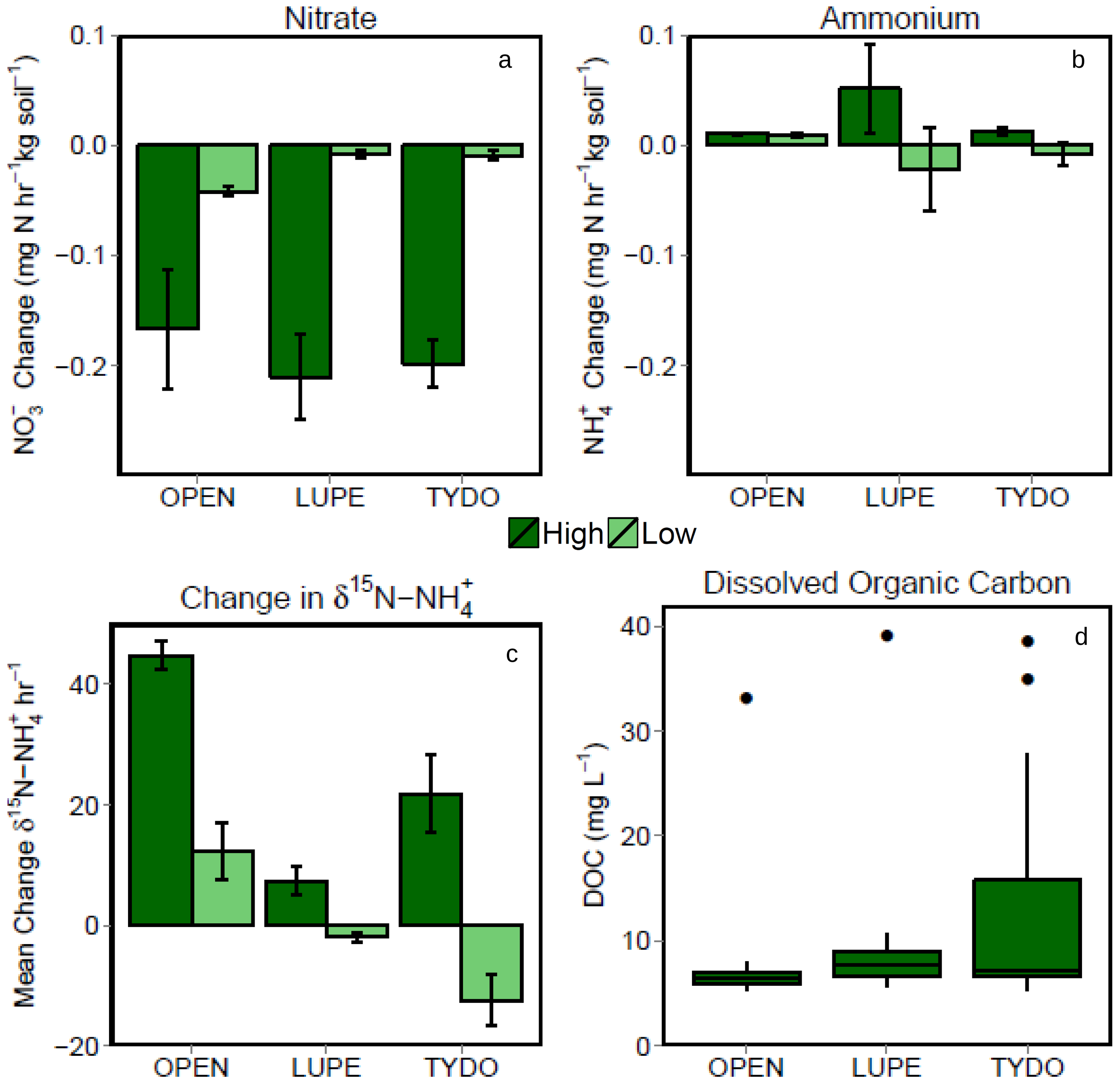

Figure 4.

In-Situ Push-Pull Experiment

We conducted 30-minute *in-situ* incubations of sediment with a ^{15}N-labeled 7 mg L^{-1} NO_3^- solution across two wetland sites and three patch types (Fig. 5).

NH_4^+ concentration increased over the incubation period (a) with a significantly lower rate of increase in the TYDO patches compared to the LUPE and OPEN patches. The added ^{15}N appeared in the NH_4^+ pool (b) suggesting dissimilatory NO3 reduction to NH_4^+ (DNRA).

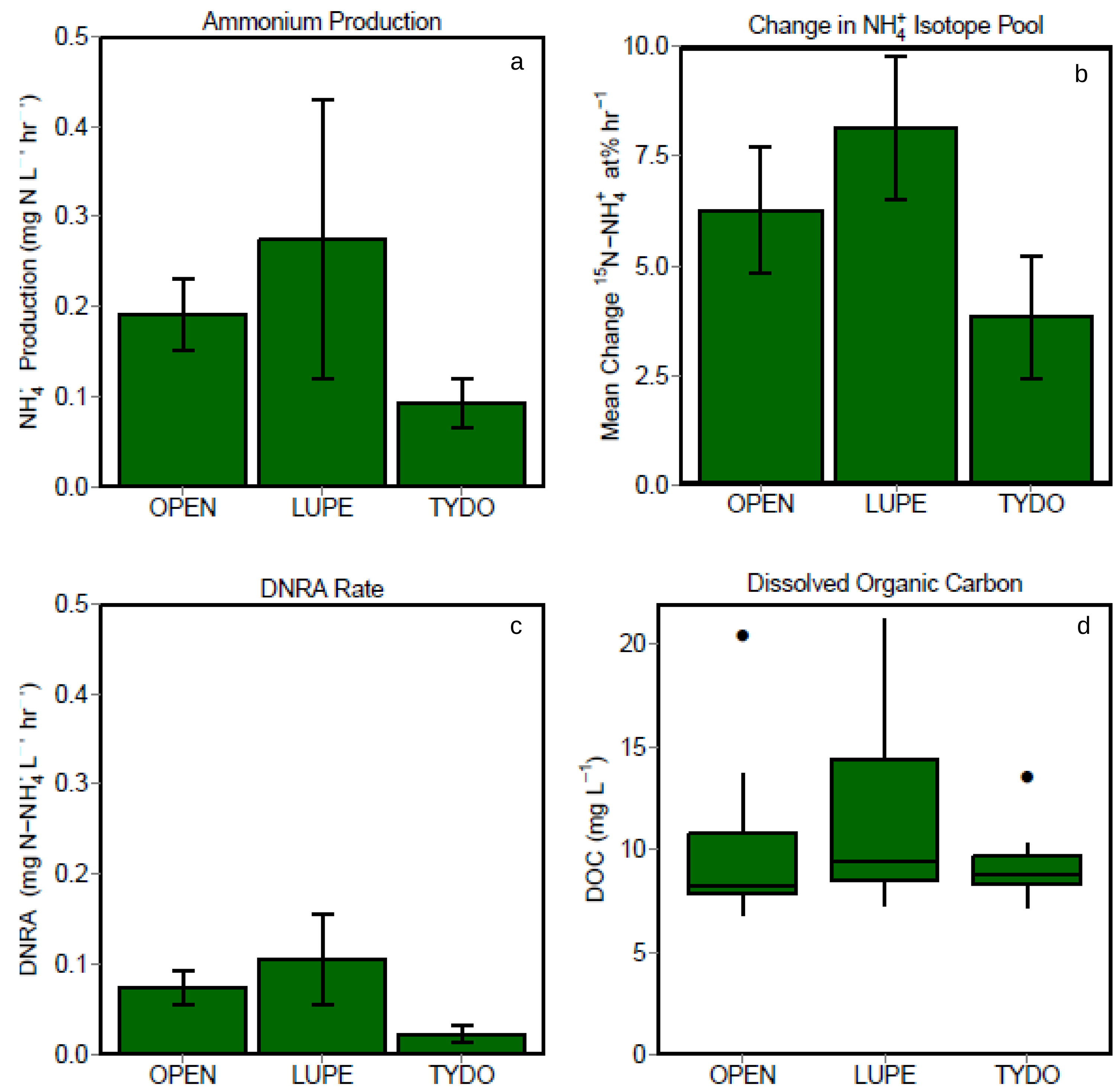

Figure 5.

Overall, DNRA accounted for 39 ± 4% of NH_4^+ production. DNRA rate was significantly lower in the TYDO patches compared to LUPE and OPEN patches and wells with higher DOC (c). DOC concentration did not statistically differ based on patch type (d); however, DOC concentration was significantly higher in one cluster of wells located at the 7th Avenue site.

A map of the "sewershed" draining to each site reveals differences in size and land use (Fig. 6), which may result in different nitrogen attenuation capacities.

Water chemistry of 7th Ave was higher in DOC, but lower in NO_3^-, NO_2^-, and DON (Fig. 7).

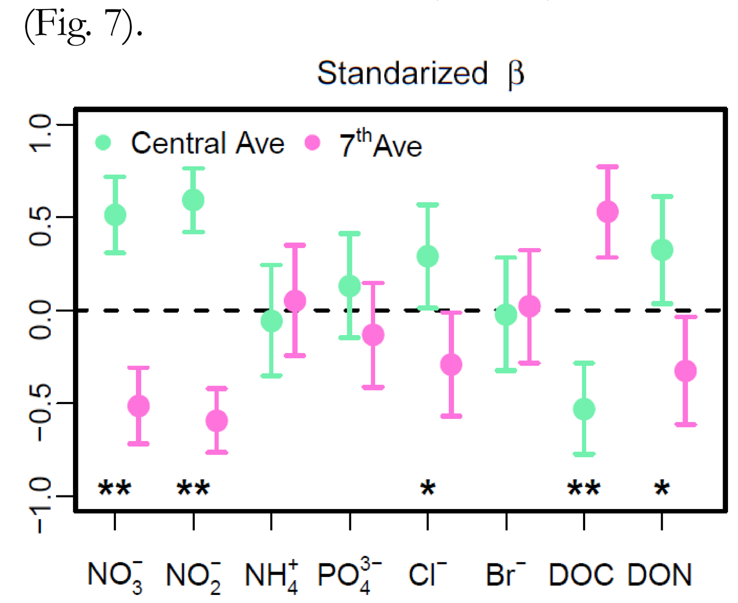

Figure 7. *p<0.05; **p<0.001

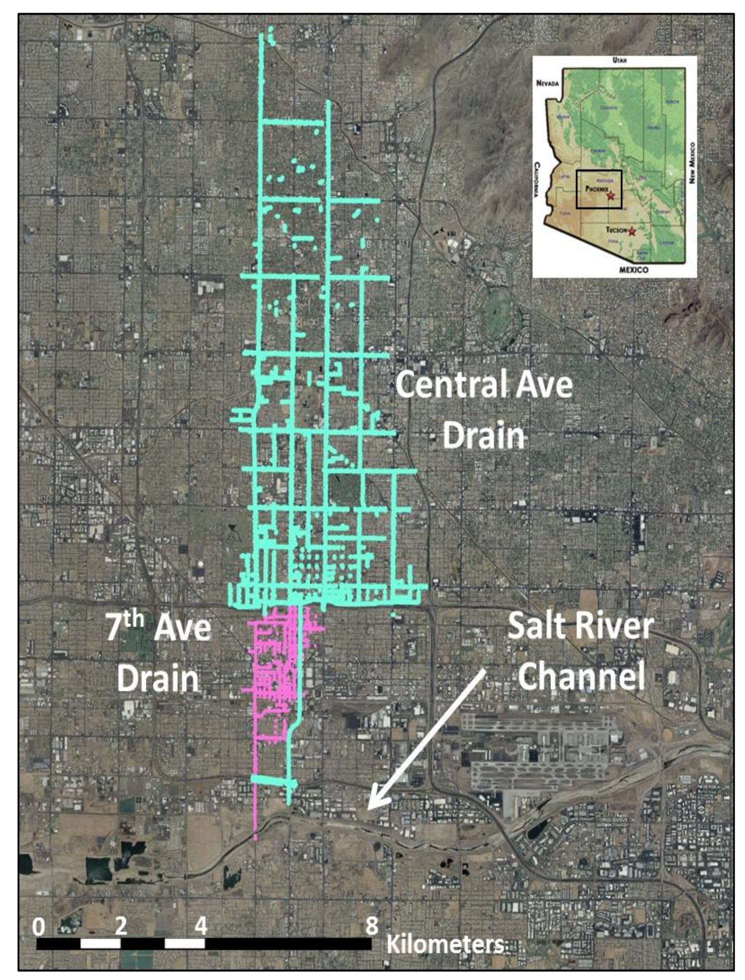

Figure 6. Map credit: M. Palta and R. Madera

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